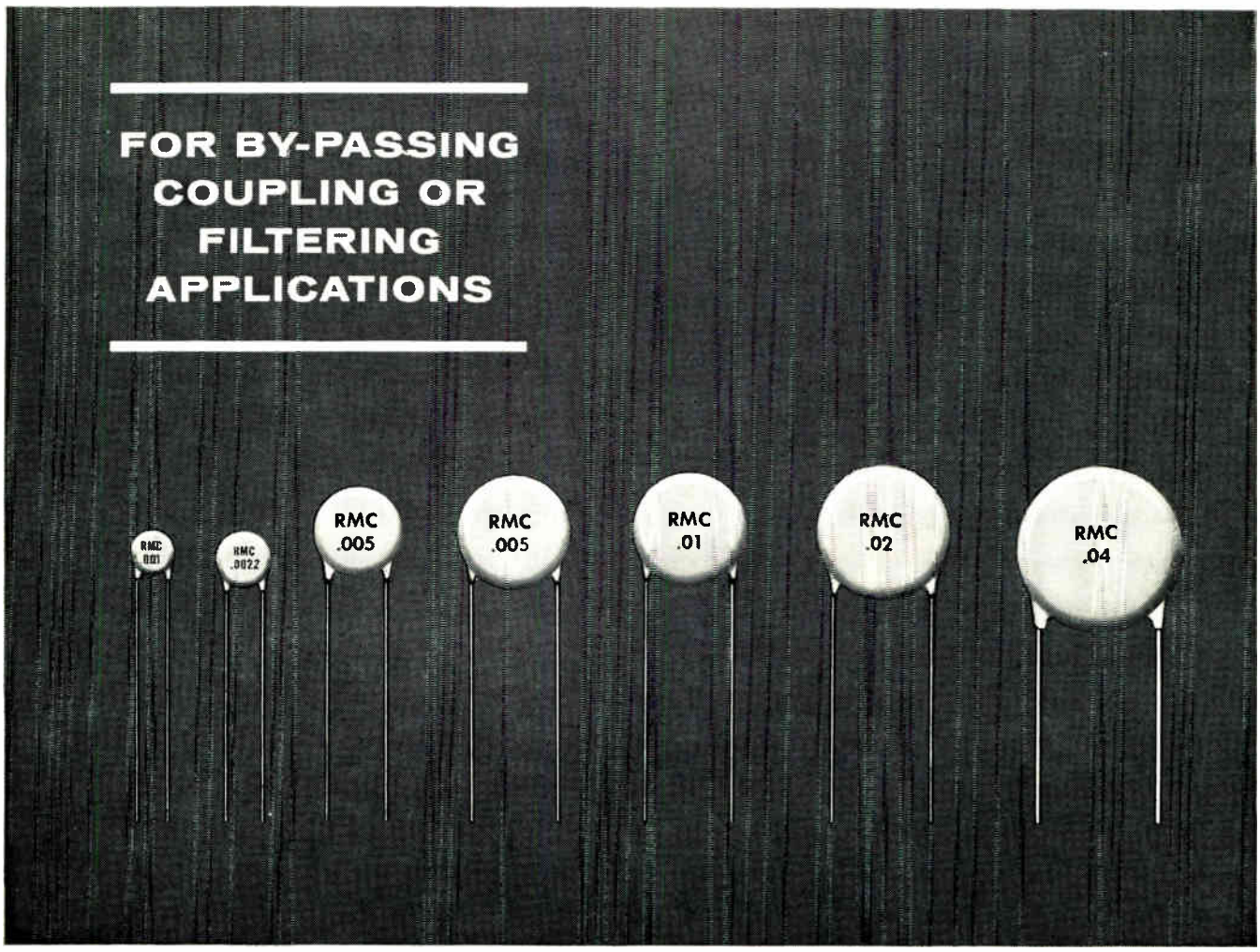
ELECTRONIC INDUSTRIES

NOVEMBER 1963

New developments in laser weapons

Microwave diodes—a progress report

World Radio History



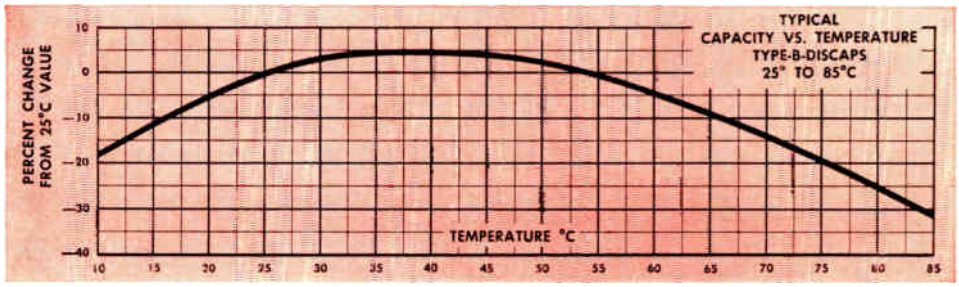
RMC Type B Discaps

Type B DISCAPS meet or exceed all EIA RS-165 specifications for Z5U ceramic capacitors. Manufactured in capacities between .00015 and .04 MFD, Type B DISCAPS are designed for by-passing, coupling or filtering applications.

A heavy ceramic dielectric element provides a safety factor where steady or intermittent high voltages occur. Type B DISCAPS show a minimum capacity change between +10°C and +85°C (see curve).

Type B DISCAPS are rated at 1000 working volts and cost no more than ordinary lighter constructed units.

Write on your letterhead for additional information on RMC DISCAPS.



DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY

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World Radio History

SHELBY A. McMILLION,
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ELECTRONIC INDUSTRIES

RECRUITERS TELL YOUR FUTURE!

THERE WAS A TIME, NOT TOO MANY YEARS AGO, when engineering seemed to be a fairly simple career. You went to school, studied hard, and in due course you got your degree. From there it was a simple matter of picking a good company, learning the basics of design or development, and, with just a little luck, progressing to a fairly challenging and rewarding position.

If you wanted to look a little further, you might see yourself with a small firm of your own—but in any case, the jobs along the way all seemed very interesting and reasonably remunerative.

If you still think that way, take another look. Engineering has changed—a great deal—in these recent years. It's no longer the simple profession that follows naturally from point to point, just so long as you keep your nose to the grindstone. Without knowing it, you can be working yourself right out of a job.

We had our own rude awakening last month when we attended a local "Recruiting Center." It had to do with the story on page 200 of this issue.

For those who haven't been to a recruiting center, it is simply a group of technical recruiters from various companies who have gotten together in some hotel or motel to interview local engineers interested in either finding, or changing jobs. It is all organized by one party, usually an employment agency. The companies pay either a flat fee for participating, or the normal employment fee if they find engineers they want to hire.

In effect, this is the "market place" where engineers with ability to sell are meeting the buyers—the industrial firms looking to hire engineering talent. And like most market places, this is a pretty heartless, dollars-and-cents atmosphere. There is no room for fantasy, nor high flown promises.

Technical recruiters are no-nonsense people who know what they are looking for, and exactly how much money they have to spend to get it.

Some of their judgements are harsh.

We went over some of the resumes with one of the recruiters. He singled one out: "This fellow is riding for a fall. His salary is way ahead of his ability, mainly because he's worked only on military contracts.—Very narrow experience. We wouldn't be interested in him, even if he would take the salary we are offering. We'd figure he was taking the job just till he could find something better.

"The answer for him is to get his Masters, or else get out of design and development work into an allied field—sales or administration."

We picked up another resume, an engineer, who got his BSEE in 1954. He had been involved in a series of layoffs. What did the recruiter think of this? "We don't go along with these stories about layoffs. Maybe it's true, but we figure if he was a good man, they would have found a place for him."

Recruiters also frown on "specialization," though they have a certain sympathy for the problem. Our friend pointed out one resume; an engineer, a B.A. in Physics, over 12 years with one company, working on scanning devices. "This man may be one of the top men in this field, but right now he is just another engineer looking for a job. It may take him months, even years, to find another job like the one he has now. He should have been more alert, kept up his education, at least gotten his Masters. There would be many more jobs open to him."

On the other side, the "specialization" angle has its funny side. Our recruiter friend waved a sheet at us, "Here's a gem! My company wants a physicist, at least an MS, to handle their laser program. The man should have a minimum of four years experience in laser design! Let's see, the first laser was built about four years ago—so there's only one candidate for this job!

—C.M.M.

World Radio History

our stock answer is YES!

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World Radio History

ELECTRONIC INDUSTRIES

November 1963
Vol. 22, No. 11

EDITORIAL FEATURES

DEPARTMENTS

BPA NBP

COVER: Artist's conception of a C-band signal comparator. This comparator feed system forms an integral component of a high-power monopulse radar system. It provides the proper phases and amplitude characteristics for the transmitted and received signals, obtaining optimum tracking accuracy in both elevation and azimuth planes. Our thanks to Gombos Microwave Inc. for their cooperation.

World Radio History

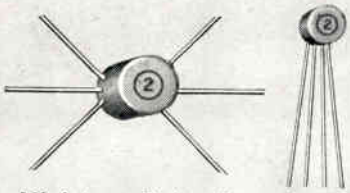
Did you know Sprague makes...?

MAGNETIC LOGIC DEVICES

Core-diode and core transistor magnetic shift registers and magnetic counters for switching and storage applications in computer and logic circuitry.

CIRCLE 131 ON READER SERVICE CARD

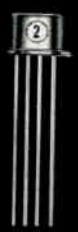
MOLDED PULSE TRANSFORMERS



Miniature Pulse Transformers with tough molded cases for increased protection against physical damage and severe atmospheric conditions.

CIRCLE 132 ON READER SERVICE CARD

NANOSECOND PULSE TRANSFORMERS IN TO-5 TRANSISTOR CASES



Special design offers distinct advantages: (1) Minified size. (2) Welded hermetic seal. (3) Increased reliability. (4) Compatibility with transistor mounting techniques.

CIRCLE 133 ON READER SERVICE CARD

SOMETHING NEW IN COUNTING TECHNIQUES

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CIRCLE 134 ON READER SERVICE CARD

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CIRCLE 136 ON READER SERVICE CARD

HERMETICALLY-SEALED TO-5 ENCASED SWITCH CORES

Designed especially for high-speed, low-power switching up to 100 kc, adaptability with conventional transistor packaging techniques, and performance under MIL-S-21038 environmental conditions.

CIRCLE 135 ON READER SERVICE CARD

ELECTRONIC MODULES TO CUSTOMER REQUIREMENTS

Custom packaging is no novelty at Sprague's Special Products Division, where "specials" are continually being developed and produced with countless variations in electrical characteristics and mechanical configurations.

CIRCLE 137 ON READER SERVICE CARD

For application engineering assistance (without obligation, of course) on any of the above products, write or call the Special Products Division, Sprague Electric Company, 233 Union Street, North Adams, Massachusetts.

<SSP-111-63 R3>

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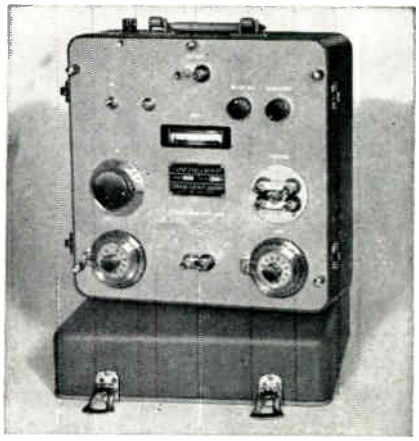
New Bridge Design For Safe, Accurate, Easy Measurement of 'Lytic Capacitors



The Sprague Model 1W2A Capacitance Bridge introduces new, improved technical refinements as well as restyling for added attractiveness and ease of operation. Built *by* capacitor engineers *for* capacitor users, it incorporates the best features of bridges used for many years in Sprague laboratories and production facilities.

Precision Measurements over Entire Range from 0 to 120,000 μF

The internal generator of the 1W2A Bridge is a line-driven frequency converter, and detection is obtained from an internal tuned transistor amplifier-null detector, whose sensitivity increases as the balance point is approached. It has provision for 2-terminal, 3-terminal, and 4-terminal capacitance measurements, which are essential for accurate measurement . . . $\pm 1\%$ of reading $+ 10\mu\mu$F . . . of medium, low, and high capacitance values, respectively.

No Damage to Capacitors

The model 1W2A Capacitance Bridge will not cause degradation or failure in electrolytic or low-voltage ceramic capacitors during test, as is the case in many conventional bridges and test circuits. The 120 cycle A-C voltage, applied to capacitors under test from a built-in source, never exceeds *0.5 volt!* It is usually unnecessary to apply d-c polarizing voltage to electrolytic capacitors because of this safe, low voltage.

Complete Specifications Available

For complete technical data on this precision instrument, write for Engineering Bulletin 90,010A to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

<4SSP-128-63>

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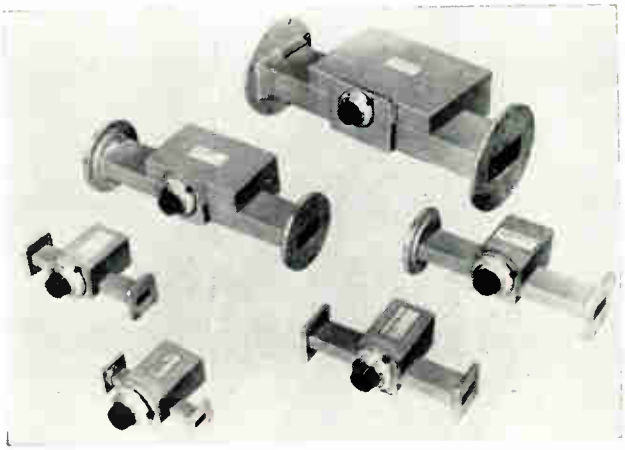
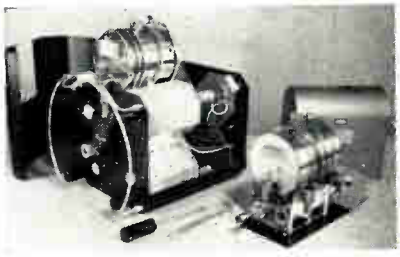
ARTICLE HIGHLIGHTS

of this issue



Microwaves—A Market in Transition 58

Microwave is a comparatively young field that is already going through advance stages of change. New technology creates new components and hardware. Makers and vendors clutch at fast waning markets on one hand, while trying to foster, woo and balance new customers on the other. Possible answers—build up foreign markets and find new domestic uses.

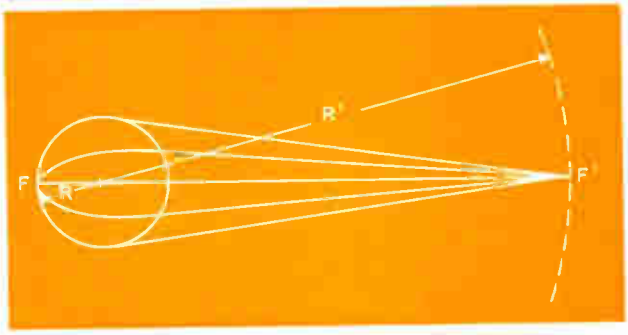


New Developments in Laser Weapons 78

Lasers provide an exciting "quantum jump" for weaponry. Weapons of the brute force, searing-heat variety can be expected soon. There will be more refined laser guns that rely on resonance effects or interactions with the target. Here's what they look like and how they work.

Microwave Diodes—A Progress Report 86

The field of microwave diodes is making rapid advances. Higher cut-off frequencies, lower noise figures, and longer life are some of the advances, with more to come. Here is a report of today's technology and predictions of advances to come in the next year or two.



New Developments in Luneberg Lens Antennas 100

In the area of microwave antennas, a good deal of significance is being attached to lens-type construction. The Luneberg lens described here offers unusual multiple-beam and scan capabilities. It is being included in the specifications for a number of pieces of sophisticated military equipment.

The Other Side of the Engineer Shortage! 196

Is there really an engineer "shortage," or is it that engineers are being wasted? Many engineering jobs still go begging each year. Here is a report that may startle many people.

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Six Tape Recorders Stacked on a Bench

Slide 6 magnetic-tape cartridges into the trim 1½-cubic-foot transport of a KRS DATA-Stact™ Portable Instrumentation Recorder. Give each cartridge double-bandwidth record/reproduce channels. Equip the transport with plug-in, interchangeable FM and Direct-type electronics. Result is a remarkable 6-in-1 recording system with up to 12 channels of data-logging capacity.

REVERSIBLE CARTRIDGES
Reliable, smooth-running KRS STACTape™ Cartridges were designed for use in DATA-Stact Recorders to meet highest instrumentation recording standards. Only in KRS STACTape Cartridges can you reverse tape direction to edit data. The housing contains up to 1,200 feet of continuous-loop ¼-inch instrumentation Mylar tape. You never touch tape during operation or storage.

MULTI-CHOICE OPERATION
With a STACT Recorder on line, you can record and reproduce data on any number of channels singly, sequentially, or simultaneously with precise synchronous start-stop operation of the 6-cartridge stack. Backlighted pushbutton controls make operation practically foolproof. A single connector provides for remote control of all cartridges.

THE ONLY BENCH MODEL WITH S.A.*
Simple design and careful manufacture of KRS DATA-Stact Recorders assure years of faultless data-logging performance. The transport uses only two moving parts: (1) A single extended non-slip capstan, and (2) a quiet, cool-running synchronous motor. All-solid-state electronics require little maintenance. Prices range from $2,500 to $7,000.

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* Stack-Able design

Send for the vital statistics that are found only in Instrumentation Bulletin DR-2.

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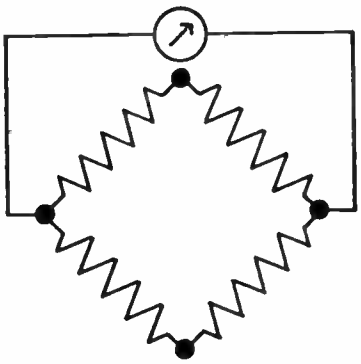
World Radio History

Two reliable techniques for finding faults on cables

TRADITIONAL



Step 1. Dispatch a field engineer to closest cable termination beyond the fault site.

Step 2. Field engineer attaches a pair of test leads to the tie point, completing a Wheatstone bridge circuit to the central station.

Step 3. Fault on cable changes resistance on one side of the bridge; an operator at the central station adjusts resistance on opposite side of circuit to balance the bridge.

Step 4. When the galvanometer reaches the zero point, the operator reads amount of resistance in ohms required to balance the bridge.

Step 5. Turning from meter to map file, he consults a table to find the gauge of cable section under test.

Step 6. Operator calculates resistance of that gauge cable in ohms-per-feet.

Step 7. Resistivity of cable in ohms-per-feet is divided into ohms resistance required to balance bridge circuit.

Step 8. Dividend equals distance in feet from tie point back to cable fault (without compensating for changes in ambient temperature and humidity which can affect performance of the bridge circuit).

For further information on this widely used technique of fault-finding, collar any power engineer who has had extensive experience on a test board.

MODERN

Step 1. Assign an operator to scan up to 30 miles of cable through a Sierra 370A Cable Fault Locator.

Step 2. See opens, shorts, or impedance variations the instant they occur; read distance to fault directly in feet from the pip on the scope.

For further information on this time and labor-saving technique of pinpointing cable faults, get in touch with Sierra Electronic Division of Philco. Ask for data on the Model 370A Cable Fault Locator. While you're at it, you might call in your nearest Sierra sales representative for a fault-finding demonstration.

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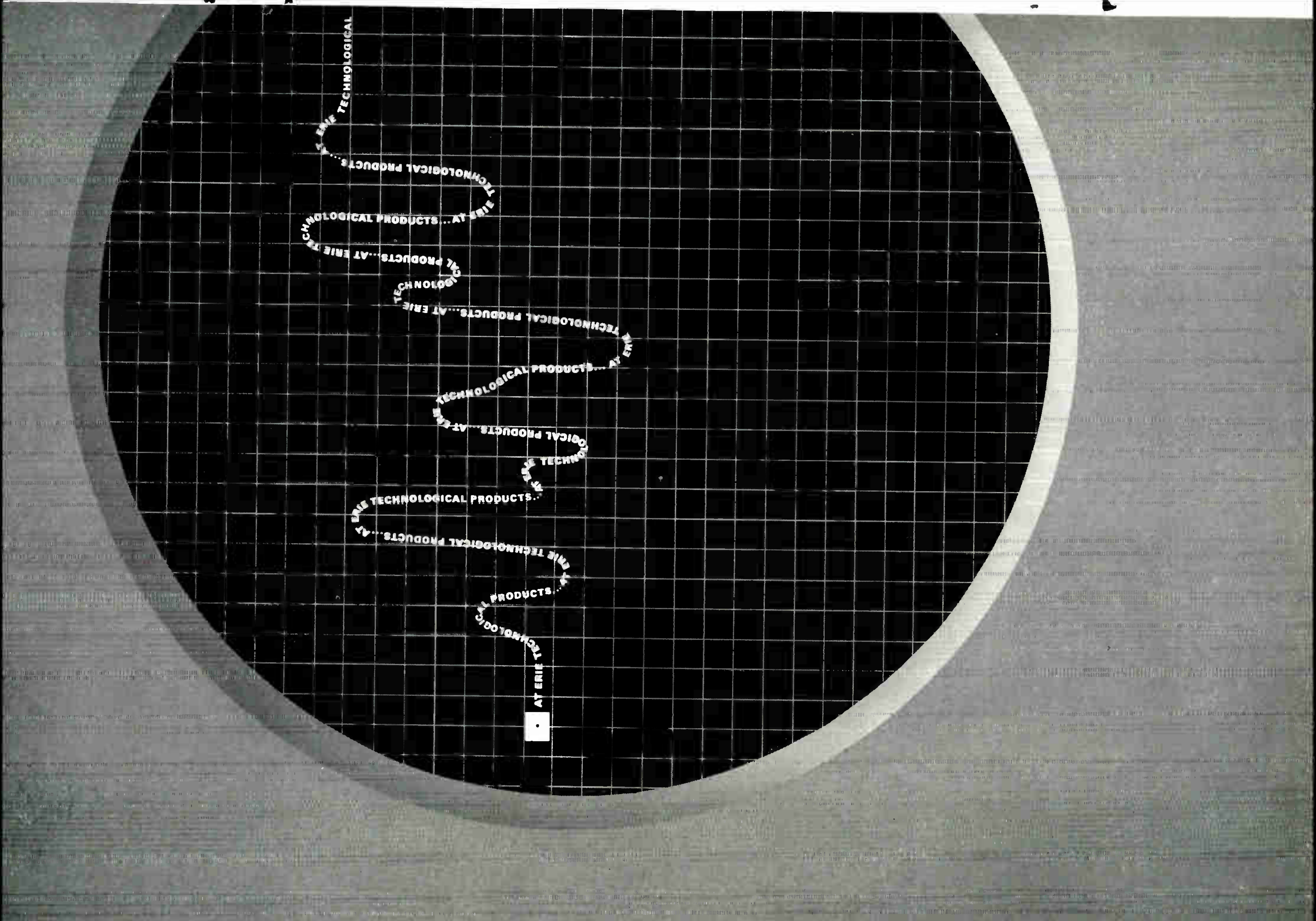

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PRODUCTS...

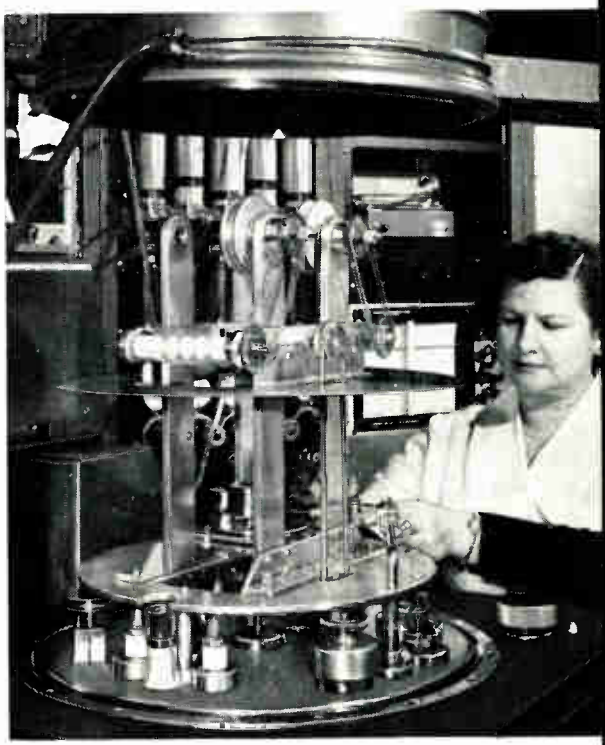
research inversely proportional to part size

As the size of the things we work on at Erie Technological Products has grown smaller and smaller . . .

The size of the talents and the group we have available to work on them has grown larger and larger . . .

Continuing enlargement of research facilities . . . additions of outstanding, dedicated specialists to our research staff . . . increased involvement by both research staff and engineering people in research projects . . . continuing emphasis by Production on improving established quality standards . . . all these are evidence of today's thinking at Erie Technological Products, Inc. . . . where Research, Production, and Quality Assurance are combined in highest reliability products for electronics.

May we tell you more . . . in an across-the-desk discussion?



Interior of a special high-vacuum unit showing a special developed fixture used in coating thin-film substrates.

WHERE IMAGINATION CREATES VALUE IN ELECTRONICS

ERIE TECHNOLOGICAL PRODUCTS, INC.

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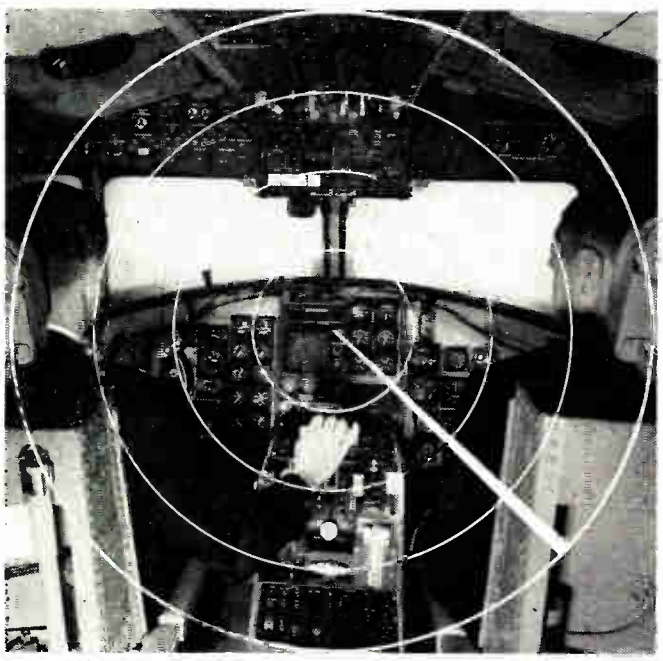
RADARSCOPE

Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation



EARLY WARNING TRAINER

Engineers check the control operations of the simulated cockpit, a part of the E-2A Hawkeye early warning and intercept control trainer. The trainer, together with a simulating system for the A-6A Intruder attack bomber, was ordered by Goodyear Aerospace by the Navy, and is set for testing soon.

HARDWARE TECH MANUAL COSTS in the millions of dollars have been saved on a yearly basis through a joint government-industry program, carried out by DOD and Aerospace Industries Association. Areas under corrective action, unknown to the public, involve thousands and thousands of technical manuals that go with "hardware" made and delivered by the aerospace industry to the DOD, according to AIA.

REMOTE RADIATION SENSING, an advanced technique for the armed services, has an economic future, reports Univ. of Michigan scientist, J. O. Morgan. Remote sensing is detecting and measuring radiation at a distance from the emitting or radiating object. All objects above absolute zero give off electromagnetic energy that can be sensed or detected. A number of detecting devices have been tested and produced at their laboratories at Willow Run for the military. Commercial uses could include survey of crops and forest fire detection.

NEW ELECTRON BEAM DEVICES may result in more sophisticated yet simpler electronic systems. Dr. Howard Scharfman, of Raytheon's Microwave and Power Tube Division, described the new concept as SPEED, which is Signal Processing in Evacuated Electron Devices. Complex military systems growth up to now had been retarded by the lack of advanced microwave parts. Raytheon's Spencer Laboratory is working on a high power beam phase shifter that employs low voltage video grid signals for phase control. The study has produced a tube less complex than a power amplifier of equal status, reports Dr. Scharfman. The tube should be less costly and long lived. He called for the use of beam devices with solid state techniques within tube designs.

SYSTEMS THAT LEARN TO RECOGNIZE PATTERNS are under study at ITT in San Fernando, Calif. Humans have amazing talent in adapting to pattern changes. They retain recognition of the pattern despite changes. The image in human memory after the change is then that of the altered pattern. The process can go on without stop until the pattern has almost no similarity to the original pattern. According to Dr. G. H. Ball, who heads the ITT group, the only criterion is that each change must not be too severe. Under an Air Force contract, ITT will study electronic systems to perform similar adaptive learning methods. Also, a system that can "learn" by itself—starting with no specific knowledge of desired pattern—will be considered.

TWO ELECTRONIC DEVICES, developed at Franklin Institute Laboratories, will help Princeton University study animal and then human biological rhythms. One device is a temperature-sensitive transmitter to be placed in small animals for temperature study. FIL Engineer Robert Goodman said the tiny three-gram telemeter will transmit data on as little as 0.1°C. temperature change. It uses only 10μw of power. It consists of a mercury cell, thermistor, silicon triode, coil, two capacitors and a fixed resistor. The second device is called an actograph. It is a series of detectors in a box that can sense when its cockroach inmate eats, drinks and strolls. Once in space, the roach's movements in and around the actograph can be monitored continuously. NASA is underwriting the study and wants to find out whether man is really dependent on earth environment and lunar cycles before he takes long space trips.

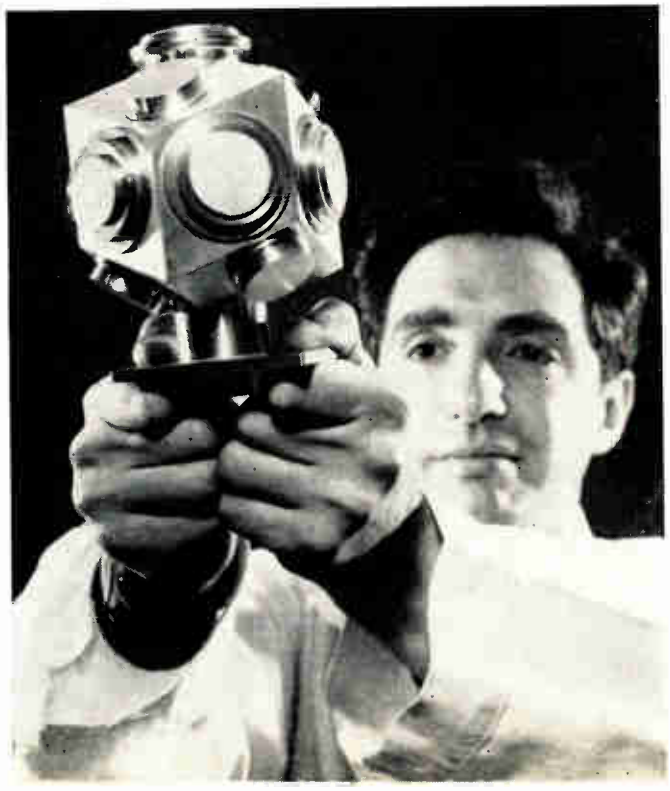
World Radio History

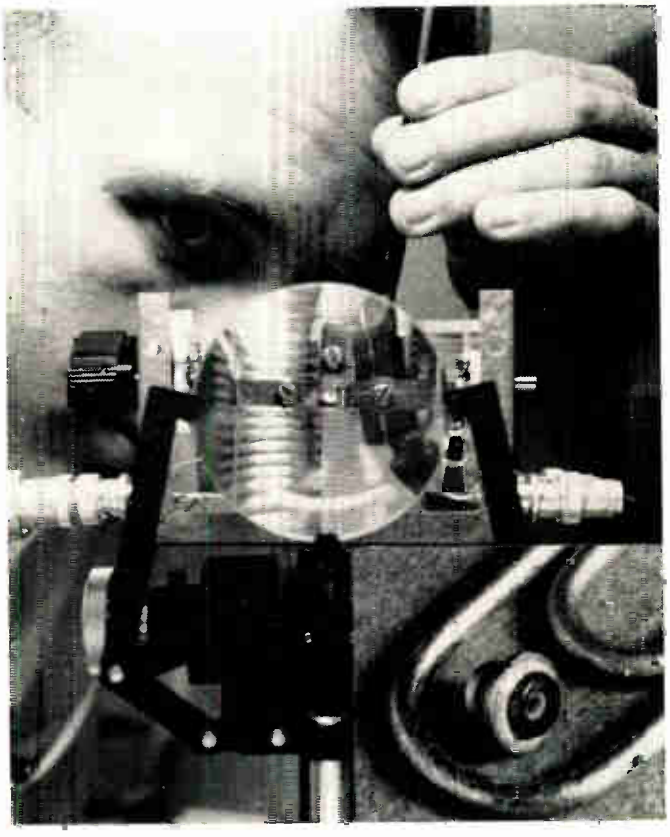
SILICON CARBIDE DIODE permits direct and continuous conversion of electric current to coherent, monochromatic laser light, at room temperatures. This new laser technology was revealed by Tyco Laboratories, Inc. The diode operates at current densities as low as 120 amp per sq. cm. Light output is blue at 4560 Å, shortest wavelength so far for diode laser action. The TLI laser can, in principle, be operated from a storage battery. Its output can be varied simply by changing the current flow. TLI president, Dr. A. J. Rosenberg, says that silicon carbide is an ideal substance for a diode laser. It is very rugged, free from contamination problems, and can withstand great heat.

SATELLITE COMMUNICATIONS REVENUES might reach between $50 to $100 million yearly by 1970. They could hit $300 million by 1975, reports S. H. Reiger, Manager of Systems Analysis for Communications Satellite Corp. Markets for such a system will first come from overseas voice messages, leased lines, data sending, and most likely from TV programs. Mr. Reiger suggests that, for the system to be self-paying by 1970, there should be assurance that orbit life will be at least a few years. He said, in effect, that a random, medium altitude system like Telstar would need 24 satellites with a guarantee of three to five years orbit life each.

MAN-MADE HELIOTROPE

The sun-seeking flower stays in the garden, but this space age Sol-seeking device will help a satellite stay heads up while in orbit. Art Stoliar, Bulova Watch Co. physicist, studies model of his sun position indicator designed for Lockheed's Agena series of satellites. The device will report exactly where the sun is.





SUPER-SENSITIVE AMPLIFIER

Small white dot in the lens is a photodetector-parametric amplifier which Sperry Rand says will boost by 100 times the receiver sensitivity of laser and radar systems. Called a photoparametric diode (see paperclip inset) tests gave amplification of less than 10^{-9} watt of light, response from dc to 2 GC.

GOLD MAY BE A SUPERCONDUCTOR, say physicists at the University of California at San Diego. Until now, no superconductivity has ever been found in either copper, silver or gold. Aluminum, a good conductor at high temperatures, increases in conductivity by more than ten billion when cooled to cryogenic temperatures—at or below −422.99° F. The California researchers found that a barium-gold alloy becomes superconducting at 0.7° K (−457.7° F.). Gold alloys had to be used since superconducting degrees for pure gold are too low to be reached by standard cryostats (low temperature equipment).

FOUR NEW METHODS of converting basic energy into electricity without any moving parts are being explored by RCA. Two methods, solar cells and special batteries, are now being applied in space power uses. Two others are thermoelectric and thermionic energy conversion. They are being developed to meet demands for larger-capacity power generating systems needed for future deep space probes. Their required heat may be supplied by compact nuclear reactors or radioisotopes. These techniques may one day have commercial use.

(More RADARSCOPE on Page 13)

World Radio History

Tough customer for tough customers with tough customers.

If your electrical equipment has to meet rugged environmental conditions where failures are too costly to be allowed, and this makes you a tough guy to please, you'll be interested in our QWLD connector.

It's tough enough to take the brunt of heavy-duty applications such as in missile launching equipment, ground radar, or power and control circuits, as well as in mining or oil field applications.

Five integral keys and keyways provide for positive polarization and positive mating even in blind locations.

Other features include improved waterproofing, closed entry socket contacts, self-ejecting coupling action. The connector is designed to meet military specification MIL-C-22992 (ships). For more information, write us in Sidney, New York.

Circle 7 on Inquiry Card

Scintilla Division

THE Bendix CORPORATION

World Radio History

RADARSCOPE

SPACE COMMUNICATIONS SYSTEM that uses an "electronic boomerang" to increase quality and quantity of data sent to earth from satellites was announced by General Telephone and Electronics Corp. Developed for the Air Force, the system self-directs its signals to any earth station that requests data. Return signal follows the same path as request signal. Heart of the system is a set of antennas that steers beams without altering the antennas' positions or that of the satellite. Engineer Walter Serniuk said that a "retro-directive phased array" technique enables the system to redirect signals in an instant along the same path used by data request signal. Present satellite systems must send signals over a large area of the earth's surface to contact a specific ground station.

VACUUM DEPOSITED THIN FILM CIRCUITS, by Melpar, Inc., held up under transient bursts of high energy gamma radiation and high temperatures. Recent tests on all-vacuum deposited flip-flop circuits showed that the circuits were not altered in any way under high radiation. Circuits using single crystal, junction devices, however, changed state under 1,000 times less radiation. Melpar is making and testing the circuits under a Bu-Weps contract.

SUPER-POWER KLYSTRON is being studied for the Air Force by Eitel-McCullough, Inc. In first phase of study, transmissions of more than 2,000,000 watts dc have been achieved. Beam power concentration exceeded 60,000,000 watts per sq. in. This is equal to energy 1,500 times greater than that of the sun's surface, noted Eimac's Dr. George Caryotakis. Phase one goal was to control sustained megawatt of dc power through a drift tube into a collector with 99.9% transmission or better. Second and final phase is the design of rf elements. Project goal is to determine whether it is feasible to produce an X-band klystron capable of 1,000,000 watts CW average power output.

SYNTHETIC RUBY GROWING with high optical quality for lasers is under study at Battelle Memorial Institute. New method involves dissolving substances in a molten oxide or fluoride flux. The substances are crystallized aluminum oxide with a trace of chromium oxide. Mixture is heated to dissolve oxides. On cooling, the rubies crystal-out. Aluminum oxide crystals can be used to seed or start the process. In this new flux method, the ruby crystallizes at temperatures as low as 1,350°F, far below the present commercial flame fusion method at 3,500°F.

MINIATURE ELECTRONIC CIRCUITS in a chip of silicon the size of a match head promise much in systems capabilities. They also pose challenges. To help circuit designers get the most out of these micro-devices, Battelle Memorial Institute is looking into ways to define and illustrate their properties. The study is being done for the Naval Air Development Center, Johnsville, Pa. Lawrence H. Stember, Jr., head of the study, says that standard methods of circuit analysis are not adequate for use in microelectronics. How a circuit will act may be predicted from knowledge of single circuit parts. But when parts are collected into one small microunit, component interaction makes this impossible. Hence, overall performance must be studied.

If it isn't one thing, it's another.

(Bits and pieces about our products and how they are used.)

Announcing that we make shorting plugs (as if you didn't know). Some of our customers have been buying shorting plugs from us for several years now, and it occurred to us that a lot of people may not know that we even make them, since we've never said anything about them in our ads.

The secret's out.

We make several dozen special plugs and receptacles for connecting and protecting electrical circuits in various types of electrical and electronic equipment. We call them "shorting plugs."

If you have a need for such a device, we'll send you complete information. Just drop us a line at 1001 S. Grande Ave., Santa Ana, California.

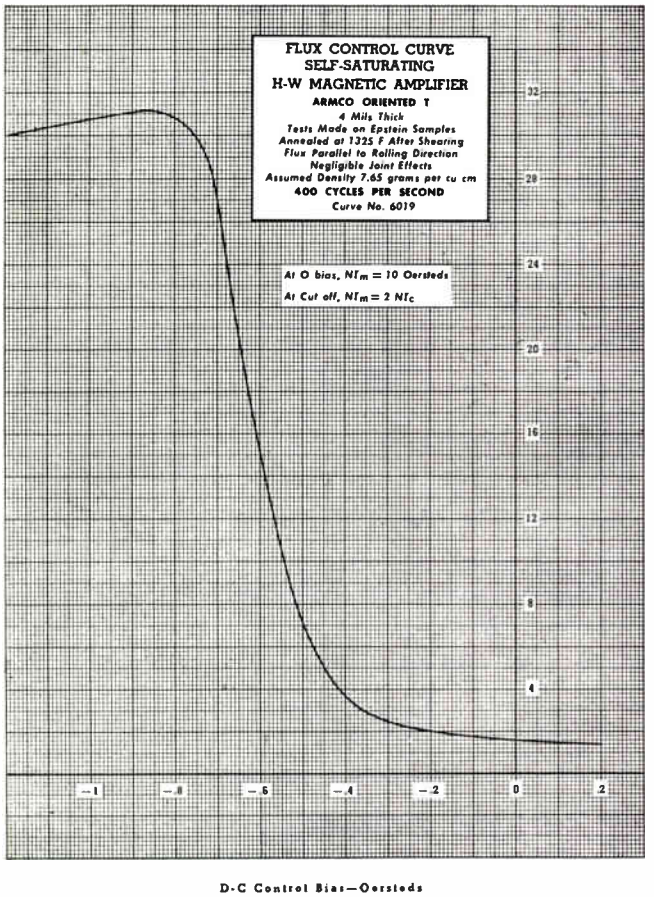
Scintilla Division

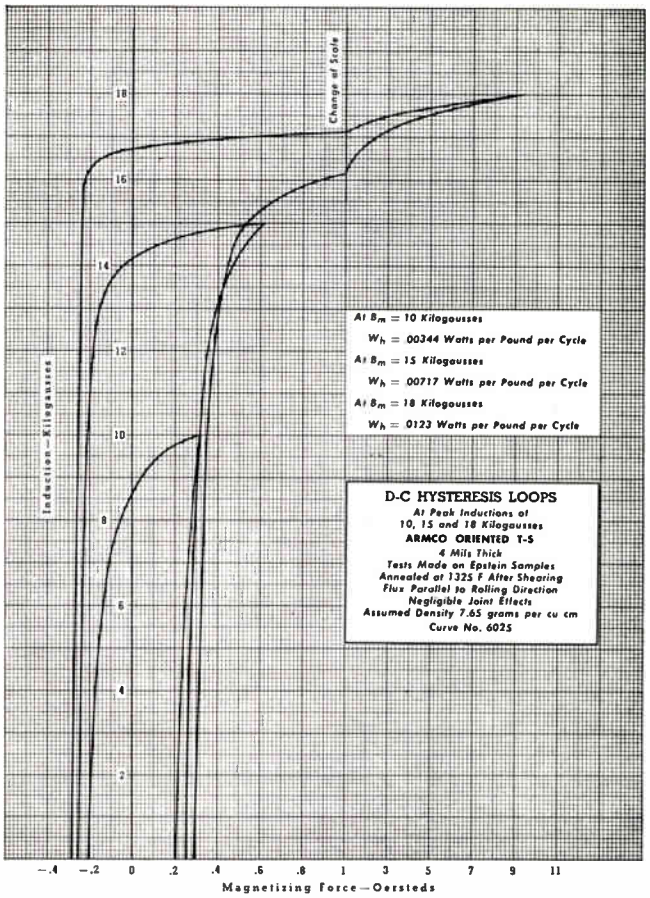
THE Bendix CORPORATION

Circle 8 on Inquiry Card

World Radio History

How Armco Thin Electrical Steels Help You Design Low-Cost, Efficient Apparatus for 400 Cps and Higher Frequencies





Armco TRAN-COR T, Oriented T, and Oriented TS provide all the advantages of high quality, low-loss electrical steels plus a wide range of magnetic properties and thicknesses. You can design more precisely and produce reliable components at least cost.

Thin Armco Electrical Steels offer all these advantages:

Exceptionally high permeability
Low hysteresis loss
Minimum interlaminar loss
High lamination factors
Properties fully developed at the mill
Unexcelled uniformly high quality

Armco TRAN-COR T, a nonoriented grade, is produced in 7 and 5 mil thicknesses; Armco Oriented T in 6 to 1 mils; and Armco Oriented TS, a super-oriented grade, 4 mils thick.

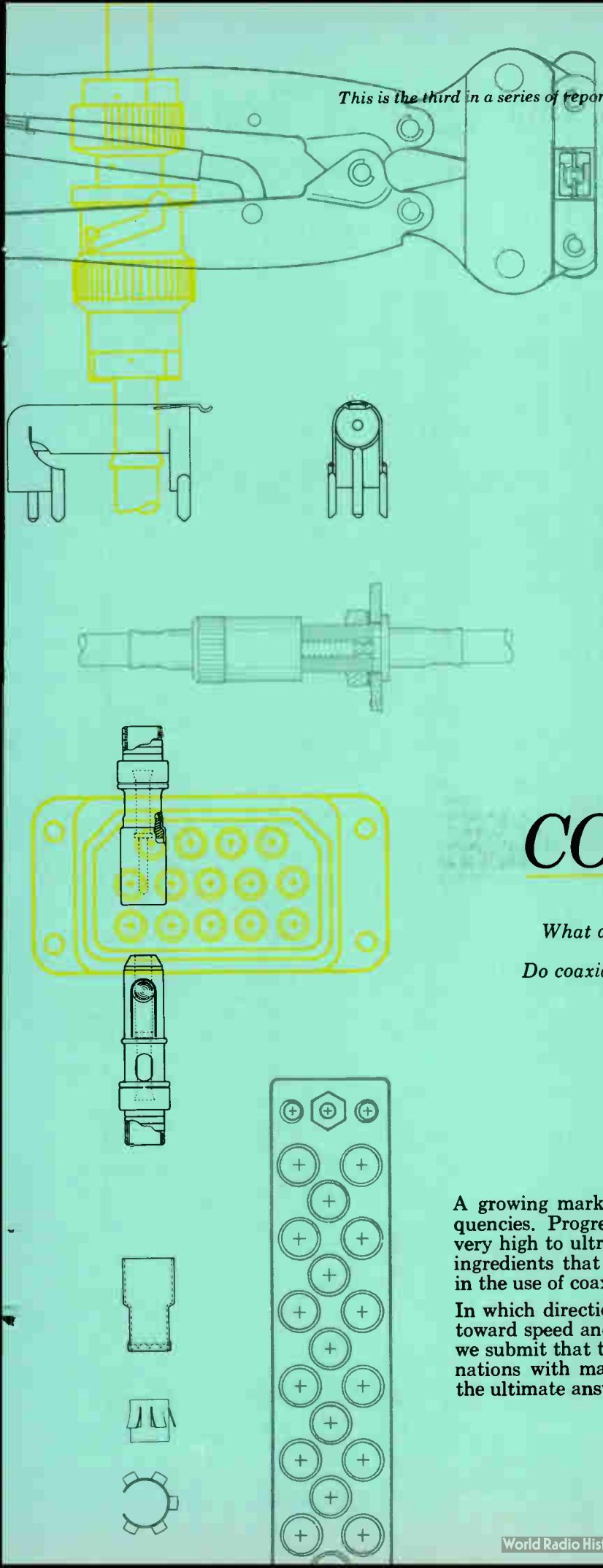
Use the multiple advantages of Armco Thin Electrical Steels for radio and television transformers as well as magnetic amplifiers, reactors, pulse generators and other components that operate at 400 and higher cps. Write us for complete information, including design curves. **Armco Division, Armco Steel Corporation, Dept. A-383, P. O. Box 600, Middletown, Ohio.**

ARMCO Armco Division

World Radio History

This is the third in a series of reports on connector design specifications.

3



Special Report From AMP On COAXIAL CABLE CONNECTORS

What are the advantages of one-crimp terminations?

Do coaxial cable connectors with crimped terminations conform to military specifications?

When can coaxial cable with inexpensive insulation be used?

What other advantages are to be found in matching terminal and tool?

A growing market. More complexity. Higher and higher frequencies. Progressively greater need for noise reduction in very high to ultra high radio frequency circuits! These are the ingredients that virtually guarantee continuous rapid growth in the use of coaxial cable connections.

In which direction is progress headed? We maintain that it is toward speed and simplification. And if this premise is upheld, we submit that the development of one-crimp solderless terminations with matched tooling for coaxial cable connectors is the ultimate answer to the problem.

Circle 67 on Inquiry Card

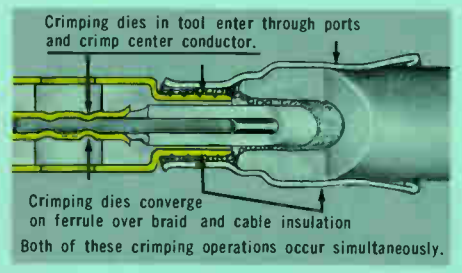
World Radio History

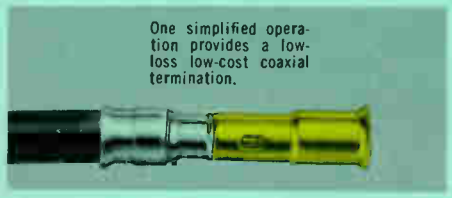
What are the advantages of one-crimp termination?

Before we answer this question, let us briefly point to the fact that over the past two decades compression-crimping of numerous types of basic terminals and connector contacts has enjoyed rapid and sustained growth. However, only in recent years has this technique been applied to the more involved task of terminating coaxial cable.

With matched terminal and tool there is no room for error. Every tool is precisely calibrated to produce the exact pressure needed to form what virtually amounts to a cold weld of the terminal or terminal barrel and the conductor. Crimping dies made of tool steel alloys converge on the areas to be crimped simultaneously, and bottom fully before they can be released, to produce corrosion-resistant connections that are virtually free of voids.

In the ever-broadening field of coaxial cable connectors, the AMP crimping method provides special—and exclusive—advantages. Unlike soldering, which calls for five separate operations, and other crimping methods that require two crimps and awkward assembly procedures, AMP alone offers a rapid one-step technique which terminates the inner conductor, the outer braid, and the cable insulation support at the same time.





With the AMP method, the elapsed time for completing most coaxial cable connections is between seven and ten seconds, compared to as much as fifteen minutes for assembling and terminating several conventional types of coaxial terminations.

This means better connections that are electrically and mechanically stable. And it means connections that are identical in appearance and performance made in less time at lower applied cost than by any other method.

Do coaxial cable connectors with crimped terminations conform to military specifications?

The answer is "yes." All A-MP* COAXICON connectors meet the requirements of MIL-C-3608A and MIL-STD-202B where applicable. As an example, the A-MP BNC COAXICON connector, a bayonet locking type, has a nominal impedance of 50 ohms and, as with all other A-MP Coaxial Cable Connectors, the center conductor and cable braid are crimped simultaneously. The following tests were run on A-MP BNC connectors having the same mating dimensions as the UG88 C/U plug and the UG89 B/U jack.

In the test for dielectric withstanding voltage, mated connectors were tested in accordance with method 301 of MIL-STD-202B. Test voltage of 1500 volts r.m.s. was applied between the center contact and outside shell, and held for 1 minute. Result: All samples withstood the 1500 volts r.m.s. difference of potential for the minute.

For salt spray the connectors were tested to method 101, test condition B (20% solution for 48 hours), of MIL-STD-202B as required by MIL-C-3608A. When the test was completed, the connectors were washed, shaken, air blasted, then permitted to dry for 24 hours at 40°C. Results: There was no evidence of destructive corrosion or pitting following the test.

Insulation resistance of the mated connectors was measured between the inner conductor and outer shell conforming to method 302, Test condition B (500 volts potential and electrification time of 2 minutes), of MIL-STD-202B. Measurements were made using a megohmmeter, and the guard circuit was used to prevent leakage currents along the coaxial cable dielectric material. The length of cable crimped to the connector was less than 1 inch. Result: Samples had an initial insulation resistance of more than 2,000,000 ohms following the salt spray.

In a separate series of tests, voltage standing wave ratio (VSWR) measurements were made and cable retention forces measured when used with RG-58 C/U coaxial cable.

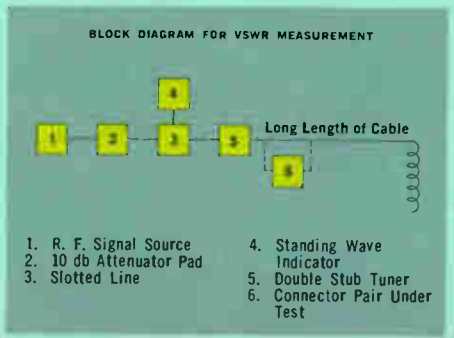
The VSWR measurements were made as follows:

(a) A long length of cable—approximately 500 feet of RG-58 c/u—was assembled to a Type N connector and connected to a slotted line through either a double stub tuner or a slide screw tuner.

(b) At the test frequencies the double stub tuner was adjusted so the VSWR recorded on the Standing Wave Indicator was 1.01 to 1 or better.

(c) The cable was cut and a test connector pair was inserted a short distance away from the Type N adapter so that the attenuation of the cable between the adapter and connector pair under test was negligible.

(d) At each test frequency a pre-tuned double stub tuner or the slide screw tuner was pre-set to the setting from step (b). The cable-to-cable VSWR of the connector pair was then obtained on the Standing Wave Indicator.



Between the test frequencies of 500 megacycles and 4,000 megacycles, the VSWR ran from a minimum of 1.04:1 to a maximum of 1.32:1, and in every instance cable retention force of the plugs and jacks tested, with a tensile machine pulling at a rate of 1 inch per minute, was in excess of 70 lbs.

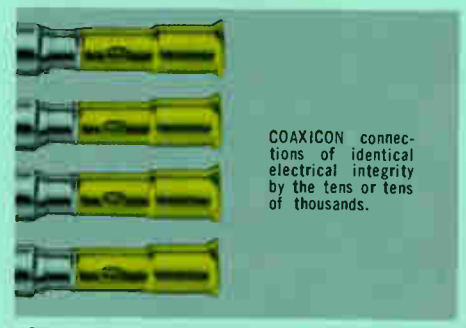
When can coaxial cable with inexpensive insulation be used?

In many general applications, one of the disadvantages of soldering is the anticipated recurrences of burned or severely damaged insulation. This negative factor assumes special significance in coaxial cable terminations. With the AMP crimping procedure, both the inner conductor and outer braid are crimped simultaneously. Other methods may call for soldering both the inner conductor and outer braid, or soldering the inner conductor and crimping the outer braid, both necessitating the use of cables with high-cost, high-temperature dielectric material.

Many A-MP coaxial cable connectors intended for non-critical temperature environments utilize relatively inexpensive polyethylene or polypropylene insulation, with temperature limits as high as 240°F. Polypropylene, for example, has a dielectric constant of 2.2, water absorption of less than .01%, and temperature tolerance of up to 240°F. This is ample protection for a wide variety of commercial and some military uses. However, wherever temperature becomes a critical factor, ranging as high as 550°F., TEFLON† dielectric material is used.

What other advantages are to be found in matching terminal and tool?

First of all, A-MP coaxial cable connectors, whether the operation calls for connecting a single cable or multiple circuits, are characterized by speed and ease of assembly resulting in sizeable production economies. But even more important is the electrical integrity of the connection, with the functions of the inner conductor and outer braid perfectly balanced in their respective roles. Regardless of the type of connector—Standard or Twin, BNC, Threaded, Miniature or Sub-miniature, etc.—every COAXICON Connector is designed to operate with maximum sustained capacity in the performance of the function for which it was designed.



With this in mind, let us briefly review the chief characteristics of this product.

Aside from the primary advantage of the time-and-money-saving one-crimp operation already discussed, the list begins with simplification of cable preparation. With the AMP technique only two stripping operations (compared with three for other techniques) are required. Moreover, a far less critical tolerance is indicated. Second point of importance is that the inner contacts are firmly stabilized. This provides better all-round performance especially under conditions of extreme vibration. The third advantage consists of high cable retention forces for both plugs and jacks. For the BNC series for example, cable

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World Radio History

retention has been measured at 70 lbs. minimum on RG-58. Fourth, as previously noted, with the AMP method, there is never any danger of heat damage to any size cable. Fifth, low voltage standing wave ratio is always the rule rather than the exception. Sixth, a significant reduction in noise level has been achieved—an especially noteworthy factor in connection with critical missile and guidance applications. Seventh, matching of terminal and tool, an exclusive AMP development, produces compression-crimped terminations of uniform quality—each an exact duplication in both physical and electrical characteristics. Finally, A-MP coaxial cable connectors, because of the nature of the crimping operation, eliminate rejects in final checkout, that occur with solder type connectors.

This evaluation covers only the more conspicuous points of comparison. From here on we give you a brief resumé of the developments of radio frequency transmission and how it has been directed in progressive steps to more sensitive and complex functions. This will be followed, in turn, by some factual data about various types of A-MP coaxial cable connectors that help channel electrical energy into innumerable step-by-step or fully programmed procedures.

The need for and development of coaxial cable

When alternating electrical energy is transmitted through ordinary conductors, any considerable increase in frequency towards radio frequency causes problems. As the rate of change rises into the megacycle range, the expansion and collapse of magnetic fields forces the current to travel towards the outer surface of the conductor. Also, constant and rapid fluctuation of electromagnetic energy causes both heat generation and power dissipation.

Another problem common to every type of transmission line is radiation. This is true, for example, of the type of transmission line used to carry telephone impulses. Cross talk and hum are frequently heard, despite the fact that frequencies rarely exceed 5,000 cycles.

Introduction of shielded wire was the first approach to these problems. This helped reduce the radiation problem, but heat dissipation or energy loss remained. Next came the open transmission line where the spacing between the two wires was exactly maintained. This produced a balanced transmission line in which unwanted radiation and induction cancelled themselves to a great extent. The obvious limitation here is that the spacing of the two wires must be maintained, and the open wires become highly impractical inside radio frequency equipment.

Coaxial cable, first introduced in the 1930's, was the most practical solution in the operation of radio frequency transmitters in the very-high and ultra-high frequency ranges. The earliest version, which has been improved and refined, is still basically unchanged. It consisted of a solid center conductor surrounded by a dielectric material covered by a braided outer conductor which, in turn, was protected by outside insulation. This arrangement offers minimum radiation with maximum flexibility. The spacing of the two conductors permits rf impedance to be accurately maintained and losses to be closely calculated.

The coaxial cable termination technique

In the beginning, soldering was the standard, accepted method for terminating coaxial cable. However, with the development of radar systems, microwave devices, satellite instrumentation, data collecting and processing equipment, and many other complex electronic devices, a faster, more advanced method became highly desirable. From the outset, it was obvious that any standard method for connecting ordinary wires could not be used. Should the inner conductor and braid be connected to any standard type terminal, excessive heat generation and power loss would be inevitable. Eliminating the spacing between the inner and outer conductors destroys the concept of coaxial cable transmission. Doing that is comparable, in effect, to pumping water through a one-inch pipe then suddenly reducing the size to ⅛". Eventually, the problem was solved with the use of the coaxial connector and perfected through the one-crimp termination technique.

All A-MP coaxial cable connectors are designed to provide concentric spacing between the outside diameter of the center contact, and the inside diameter of the outer sleeve or barrel of the connector shell. The spacing of these diameters and the dielectric between them determine the impedance of the connector. The cardinal point here is that A-MP coaxial cable connectors designed for rf use are internally proportioned to match the impedance values of any cable to which they are attached. This attention to design assures that A-MP coaxial cable connectors have minimum impedance discontinuities—an extremely important factor in circuits in which timing or phasing relationships are important. In radar applications, for example, impedance discontinuity can produce reflections that result in multiple echo readings and ranging errors.

The basic types of coaxial cable

Of the many sizes of coaxial cable now in use, ranging from ⅛" to 1" in outside diameters, the *flexible type* is, by its very nature and adaptability, most commonly used. It is ideal for interconnections in electronic systems and low power transmission lines.

There are several cable configurations that fulfill this definition, principally the true coaxial and the double shielded which is a slight modification.

Semi-flexible or *metal jacketed* cables are basic coaxial constructions using a metal jacket instead of a braid construction. This cable is constructed by forming a seamless metal tubing (aluminum or copper) tightly onto the cable dielectric. From a shielding and also attenuation standpoint, this configuration represents the ultimate in solid core designs. Most common application: antenna systems in short wave, broadcast, and communications equipment.

Special cable modifications include triaxial, dual, twin conductor and armored.

Types of basic coaxial cable connectors

There are five main classifications of coaxial cable connectors, all of which are designed for use with flexible cable: (1) Large for use with cable of more than ½" diameter (RG17/U, etc.); (2) Medium—¼" to ½" diameter (such as RG 8/U cable); (3) Small for RG 58/U type cable with .125" to .250" diameter; (4) Miniature with diameters of .075" to .175" (RG 188/U category); (5) Subminiature for cable sizes with diameters of .045" to .080" (RG 196/U).

"N" CONNECTORS

The "N" is a threaded coupling connector designed for ¼" to ½" diameter cables. There are designs for 50 ohm and others to match 70 ohm cables. With TEFLON, the "N" may be used as high as 10,000 megacycles; it can be used with peak voltages of 500 volts.

"C" CONNECTORS

The "C" connectors are weatherproof. They are the bayonet-lock coupling version of the "N" series.

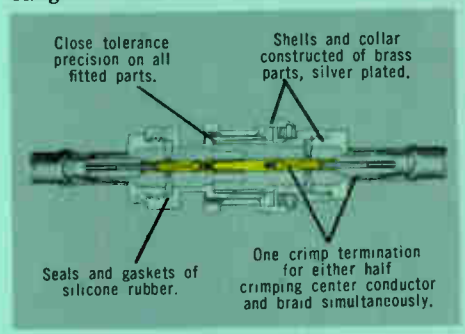
Into this general grouping fall a number of A-MP connectors for a wide variety of rf and other applications all of them distinguished by AMP precision engineering, reliability, and one-crimp, low-cost termination method.

BNC SERIES CONNECTORS

The BNC Connectors are fitted with a bayonet-lock coupling for quick connect and disconnect. They are a low-voltage, constant impedance type designed for RG 58/U and RG 55/U cables. AMP has modified them for use with RG 59/U, RG 62/U, RG 142/U and many other cable sizes. They are recommended for application up to 10,000 megacycles when used with RG

55/U or RG 58/U cable. Maximum voltage may not exceed 500 volts.

Various versions of BNC COAXICON Connectors have been designed to meet critical military and commercial needs, and both were tested in accordance with MIL-C-3608A. They are available in a wide range of cable sizes for miniature RG/U

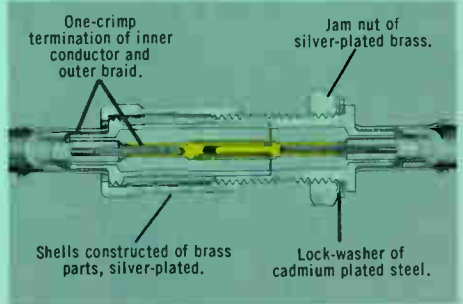


diameters of .075" to .200", and they are intermatable with comparable UG/U series connectors. As with all other A-MP coaxial cable connectors, one controlled stroke of a matching crimping tool results in simultaneous termination of the inner conductor, outer braid and insulation support.

THREADED COAXICON CONNECTORS

This type has 50-ohm nominal applications and accommodates a broad range of RG/U cable diameters in Standard, Twin, Miniature and Subminiature sizes. A number of adapters—right angles, feed-

throughs, "T", and printed circuit configurations—are available, and in all cases, the receptacle half accommodates panels from 1/32" to ¼" thick. The locknut and/or panel provides a shield for the crimping port. A nylon bushing is also available to insulate a connector from the panel. With intermatable internal contacts and the use of various diameter cable entrance ends, it becomes possible to mate many sizes of dissimilar cable.



World Radio History

Types of Multiple Connectors

Multiple COAXICON Connectors are available in Standard, Twin Standard, and Miniature sizes. Connector housings are made of general-purpose, arc-resistant phenolic or glass-filled diallyl phthalate. A special type of retention spring is used to retain the contacts in the connector and to serve as a shield for the crimping ports.

Standard

This version of the A-MP Coaxial Cable Connectors is available in a wide variety of housing configurations. This type utilizes single or twin contacts and accepts RG/U cable sizes in most common use in both single and twin conductors. With the weight factor becoming more important in many applications, it is of interest to note, for example, that the overall weight of the single connection, including retention spring, amounts to only 4.9 grams.

Miniature Connector

The Miniature Connector provides considerably greater circuit density. It is, in fact, a sealed down version of the standard connector with .265" center to center spacing for the contacts. It overlaps some of the standard COAXICON connector cable sizes, and is available with an increasing number of connector configurations.

New coaxial cable developments

Two new A-MP coaxial cable connectors, featuring "T" and "Y" configurations have recently been developed for modular computers. In the "T"-shaped connectors, three cable housings of coaxial cables are

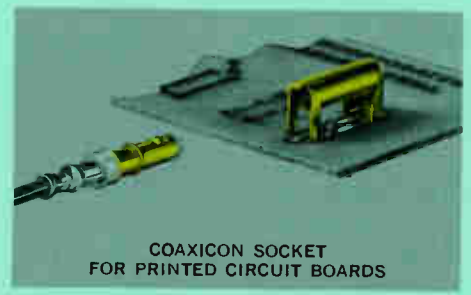
COAXICON "T" CONNECTOR

joined to a center housing. Every central "T" contact is mated with three cables, each of which is terminated with the appropriate standard or miniature contact. Any of the three cable housings joined to the center connector housing can be removed without disconnecting the two remaining units. The "T" connector is available in ten position standard and twenty-five position miniature coaxicon contact configurations.

COAXICON "Y" CONNECTOR

The "Y"-shaped connector requires less space than the "T" configurations. As with the "T" configurations, three cables can be connected, and again, any of the three plug sections of the cable can be removed without disconnecting the other circuits.

Another new AMP development in keeping with the rapid trend toward miniaturization, is a miniature coaxial cable socket for printed circuit boards. This socket is designed for 1/16" and ⅛" boards with grid spacing of 0.100". It mates with any miniature COAXICON male contact,



COAXICON SOCKET
FOR PRINTED CIRCUIT BOARDS

and may be mounted at the edge of the board or near components. Four pointed "V"-legs are shaped for easy insertion into the board, whether or not eyelets have been provided, and for maximum wicking and solder fillets. These legs extend 0.050" through the board. For breadboard use, the ⅛" board contact may be used on a 1/16" board. When that is done, the extra leg length can be utilized for hand-soldering wires or components to the leg. The ⅜" profile provided for in the design permits an exceptionally compact arrangement.

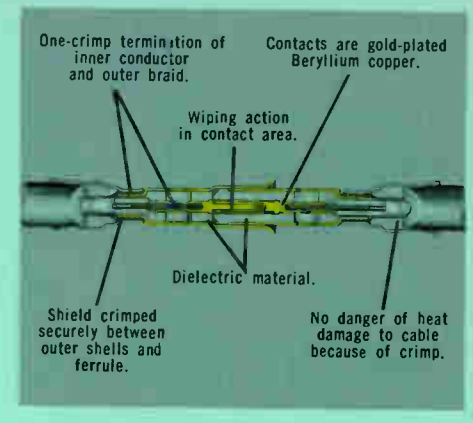
Miniature COAXICON Printed Circuit Sockets permit a choice of two kinds of contact retention: (1) spring retention with minimum holding force of 1¼ lbs.; (2) a positive-lock type that holds contact components firmly in place. On this version the male contact is depressed for removal.

Contacts—the critical factor in coaxial performance

The A-MP COAXICON Coaxial Cable Contact, regardless of size and type, is the key to reduction of power loss and infiltration of noise in the operation of a wide variety of complex and sensitive equipment.

The Standard COAXICON Contacts were the first of a series manufactured by AMP. They are basic to the design principle involved, and will therefore be described here as typical of other A-MP coaxial cable contacts. When precision-crimped with matching tools, then assembled and properly positioned in a suitable housing, they provide extraordinarily effective and reliable coaxial cable circuitry.

The contact consists of inner male and female components screw-machine processed from bronze. It is separated from an outer shell of brass by polyethylene insula-



tion which is noted for its dielectric and mechanical properties and which holds the inner contact accurately positioned within the shell. Bell-mouth design assures easy entry of the inner conductor of the cable into the inner contact. Bell-mouthing is also featured for easy mating of the outer shells.

A cantilever spring is built into the outer shell of the male contact. The retention force of this spring against the inner wall of the female contact, along with the retention force applied by the inner contacts, provides ample withdrawal force. Crimping ports allow special crimping dies to enter the outer shells and converge upon the inner contacts.

Gold-Over-Nickel Plating

Over the years AMP has experimented extensively with plating processes in an effort to find the ultimate, most universally applicable plating method for use in sensitive and critical applications.

Gold, with its uncommonly low electrical resistance and high resistance to corrosion, oxidation and humidity, was found to be the most effective and practical plating when coupled with nickel subplating. Through the use of an exclusive quality-control X-ray technique, which measures plating thickness to a millionth of an inch, we are able to satisfy special requirements dictated by the geometry of the products as well as the gradual wear caused by periodic separation and reinsertion of contacts.

COAXICON Coaxial Contacts—including outer shells—are pre-plated and assembled. On request these contacts may be plated with silver or gold over silver, but the standard AMP procedure consists of plating with gold over nickel for optimum electrical performance in an ever-widening range of applications.

These, then, are the salient points concerning the origin, development and utilization of coaxial cable in the burgeoning field of electrical electronic technology. Additional information, much of which can be tailored to specific design requirements or currently existing or projected needs of your own, will be supplied on request. This might include detailed specifications as well as research, testing, and engineering data applicable to uses beyond the scope of this report. Regardless of the nature of the problem, we shall welcome your inquiry, confident that we can help. Should you require more information on our general line of COAXICON Connectors, or if you need more specific data, write us briefly outlining the problem.

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Harrisburg, Pennsylvania
INDUSTRIAL SALES DIVISION

A-MP products and engineering assistants are available through subsidiary companies in:
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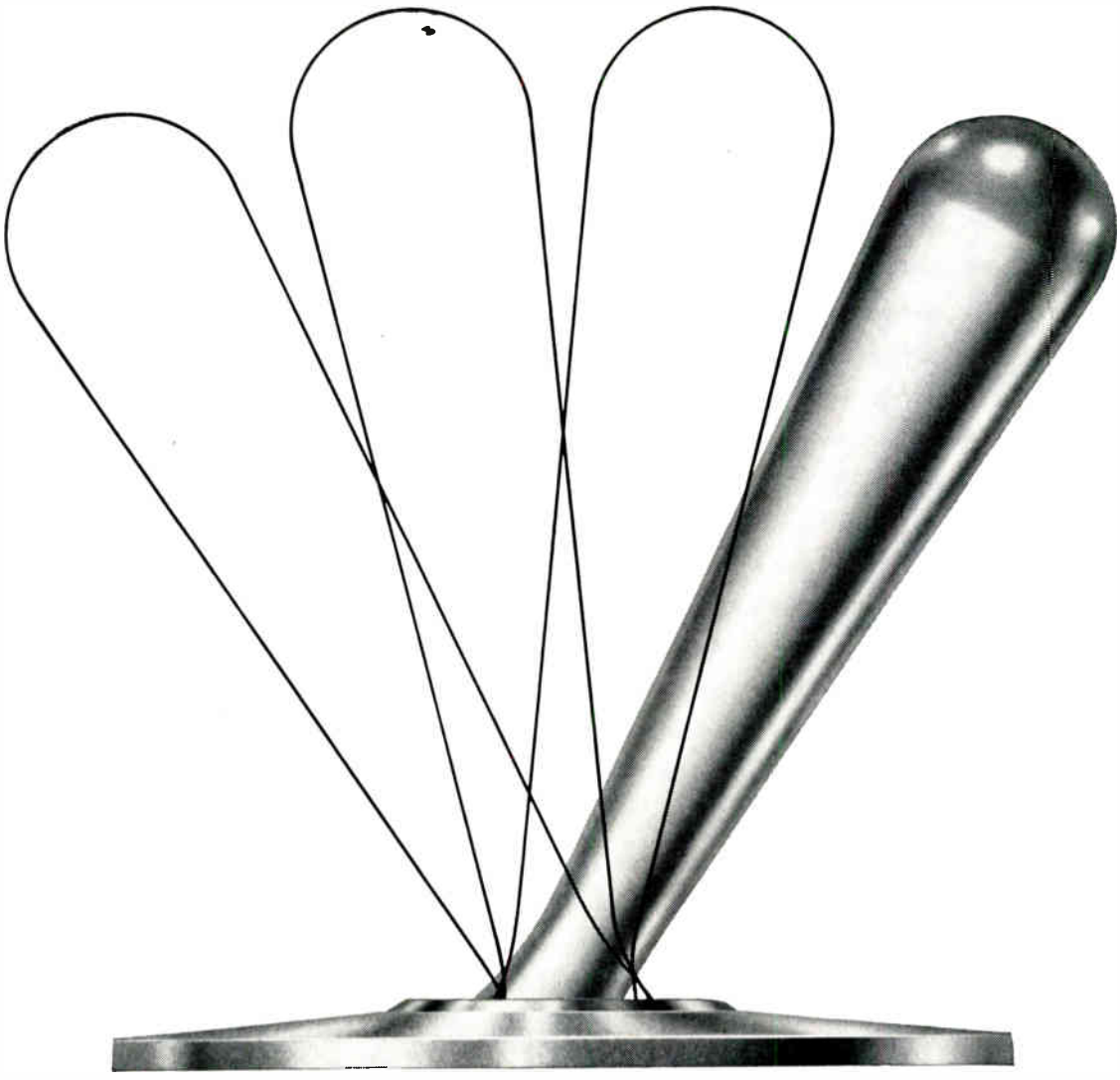

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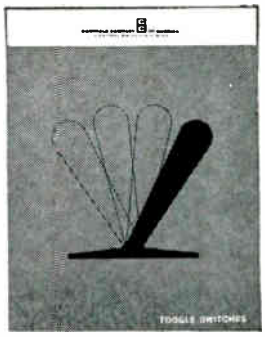

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Type MX Hermetic
Snap-acting to open on temperature rise only. Copper housing responds more readily than steel types. Standard tolerances ±3°F with 2 to 6°F differentials; 1 to 4°F differentials on special order. Temperature 10° to 260°F. Various terminals and mounting brackets. See Bulletin 6100.

Type AX Hermetic
Similar to Type MX but to close on temperature rise. Wide selection of terminals and mounting provisions, highly responsive non-ferrous metal housing. 2 to 6°F differential. Bulletin 3200.

Type C Hermetic
Field-adjustable, positive-acting. Electrically independent bimetal strip type for operation from —10° to 300°F. Nickel-silver case with or without ploting, depending on specifications. Turret terminals or wire leads. For ratings, etc., Bulletin 5000.

Type A Hermetic
Electrically independent bimetal disc and high-response brass case for quick, snap-action control from —10° to 300°F. Various non-ferrous metal enclosures, wide variety of terminal arrangements and mounting provisions, including brackets. Bulletin 3000.

*Above Stemco Thermostats are designed and manufactured to meet most requirements of applicable MIL specifications.

A-7222A

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COMING EVENTS

...in the electronic industry

NOVEMBER

Nov. 6-8: Annual Mtg. of Soc. for Experimental Stress Analysis; Statler-Hilton, Boston, Mass.

Nov. 6-8: 12th Annual Instrumentation Conf.; Louisiana Polytechnic Institute, Ruston, La.

Nov. 6-8: Southeast Reg. Conf., NACE; Key Biscayne Hotel, Miami, Fla.

Nov. 6-9: Annual Mtg. of the Plasma Div., APS; San Diego, Calif.

Nov. 6-9: Acoustical Soc. of America; Univ. of Mich., Ann Arbor, Mich.

Nov. 11-13: Radio Fall Mtg., IEEE, EIA; Manger Hotel, Rochester, N. Y.

Nov. 12-14: Meeting, American Meteorological Soc.; Univ. of Ill., Urbana, Ill.

Nov. 12-14: Fall Joint Computer Conf., AFIPS (IEEE, ACM, Simulation Councils, Inc.); Conv. Ctr., Las Vegas, Nev.

Nov. 12-14: Mfrs. Automation Show & 7th Conf. on Mfg., Automation, Mfg. Eng. Council; Purdue Univ., Cobo Hall, Detroit, Mich.

Nov. 12-15: 9th Annual Conf. on Magnetism & Magnetic Materials, IEEE (PTG-MTT), AIP; Chalfonte-Haddon Hall, Atlantic City, N. J.

Nov. 13-15: Eastern Analytical Symp. and Instrument Exh., Soc. for Applied Spectroscopy and American Microchemical Soc.; Statler-Hilton Hotel, New York, N. Y.

Nov. 17-22: Winter Annual Mtg., ASME; Bellevue-Stratford Hotel, Philadelphia, Pa.

Nov. 17-22: Annual Mtg., Radiological Soc. of North America; Chicago, Ill.

Nov. 18-19: Symp. on Unconventional Inertial Sensors, Republic Aviation Corp. and Bureau of Navy Weapons; Republic Aviation Corp., Farmingdale, N. Y.

Nov. 18-19: 4th Electrical/Electronic Trade Show, Electrical Representatives Club and Electronic Representative Assoc.; Denver Hilton Hotel, Denver, Colo.

Nov. 18-20: 16th Annual Conf. & Exh. on Eng'g in Medicine & Biology, IEEE, ISA; Lord Baltimore Hotel, Baltimore, Md.

Nov. 18-20: Nat'l Symp., Soc. of Aerospace Material and Process Engineers; Olympic Hotel, Seattle, Wash.

Nov. 18-21: Joint Mtg. and Atom Fair Exh., ANS, AIF; New York Hilton, Americana Hotel, New York, N. Y.

Nov. 18-22: 10th Nat'l Plastics Exp. & Nat'l Plastics Conf., SPI; Sheraton-Chicago Hotel, McCormick Place, Chicago, Ill.

Nov. 19-21: 5th Int'l Automation Congress & Expos.; Sheraton Hotel, Philadelphia, Pa.

'64 Highlights

IEEE Int'l Conv., Mar. 23-26; Coliseum, New York Hilton, New York, N. Y.

WESCON, Western Electronic Show and Conv., Aug. 25-28, IEEE WEMA; Sports Arena, Los Angeles, Calif.

NEREM, Northeast Research & Eng. Mtg., Nov. 4-6, IEEE; Boston, Mass.

Nov. 19-21: Conf. on Stratosphere-Mesosphere Structure, AIAA, AMS, et al; Texas Western College, El Paso, Tex.

Nov. 21: Maecon Symp., Instrumentation and Measurement; Hotel Continental, Kansas City, Mo.

DECEMBER

Dec. 1-5: 56th Annual Mtg., AIChE; Rice Hotel, Houston, Tex.

Dec. 3-5: Winter Conf., EIA; Statler-Hilton Hotel, Los Angeles, Calif.

Dec. 4-6: AIAA/Air Force Testing of Manned Flight Systems; Edwards AFB, Calif.

Dec. 4-6: Ultrasonics Eng'g Symp., IEEE (PTG-UE); Marriott Motor Hotel, Washington, D. C.

Dec. 4-6: 21st Electric Furnace Conf., AIME; Drake Hotel, Chicago, Ill.

Dec. 5-6: 14th Nat'l Conf. on Vehicular Communications, IEEE (PTG-VC); Adolphus Hotel, Dallas, Tex.

Dec. 6: 4th Annual Seminar on Reliability in Space Vehicles, PTG-R, ED, CP; Los Angeles, Calif.

Dec. 9-11: URSI-IEEE Fall Mtg., IEEE, URSI, et al; Seattle, Wash.

Dec. 19-21: APS Mtg.; Pasadena, Calif.

Dec. 26-28: Amer. Astronomical Soc. Mtg.; Washington, D. C.

Dec. 26-30: Annual Mtg., Amer. Ass'n for the Advancement of Science; Hotel Cleveland, Ohio.

JANUARY 1964

Jan. 7-9, 1964: 10th Nat'l Symp. on Reliability and Quality Control, IEEE, ASQC; Statler-Hilton Hotel, Washington, D. C.

Jan. 22-24, 1964: 19th Annual Instrumentation Symp. for the Process Industries; Texas A & M College, College Sta., Tex.

FEBRUARY

Feb. 2-7: IEEE Winter Power Mtg., IEEE; Statler-Hilton Hotel, New York, N. Y.

Feb. 3-7: Int'l Conf. on Materials, ASTM; Sheraton Hotel, Philadelphia, Pa.

Feb. 5-7: 1964 Nat'l Winter Conv. on Military Electronics, IEEE; Ambassador Hotel, Los Angeles, Calif.

Feb. 19-21: 1964 Int'l Solid-State Circuits Conf., IEEE and Univ. of Pa.; Philadelphia, Pa.

MARCH

Mar. 2-6: 15th Conf. on Analytical Chemistry & Applied Spectroscopy; Penn Sheraton Hotel, Pittsburgh, Pa.

Mar. 16-20: Western Metal & Tool Expos. and Conf., American Soc. of Tool & Mfg. Engineers and ASM; Pan Pacific Auditorium, Los Angeles, Calif.

Mar. 23-26: IEEE Int'l Conv.; Coliseum and New York Hilton, New York. N. Y.

Mar. 31-Apr. 2: ASM Gulf Coast Metalworking Exh. & Conf., ASM; Shamrock-Hilton Hotel, Houston, Tex.

APRIL

Apr. 1-2: 5th Symp. on Eng. Aspects of Magnetohydrodynamics, IEEE, AIAA, MIT; MIT, Cambridge, Mass.

Apr. 6-9: Int'l Conf. on Nonlinear Magnetics, IEEE; Shoreham Hotel, Washington, D. C.

Apr. 14-16: American Power Conf., IEEE, et al; Sherman Hotel, Chicago, Ill.

Apr. 19-25: Int'l Conf. & Exhib. on Aerospace Electro-Tech., IEEE, et al; Westward-Ho Hotel, Phoenix, Ariz.

Apr. 21-23: Spring Joint Computer Conf., AFIPS(IEEE-ACM); Sheraton-Park Hotel, Washington, D. C.

Apr. 22-24: Southwestern IEEE Conf. & Elec. Show, IEEE; Dallas Memorial Auditorium, Dallas, Tex.

Apr. 28-30: 12th Annual Conf. on Electromagnetic Relays, NARM; Oklahoma State Univ., Stillwater, Okla.

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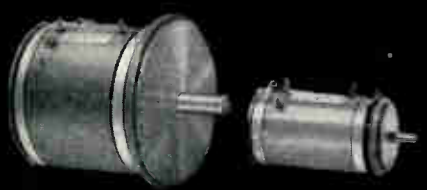
POTS?



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CLARE SEALED Stepping Switches

provide compact, maintenance-free, long-life sequential switching for complex industrial and military applications in damaging environments

CLARE 8 level, 52-point stepping switch, wired and ready for sealing, requires 4½ sq. in. less chassis space than other sealed switches of comparable size. CLARE 8 and 12 level, 26-point switches mount in 11 sq. in. less space than comparable models.

Hermetically sealed in steel enclosures, CLARE Sealed Stepping Switches add to operating life, eliminate tampering and permit extended use or storage with no deterioration of operating characteristics. Enclosures may be hermetically sealed with nitrogen or fluid.

When sealed in fluid and remotely pulsed, operating life permits 10-15,000,000 steps. CLARE design which permits more levels per switch... and more levels in less space... allows CLARE sealed switches to provide the most switching capacity in the smallest space. A wide variety of enclosures plus a complete range of connectors make CLARE Stepping Switches extremely flexible and easily adaptable to almost all applications.

CLARE Sealed Stepping Switches include spring-driven, cam-operated and direct-drive units with capacities from 10 to 52 points. Sealing in fluid is recommended where unusually long life is a requirement or high shock or vibration are factors.

CLARE Engineering will cooperate to develop special switches to meet unusual problems. Address: C. P. Clare & Co., Group 1106, 3101 Pratt Boulevard, Chicago, Illinois 60645.

Electrical and Mechanical Characteristics of Sealed Spring Driven Stepping Switches and Cam Switches

Type	Points per Electrical Level	Electrical Levels (max.)	Operating Speeds			Nominal voltages and Coil resistances
			Sealed in Fluid	Sealed in Nitrogen		
			Remotely Pulsed	Self-Interrupted	Remotely Pulsed	
210	10, 20 or 30	12-10 pt., 6-20 pt., 4-30 pt.	25 steps per second at nominal voltage with 66% "on" time; 25°C	60 steps per second at nominal voltage 25°C	30 steps per second at nominal voltage with 66% "on" time; 25°C	6, 12, 24, 48, 60 and 110 vdc 1.5-600 ohms
211	11, 22 or 33	12-11 pt., 6-22 pt., 4-33 pt.				
20	10, 20 or 40	16-10 pt., 16-20 pt., 12-40 pt.				
26	13, 26 or 52	16 13 pt., 16-26 pt., 12-52 pt.				
200	Up to 8 cams, to 6 contact springs per cam and 30, 32 or 36 steps per revolution.					

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Relays and related control components

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NEW, SUPER-MINIATURIZED FERRITE COMPONENTS

for smaller, lighter microwave systems and equipment

Miniature isn't good enough anymore!! The growing need for smaller systems packaging can only be answered by super-miniaturized components of assured reliability and top performance characteristics. These new waveguide, coaxial and strip type components meet major MIL specs for shock and vibration. All coaxial components are self-magnetic shielding due to an internal magnet. All components are temperature stabilized. Here is a ready-to-go line of super-miniaturized components that ideally fits today's smaller, lighter package requirements.

NO.	PART NO.	TYPE	FREQUENCY (GC)	ISOL. (MIN)	(MAX) INS. LOSS	(MAX) VSWR	(MC) BANDWIDTH	SIZE	WEIGHT
A	W-F-IS-C-021-1000	WAVE	3.95- 5.85	20 DB	0.5 DB	1.25	150	3½" Dia. x 1"	9.5 oz.
B	W-F-IS-X_B 024-750	WAVE	5.85- 8.2	20 DB	0.5 DB	1.25	200	3⅛" Dia. x ¾"	5.0 oz.
C	W-F-IS-X_L-041-750	WAVE	7.0 -11.0	20 DB	0.5 DB	1.25	400	2" x 1⅞" x ¾"	3.0 oz.
D	W-F-IS-X-044-500	WAVE	8.2 -12.4	20 DB	0.5 DB	1.25	600	1⅞" x 1⅝" x ½"	1.7 oz.
E	W-F-IS-K_U-016-500	WAVE	12.4 -18.0	20 DB	0.5 DB	1.25	800	1½" x 1⅝" x ½"	.60 oz.
F	W-F-IS-K-006-500	WAVE	18.0 -26.0	20.5 DB	0.5 DB	1.25	800	1" x ⅞" x ½"	.35 oz.
G	S-F-IS-C-202-1250	STRIP	5.4 - 5.9	15 DB	0.5 DB	1.25	400	1" Dia. x 1.25" H.	.70 oz.
H	S-F-IS-X-009-1000	AIR STRIP	8.2 -12.4	20 DB	0.5 DB	1.25	600	1" Long x ¾" Sq.	1.5 oz.
I	C-F-IS-S-008-875	COAX.	2.7 - 3.2	20 DB	0.5 DB	1.20	—	4½" x ⅞"	5.2 oz.
J	C-F-IS-C-004-875	COAX.	5.4 - 5.9	20 DB	1.0 DB	1.15	—	3" x ⅞"	3.2 oz.
K	C-F-IS-C-002-500	COAX.	5.4 - 5.9	40 DB	1.5 DB	1.25	—	4" x ½"	3.7 oz.

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WASHINGTON TRENDS

NASA ISSUES RELIABILITY GUIDES FOR CONTRACTORS—Space contractors in electronics have a new set of guidelines to worry about. The guides spell out tasks to be included in reliability programs in design, fabrication and use of developmental type hardware systems. Guides will be applied to contracts rated over $1 million "and certain other items critical to the performance of spacecraft, launch vehicles or other equipment for space flight." Copies of NPC 250-1, "Reliability Program Provisions for Space System Contractors," are being given out by contract officers at all major field research centers.

FCC IRKS CONGRESS, INVESTIGATION THREATENED—Recent actions and speeches by FCC are causing sharp irritation in both Senate and House. Chairman Oren Harris, House Commerce Committee (that created the FCC and which originates any major changes) charges that FCC is overstepping its authority by: proposing to limit the number and length of radio and TV commercials; proposing to ban race results; attempting to regulate community antenna TV systems; attempting to regulate the volume of news broadcasts dealing with race integration and segregation. Harris claims the Commission has no authority to act in these areas.

DYNASOAR IN BIG PUSH—Despite pros and cons, Dynasoar manned-spacecraft still has the "go" sign in the Pentagon. Military men say the Dynasoar, intended to shoot into space, maneuver and then return like an aircraft, will get a big push next year. The push will be based on the craft's usefulness for data on how its human pilot can operate in space. Push will be aimed also at testing new structure techniques in using advanced materials.

MORE TALK OF DEFENSE CUTS — There's fresh talk all over Washington about the "desirability" of cutting defense spending. Those who would cut (some urge trimming as much as 10% from the $47 billion defense total) say the atom test ban makes big defense outlays unnecessary. But most members of both political parties are not so sure. They point to the continuing need for R&D in all areas of procurement. A group of Senate liberals demanding the cuts wants the money spent instead on new programs and controls over health, education, welfare, transport, and farm output. While this group is not likely to have its way at any early date, it is important to keep a close watch on this trend.

BATTLE COMSAT BUYING RULES—Industry spokesmen are demanding that FCC alter proposed rules on procurement by the Communications Satellite Corp. (COMSAT). Among attackers is the Electronic Industries Association, which charges the rules are unworkable, unprecedented, and costly. EIA feels small firms would be hit because rules are too complex. They go beyond the COMSAT law (by applying to subcontractors), and would increase costs without any offsetting benefits. EIA wants FCC to regulate only contracts over $250,000 or $100,000 rather than the $2,500 proposed; eliminate proposed detailed reports unless sole-source procurement or other low bid is accepted, and exclude all R&D contracts from the rules.

SUBCONTRACTING TO RISE — Major prime government contractors have agreed to expand their subcontracting. A group of 26 primes, who together get more than 40 cents out of every dollar spent in military procurement, have promised Washington they'll exceed their minimum legal requirement of subcontracting they do. They have promised to look up more small business sources. They will make every effort to farm out portions of their prime contracts.

NASA FIGHTS FOR FUNDS — The National Aeronautics and Space Administration is urging the Senate Appropriations Committee to restore the deep cuts in its budget. Their main pitch: The moon program is already deep in contracts, personnel, and facilities. Any cutback now will boost cost. In addition, they argue that the President's offer to cooperate with the Russians in a moon landing should not slow our own efforts. Benefits of the moon program will help all other space efforts, including military ones.

BIG R&D FIRMS STAY "SMALL"—Electronic firms bidding on U. S. contracts for R&D can keep their "small business" tag despite annual income. Small Business Administration has dropped the general $1 million annual income yardstick. This permits more firms to handle government contracts. SBA spokesmen say most firms that bid on R&D contracts may have earned much more than $1 million in previous years. The new rule draws the line at production of hardware. If a firm produces no hardware, and is engaged solely in R&D, it remains "small" if employees do not exceed 500. If a firm must produce hardware, such as a prototype computer, the same size standard applies that would apply to a small manufacturer of computers.

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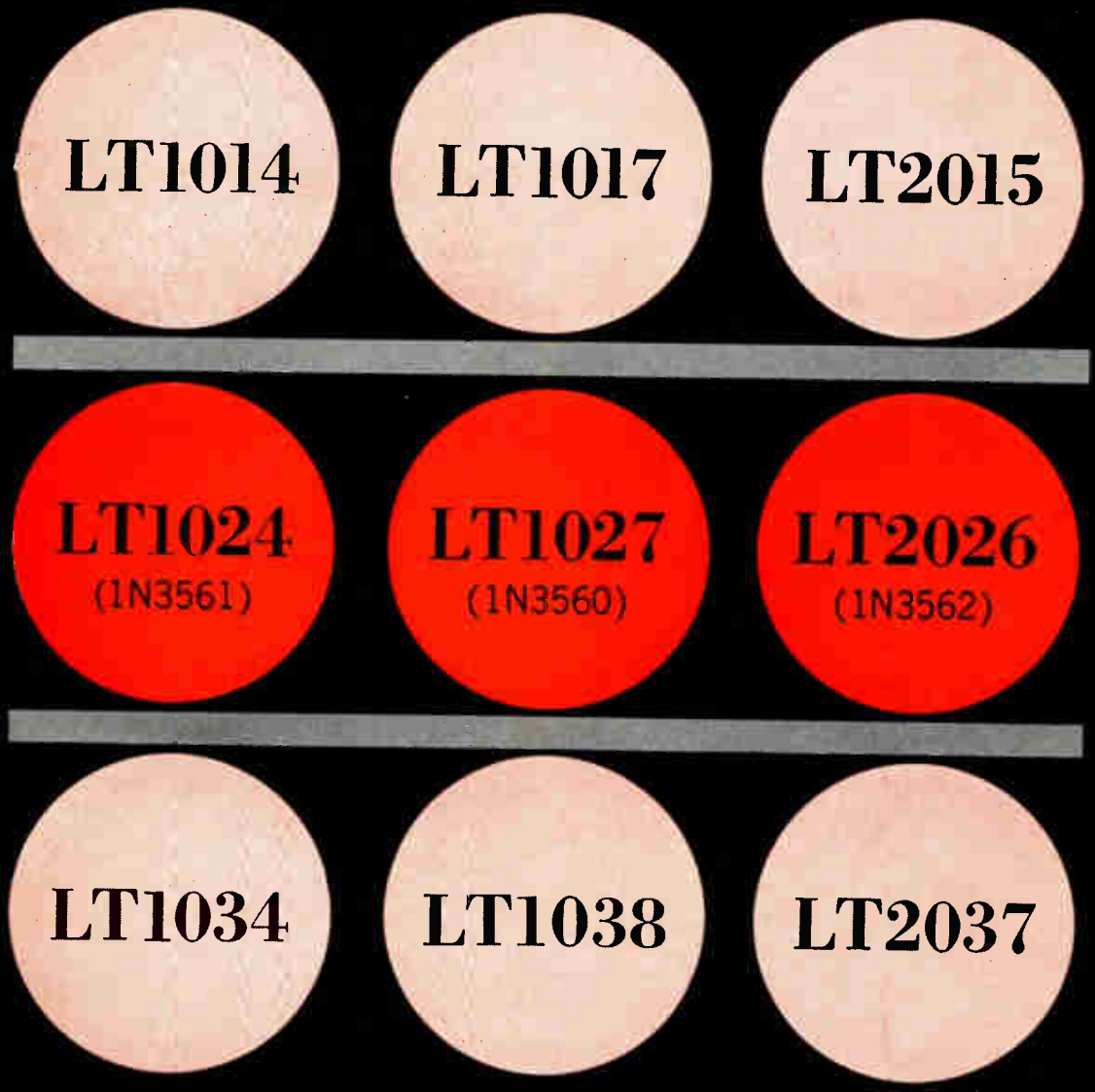

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PHILCO ANNOUNCES SIX NEW TUNNEL DIODES FOR UHF AND COMPUTER APPLICATIONS

Now, Philco provides the circuit designer with an expanded line of Tunnel Diodes to meet specific application requirements. All units are particularly well suited for low-level switching and small-signal applications. Prices are compatible with parameters. Production expansion provides immediate delivery on all types as well as capability to produce units to meet other requirements. For Data Sheet LT1000, LT2000 Series, write Dept. EI1163.

1N3353 GERMANIUM BACKWARD DIODE

Useful for low-level detection or threshold detection systems in conjunction with Tunnel Diodes. Also suitable for conventional mixing and detecting applications. Philco can provide to specification matched pairs of Backward Diodes or Backward and Tunnel Diodes in custom packaging. We invite your inquiry.

Type	I_P, ma Typ.	Tolerance %	I_P/I_V min.	C, pf Typ.*	R_S Typ.**
LT1014	1.00	2.5	8	5	1.5
LT1017	1.00	2.5	5	5	1.5
LT1024 (1N3561)	1.00	2.5	8	9	1.5
LT1027 (1N3560)	1.00	2.5	5	9	1.5
LT1034	1.00	5.0	8	10	2.0
LT1038	1.00	5.0	4	10	2.0
LT2015	5.00	2.5	7	25	0.9
LT2026 (1N3562)	5.00	2.5	6	45	0.7
LT2037	5.00	5.0	5	50	0.7

*This value includes case capacitance which is typically 2pf.

**The total series resistance, R_S, is measured at a reverse current of 70 ma. The diode maximum reverse current rating may be exceeded for the brief interval of time necessary to perform this measurement.

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MARKETING

Facts and Figures Round-Up

MICROWAVE MARKET RISING AS USES AND EXPORTS INCREASE

Factory sales of microwave components for 1962, not including tubes and antennas, have been put at about $75 million. Total sales of electronics components are nearly $4 billion, according to the Electronics Division, Business and Defense Services Administration, U. S. Department of Commerce.

Among current predictions around the industry, including educated forecasts and wild guesses, are total microwave component sales of $100 million for 1963. Lorne D. Armstrong, Micro State Electronics Corp., is one of several industrialists who placed the microwave component market for 1968 near the $500 million level. Some, Mr. Armstrong reports, say his figure is somewhat conservative. Mr. Armstrong, among others, also sees a microwave semi-conductor market of $75 million by 1968.

In general, electron tubes increased 1.7% in total sales over 1961 to $875 million in 1962. A 10% rise in sales of power and special purpose tubes, according to the Commerce Department, especially in microwave, more than offsets declines of 1.7% in receiving tubes and 3.5% in TV CRT output. Some microwave tubes in fact showed increases of as much as 100% or more.

Klystron sales jumped from about $28 million in 1961 to nearly $59 million in 1962. Magnetrons had the greatest percentage increase—150% —from $16 million to more than $40 million. Traveling wave tubes, backward and forward, spiraled up from $23 million to $55 million.

If current predictions for the market in general hold firm, microwave tube sales for 1963 could top $200 million.

Semiconductor diodes for the microwave market, though only about 10% of the microwave tube market at present, showed something like 26% rise over 1961. Mixers, detectors, parametric diodes and others went from $9.6 million to $11.8 million. Tunnel diodes, though not all for microwave, went up 50% from a little below $1 million to $1.5 million. Sales in microwave semiconductors for 1963 are currently guessed at about $25 million, or about 25% of the total microwave component market. About one third of this, or $8.5 million, is estimated for microwave transistors. The remainder is for diodes.

Extravagant increases in microwave shipments and sales may be reflected in the fact that microwave technology is being used more and more in commerce and industry, especially by firms known as common carriers.

Another important reason is the tremendous upsurge in amounts of microwave hardware and systems being exported to other countries. In fact, exports currently account for an estimated 40% of all microwave shipments and sales.

Elsewhere in the electronics market, although unit shipments of semiconductors in general increased 35% over 1961, the value of shipments showed only a 1% rise to $571 million, reflecting a continuing decline in unit price of many semiconductor types.

Capacitor sales gained 16% to $349 million, and resistors rose 23% to about $350 million. Connectors showed a gain of 30% to $248 million; complex components marked a large gain of 77% to $67 million.

Relay sales recorded 10% rise to $201 million, reversing the slight 1961 decline. The reason mostly was introduction of advanced types.

HIGH SPENDING PUTS R&D UNDER EYE OF CONGRESS

Higher spending for R&D has put the whole R&D market subject to a coming series of actions. Latest National Science Foundation data reveal that $11.6 billion was spent on industrial R&D in 1962—6% above 1961.

Congress is perking up to the fact that the Government financed $6.7 billion and industry $4.8 billion. In mid-1962 a broad report from Bureau of Budget urged greater Federal control on all R&D contracts. Congress, still somewhat unhappy over the state of R&D, has ordered investigations to conduct research in the subject.

Results should help the Government and industry to reshape the future course of R&D. The National Science Foundation, the National Institutes of Health, as well as NASA and DOD programs of R&D will be studied by our legislators.

'OFF-SHELF' HARDWARE PUSHED FOR AEROSPACE PROJECTS

While some defense contractors resent DOD prodding to cut costs, others are promoting goods "off-the-shelf." Their sales pitch is that certain catalog items can be used for exotic aerospace projects, as well as for routine needs.

A cited example is the "Transpac" TC222 DC to DC converters, made by Electronic Research Associates, Inc. They were used with success in the recent Stratoscope II flight that sought life-supporting elements on Mars.

In a similar vein, U.S.A.F. Secretary Eugene M. Zuckert has stressed that several off-the-shelf sub-systems will be "government furnished equipment" for the F-111 (formerly TFX) Air Force/Navy tactical fighter aircraft. Sub-systems include: TACAN, intercom and instrument landing systems, UHF radio, navigation gear, and IFF transponder.

In a sense, this practice goes back to the old days when the Government provided most of the innards that former airframe builders installed in most finished aircraft.

INDUSTRIAL ELECTRIC SALES PUT AT $20 BILLION IN '63

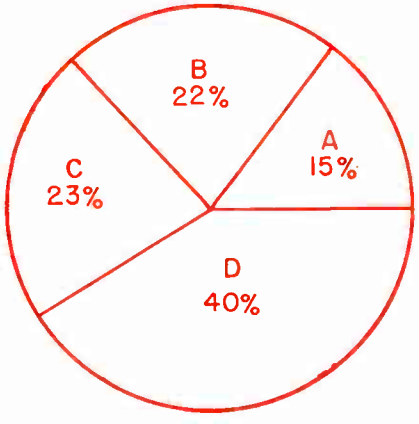
Sales of industrial electrical and electronic products should set a record high of some $20 billion this year, predicted Orland M. Scott, vice president and group executive at IBM.

He said also that capital equipment business expenditures should reach a new high in 1964, perhaps up to 10% above 1963 totals.

Scott cautioned against being "lulled by seemingly comforting statistics. They do not reveal changes within the market structure."

Marketing will have to take the lead to help business meet the problems of changing customer needs, changing technology, and a changing environment, he added.

WHO'S GETTING THE MICROWAVE HARDWARE THIS YEAR?



Percent of 1963 market *

A. U. S. Government (Defense/Non-Defense Direct Sales)	15%

(Percentages below include unknown but substantial amounts of U. S. Government dollars in defense and non-defense for the domestic scene and in foreign aid)

B. Industry (Communications, Telemetry, TV)	22%
C. Common Carriers (Telephone, Telegraph)	23%
D. Exports to other nations	40%

*1. Figures include all types of microwave products and service

2. They do not include Western Electric, largest single factor in microwave business outside of Department of Defense

3. They do include companies that sell to Western Electric (See article—"Microwaves—A Market In Transition")

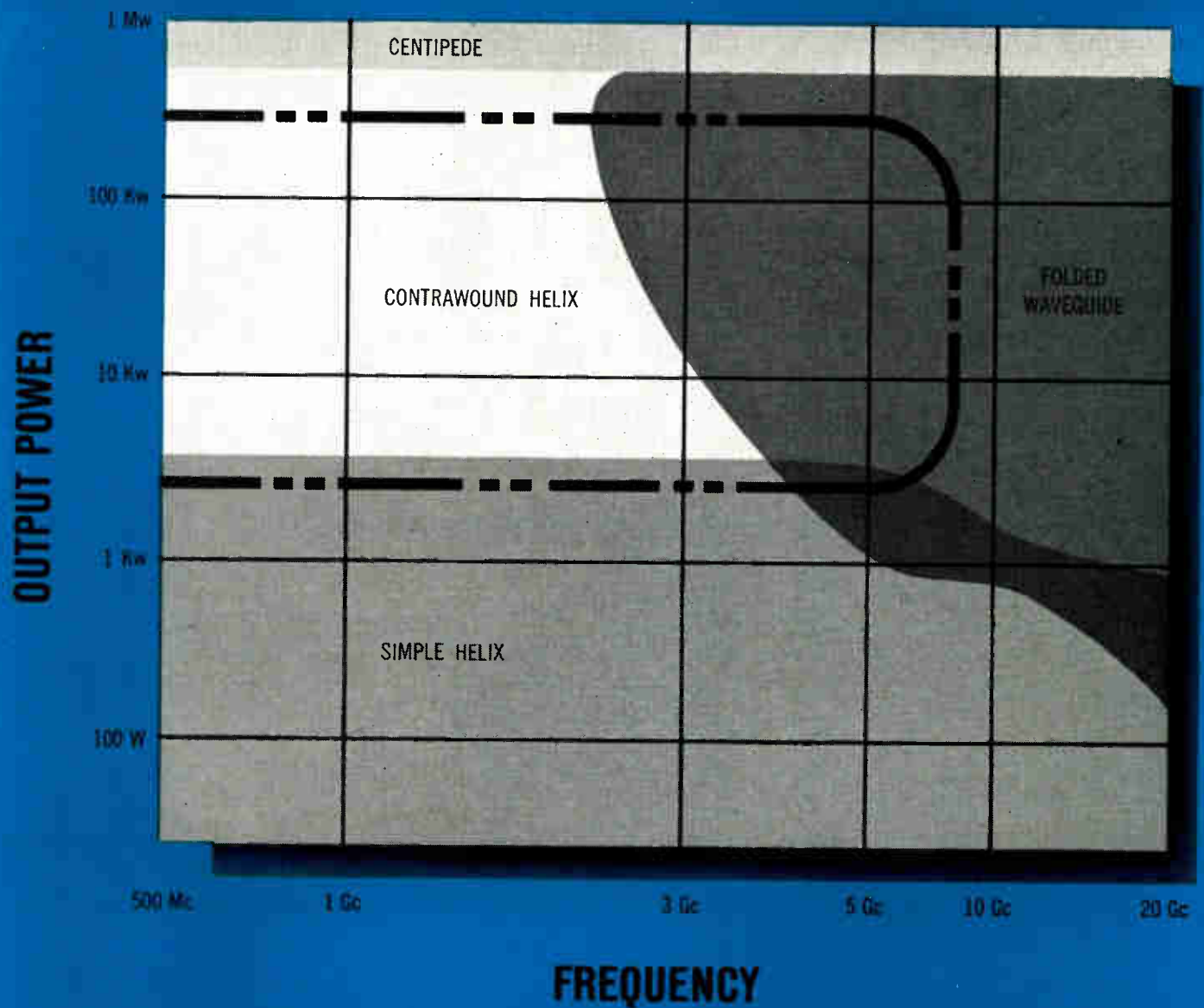
World Radio History

A look at the chart below reveals that practically any combination of high power and frequency can be met by at least one of Sylvania's traveling-wave tubes — a growing line that originated with the B-58 Hustler program. Sylvania's experience in building all of the four types insures that you will get the optimum combination of values for these important factors: dispersiveness (variation of phase velocity with frequency), interaction impedance (field strength at the position of the electron beam), interfering modes, and heat dissipating ability.

Simple helix is the ideal slow-wave structure at all frequencies from 500 Mc to 20 kMC at peak power levels up to a few kilowatts. At higher peak levels the contrawound helix or the folded waveguide structure is indicated. The "ring-bar" type of contrawound helix is best from 500 Mc to about 5 kMC, but at higher

From one experienced source:

High-power TWT's for the full range



World Radio History

frequencies the more rugged folded waveguide structure must be used. At power levels above 500 kw, for all frequencies, a forward fundamental coupled-cavity circuit is most appropriate, such as the centipede structure shown.

In some power and frequency ranges, two or three of the structures are applicable, as the chart shows. In these regions, other considerations such as average power capability, mechanical configurations or suitability for PPM focusing will determine the structure to use.

Whatever type of high-power traveling-wave tube may be called for in your application, Sylvania probably has it. See your Sylvania sales engineer, or write to Microwave Device Division, Sylvania Electric Products Inc., Mountain View, California.

# of power-frequency combinations

	Simple Helix Structure				Contrawound Helix	Folded Waveguide	Centipede
	LOW FREQUENCY	**100 WATTS CW**	**SMALL, LIGHTWEIGHT**		**S-BAND**	**X-BAND**	**HIGH POWER, BROAD BAND**
	SYT-4383	SYT-4369	C-Band SYT-4393	X-Band SYT-4394	SYT-4378	SYT-4428	SYT-4341
Frequency (Gc)	0.5-1.0	7-10	4-8	7-12	2.7-3.5	8.5-9.5	8.5-9.2
Min. Power Output	2 kw pk	100 watts CW	1 kw pk	1 kw pk	5 kw pk	1 kw CW	1 meg pk
Min. Gain	30 db	30 db	30 db	30 db	34 db	40 db	30 db
Focusing	PPM	PPM	PPM	PPM	PPM	Solenoid	Solenoid
Max. Duty Cycle	0.01	CW	0.01	0.01	0.002	CW	0.001
Length (in.)	40	14	18	14	20	20	32
Weight (lb.)	50	2	2	2	12	50	100
Cooling	Forced Air	Forced Air	Forced Air	Forced Air	Forced Air	Water	Water

Tentative data—subject to revision

Circle 12 on Inquiry Card

MICROWAVE DEVICE DIVISION

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

World Radio History

SOUND THE ALARM ►

One of new ALRI (Airborne Long Range Input) aircraft which is packed with gear which provides automatic detection of intruders, processing of information and transmission to ground-base stations. Burroughs Corporation was manager for the system.

ELECTRONIC GIANT

Maureen O'Donnell (left) peers around an RCA superpower-electron tube. This amplifier tube was developed for use in the 2-mile linear accelerator at Standford Univ. It is capable of producing 24 million watts peak power.

REDUCTION ►

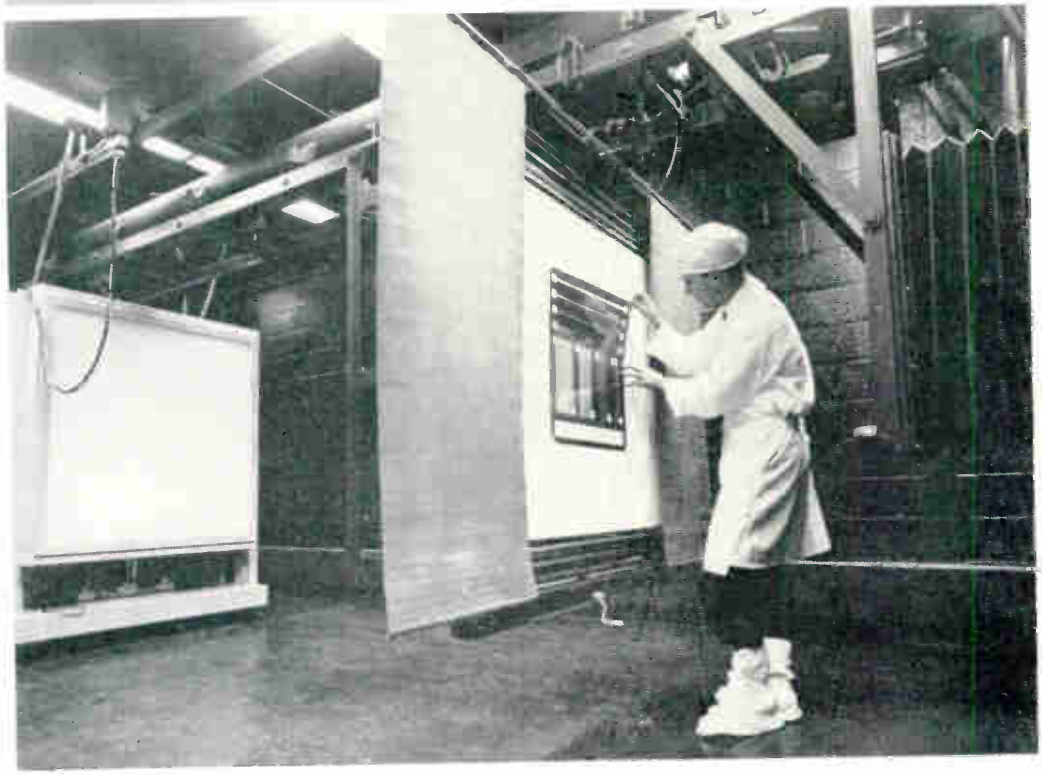
Camera facility (rt) of Westinghouse Molecular Electronics Div. at Elkridge, Md., produces masking slides with a tolerance equal to only a fraction of the width of a hair. Operator mounts a pattern which will be photographed and reduced to about the size of a pinhead.

World Radio History

SNAPSHOTS... OF THE ELECTRONIC INDUSTRIES

TRAFFIC CONTROL

Engineer checks console of Special Purpose Control Traffic Computer (center) which gathers data from traffic detector elements in new Traffic Control System in Toronto. Information is then fed into the Univac 1107 Thin-Film Memory Computer. Operator at control console (left) switches one of the tape units (right) on line. Tapes are used to store traffic load information as well as feed previously programmed instructions into computer.

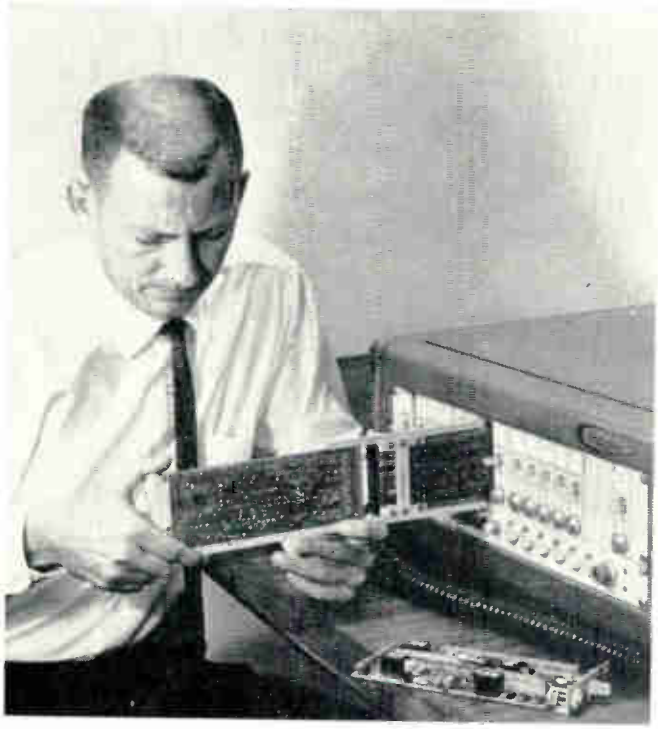


"TOUCH-TONE"

"Touch-tone" telephone switchboard which cuts communication time in half has been installed in Continental Airlines' new hdqrs. bldg. in Los Angeles. Cordless switching system was designed by the airline and built for just them by Pacific Telephone.

World Radio History

SNAPSHOTS... OF THE ELECTRONIC INDUSTRIES (Continued)



FLEXIBLE SYSTEM

Engineer J. Wagoner demonstrates ease of repair of ITT (Kellogg Div.) voice communications system. Console permits direct-line and party-line circuits, conference nets, and public - address - system facilities, as well as interworking with normal dial telephone systems.

IT'S A SNAP

Charles Fink prepares SNAP-9A nuclear generator for space flight. Generator is the latest in a series designed as dependable, long-lived electrical supplies for satellites Mr. Fink directed development and testing of SNAP-9A for Martin Co.'s Nuclear Div., the AEC's contractor for the program.

MOVING MAP

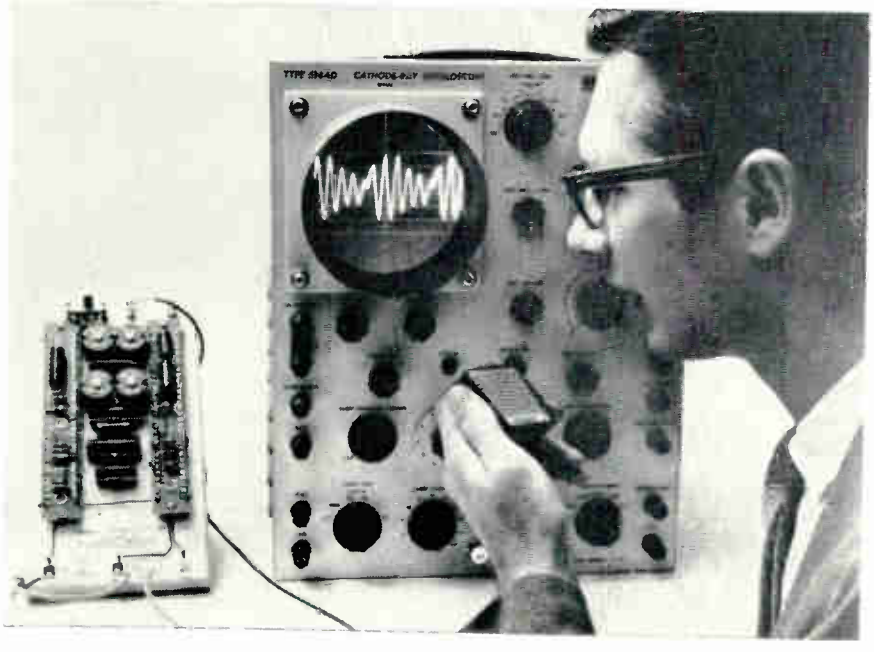
Engineer R. Vago adjusts brightness on map indicator of Computing Devices of Canada Ltd.'s (Ottawa) Tactical Moving Map Display. Equipment provides a pilot with a brightly lit map of topographic detail surrounding present aircraft position Map movement is automatic.

SUPER-CLEAN

Miniature vacuum cleaner sucks specks of dust from precision parts of an accelerometer that will be used on the Saturn rocket space vehicle. Sperry Gyroscope Co. technician uses a microscope to assure that components will be spotless before assembly.

TEACHING AID

R. Thompson, Bell Telephone Labs engineer operates Formant Separating Filter which is part of a new aid, the "Speech Chain." New aid allows a teacher to display on a scope, the contribution of first vocal tract resonance (formant) to complex waveform of speech.



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Now Motorola Has BOTH . . .

SILICON PNP & NPN

STAR* TRANSISTORS

(TO-5) 2N2904 2N2905

(TO-18) 2N2906 2N2907

(TO-5) 2N2218 2N2219

(TO-18) 2N2221 2N2222

IMMEDIATELY AVAILABLE from your Motorola District Representative or Motorola Semiconductor Distributor. Priced even lower than non-passivated PNP devices designed for similar applications, the new high-voltage PNP silicon epitaxial passivated STAR transistors are made by the revolutionary annular process, and are the newest additions to Motorola's growing line of BAND-GUARD* types.

PNP Min.	PNP Max.	CHARACTERISTICS	NPN Min.	NPN Max.
60V	–	BV_{CBO}	60V	–
40V	–	BV_{CEO}	30V	–
5V	–	BV_{EBO}	5V	–
–	20nA	I_{CBO} @ 50V	–	10nA
–	0.4	V_{CE} (sat) I_c=150	–	0.4
–	1.3	V_{BE} (sat) I_b=15	–	1.3
		h_{FE} @ 0.1 mA		
20	–	2N2904, 2N2906 2N2218, 2N2221	20	–
35	–	2N2905, 2N2907 2N2219, 2N2222	35	–
		h_{FE} @ 1 mA		
25	–	2N2904, 2N2906 2N2218, 2N2221	25	–
50	–	2N2905, 2N2907 2N2219, 2N2222	50	–
		h_{FE} @ 10 mA		
35	–	2N2904, 2N2906 2N2218, 2N2221	35	–
75	–	2N2905, 2N2907 2N2219, 2N2222	75	–
		h_{FE} @ 150 mA		
40	120	2N2904, 2N2906 2N2218, 2N2221	40	120
100	300	2N2905, 2N2907 2N2219, 2N2222	100	300
		h_{FE} @ 500 mA		
20	–	2N2904, 2N2906 2N2218, 2N2221	20	–
30	–	2N2905, 2N2907 2N2219, 2N2222	30	–
–	8 pf	C_{ob}	–	8 pf
–	30 pf	C_{ib}	–	20 pf
200 mc	–	f_T	250 mc	–

*Trademark of Motorola Inc.

"new leader in Total Silicon Technology"

MOTOROLA Semiconductor Products Inc.

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83-058

World Radio History

Sampling TEKTRONIX OSCILLOSCOPES

with 2 mv/cm sensitivity and fractional-nanosecond risetime

Type 561A—Sampling or Conventional Plug-In Units

With sampling plug-in units, the Type 561A becomes a low-drift sampling system that operates like a conventional oscilloscope—but with sensitivity and bandwidth possible only through sampling.

For sharp displays and convenient photography, the crt features a "no-parallax" internal graticule with controllable graticule lighting. Other oscilloscope features include risetime of 0.4 nsec in both channels . . . internal triggering from A and B signals . . . time measurement range down to 100 μsec . . . calibrated vertical sensitivities from 2 to 200 mv/div . . . sweep delay through 100 nsec.

Also, a monitorable dc-offset voltage simplifies measurement of millivolt signals in the presence of a ±1 volt dc component; and a smoothing control permits reducing time jitter and amplitude noise, if needed.

Type 561A Oscilloscope (as illustrated) $2220

Type 567—Analog Displays plus Digital Readout

With digital and sampling plug-in units, the Type 567 shows readout of pulse amplitudes as small as 2 mv peak-to-peak . . . of pulse risetimes as fast as 0.4 nsec . . . of time differences as small as 50 psec up to 100 μsec. After measurement points on the displayed waveform have been selected once, for all successive similar measurements, digital data of further tests can be read directly. Indicators light to designate readout status—whether *in* the present limit range, *below* it, or *above* it. The digital presentation and indicator lights show immediately if the item tested has met specifications.

Also, the Type 567 can be programmed externally for automatic test systems.

Type 567 Oscilloscope (as illustrated) $4950

Type 661—Choice of 3 Dual-Trace Units

Most versatile Tektronix sampling system, the Type 661 features a highly adaptable timing unit and choice of 3 dual-trace units:

1 Type 4S1—with 0.35-nsec risetime, delay lines and internal triggering,
2 Type 4S2—with 0.1-nsec risetime, no delay lines or internal triggering, and
3 Type 4S3—with miniature low-noise direct-sampling probes, 0.35-nsec risetime, risetime control, and 100-k, 2-pf input impedance. In addition, each dual-trace unit features 2 mv/cm sensitivity, monitorable dc-offset, signal inversion, smoothing control, and 5 display modes.

Also, the Type 661 can be used with a wide range of Tektronix probes, sampling accessories, test jigs and associated instruments to utilize full capabilities of the compact and complete sampling oscilloscope.

Type 661 Oscilloscope (as illustrated) $3500

For a demonstration of any of these oscilloscopes in your own sampling application, please call your Tektronix Field Engineer.

SAMPLING NOTES available—an informative 16-page booklet on concepts and systems—by writing to the Advertising Department, P. O. Box 500, Beaverton, Oregon.

Tektronix, Inc. / P. O. BOX 500 · BEAVERTON, OREGON 97005 Phone (Area Code 503) Mitchell 4-0161 · Telex: 036-691 · TWX: 503-291-6805 · Cable: TEKTRONIX · OVERSEAS DISTRIBUTORS IN 27 COUNTRIES

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Tektronix Canada Ltd.: Montreal, Quebec • Toronto (Willowdale), Ontario • Tektronix Australia Pty. Limited, Sydney, New South Wales

World Radio History

EVEN IN BRIGHTEST LIGHT

NEW IEE READOUTS READ SHARP & CLEAR

IEE READOUTS NOW 4-TIMES BRIGHTER · Rear-projection IEE one-plane readouts now have a new brightness-building lens system (Pat. Pend.). With this system, they provide character brightness at least 4-times greater than possible before. IEE's greater brightness makes for visual crispness and unmistakable clarity at wider angles, longer distances; great readability even under most adverse high ambient light conditions.

4-TIMES BRIGHTER WITH CONVENTIONAL LAMPS · IEE readouts operate with the same standard MS and commercial lamps normally used. Greater brightness is achieved with lenses, not with lamps. For example, our previous models using 6.3 v lamps gave a light level of approximately 27 foot-lamberts, as bright or brighter than competitive devices. The new IEE readout, operated with *identical lamps* at rated voltage, gives you rated lamp life and over 100 foot-lamberts!

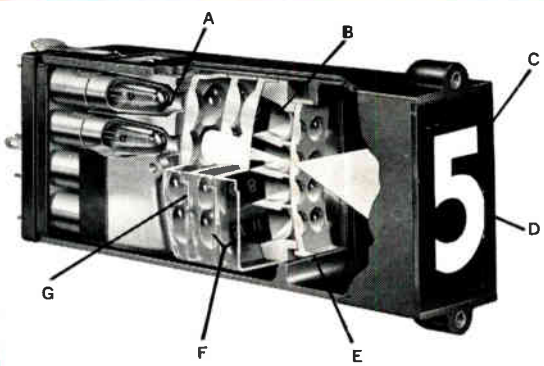
LONGER LAMP LIFE, TOO! · If optimum readout brightness is not your prime requirement, operate the IEE readout at reduced voltage. You'll still get *double brightness* plus *10-times the lamp life* (up to 30,000 hours from 6.3 v lamps operated at 5.3 v).

UNIQUE DISPLAY VERSATILITY · All Series 10 IEE readouts (shown actual size above) are now equipped with the new brightness-building lens system. These readouts also continue to offer the unique display versatility of all IEE rear-projection readouts. 12 lamps provide:

- INDIVIDUAL NUMERALS & LETTERS
- DIGITS WITH POLARITY
- WORDS & MULTI-DIGITS
- MODE/WORD INDICATIONS • MULTIPLE WORDS
- COLOR EMPHASIS • ANY SYMBOLS

NEW OPTICAL PRINCIPLE IN READOUT DESIGN

Three of the four lenses in the new IEE Series 10 readouts are now basically square to permit greater usable lens area in limited space. This increase in size permits the new lenses to collect twice the light while requiring only half the magnification. The two factors combined provide 4-times the brightness of older units.



A. STANDARD MS OR COMMERCIAL LAMP
B. FILM CONTAINING DISPLAY SYMBOL (NUMBERS, LETTERS, WORDS, SYMBOLS, COLORS)
C. NON-GLARE VIEWING SCREEN
D. 4-TIMES BRIGHTER CHARACTER 1⅛" HIGH (MAX.)
E. PROJECTION LENS
F. DUAL SQUARE-LENS CONDENSERS PROVIDE GREATER COVERAGE AT LOWER MAGNIFICATION
G. SQUARE LIGHT-COLLECTING LENS UTILIZES APPROX. 100% MORE LIGHT THAN OLD SYSTEM; TRANSMITS DOUBLE-SIZE CONE TO CONDENSING LENS

IEE one-plane rear-projection readouts are available in several sizes offering maximum character heights from ⅝" to 3⅜". Your inquiry will bring the comprehensive new "Readout Display Selector Guide" which includes specifications and other technical information on the entire IEE line of readout devices.

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

5528 Vineland Avenue, North Hollywood, California • Phone: (213) 877-1144 • TWX: (213) 769-1636

Representatives in Principal Cities

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World Radio History

WHAT'S NEW

Ku MAGNETRONS

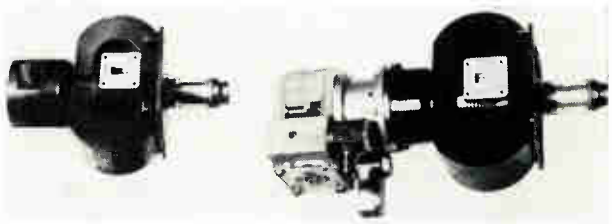
A FAMILY OF COAXIAL-CAVITY KU BAND MAGNETRONS for airborne radar equipment is said to offer up to 25% more efficiency than vane and strap tubes. The lower current density of the large-diameter cathode almost doubles magnetron life for a given power level. These magnetrons show little or no degradation of power or stability during life.

The construction, in which a high-Q external cavity is symmetrically coupled to the interaction region, offers advantages over the vane and strap design, especially at Ku-band. The magnetrons are relatively insensitive to load changes at the output and to current changes at the input. Consequently, they can accept poorly shaped input pulses that cause severe freq. pushing in conventional devices.

The ring tuner, which is readily adaptable to either mechanical or hydraulic tuning, has no internal bearing surfaces. This contributes to mode stability and freedom from arcing.

Two of the new units include a mechanically-tuned retrofit, type SYM-4362, which replaces vane and strap magnetrons in airborne radar. It has a 60kw min. power output and is tunable over 16.0 to 17.0GC. The type SYM-4328 sweeps through 1GC at a rate of 60CPS. A hydraulic drive system with mechanical-electrical servo loop converts input changes to freq. changes. The units has a 16.0 to 17.0GC, 90kw min. power output. Sylvania Electric Products Inc., 1035 Westminster Dr., Williamsport, Pa.

The actuator and tube of SYM-4328 (l.) is available as an integral unit. SYM-4362 (r.) has a 60kw. power output.



More What's New on Pages 41 & 43

SMALL FILM CAPACITOR

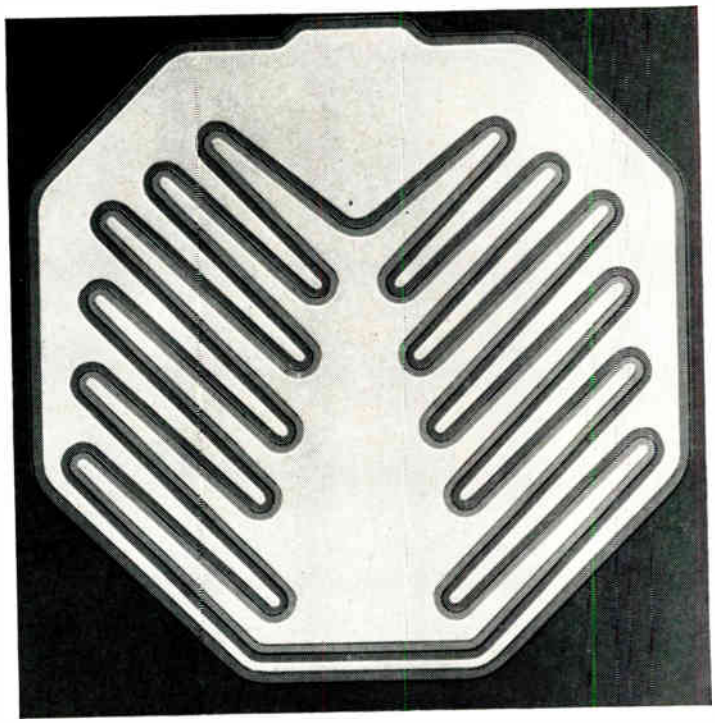
A NEW POLYCARBONATE RESIN DIELECTRIC and improvements in laboratory fabrication has resulted in a metallized-polycarbonate, stripped lacquer film capacitor. The polycarbonate resin was developed by the Tennessee Eastman Co., and the laboratory fabrication was developed by Bell Labs. This capacitor has low-loss characteristics approaching those of present polystyrene or mica capacitors and can be operated over a wide temp. range.

The new 50v. units are suitable for use with transistors and where small size and high capacitance-to-volume ratios are essential. They operate over −78° to +125°C; have a temp. coefficient of capacitance of ±50ppm/°C; and are self-healing. Additional information may be obtained from Bell Telephone Labs., 463 West St., New York 14, N. Y.

Fragile lacquer film cannot be wound satisfactorily on ordinary capacitor-winding machines. A new tangential winder keeps the supply rolls of metallized film in contact with the mandrel during winding, so that the film is never unsupported.

World Radio History

25 watts output at 50 mc from a silicon planar epitaxial transistor?



Yes, here's one for you.

The Bendix® BIG (for Bendix Interdigitated Geometry) Leaf is a silicon planar epitaxial NPN transistor with the highest power-frequency combination now available. Class C power outputs of 25 watts at 50 mc can be achieved and the BIG Leaf has gain-bandwidth products up to 300 mc. The new configuration provides a lower collector saturation voltage, typically 0.2 volt at 2 amperes, higher gain and excellent beta linearity at collector currents up to 10 amperes.

The gain-bandwidth product (f_t) for the new line is due to a brand new Bendix diffusion technique, large emitter periphery, low capacitance and low base resistance. Major applications for the BIG Leaf include HF mobile and portable transmitter, high current switching and high frequency inverters. Since the overall efficiency of the unit is much better than a vacuum tube in the same application, HF, VHF, Class A, and Class C amplifier and oscillator applications are attractive possibilities.

For more detailed performance data on the 2N3016—2N3018 contact your nearest distributor (or the nearest Bendix sales/service office) and tell them you're interested in the BIG Leaf.

Bendix Semiconductor Division
HOLMDEL, NEW JERSEY

THE Bendix CORPORATION

Burbank, Calif.—(213) Victoria 9-3961; **Chicago**—(312) 637-6929; **Dallas**—(214) 357-1972; **Detroit**—(313) JOrdan 6-1420; **Holmdel, N. J.**—(201) 747-5400; **Minneapolis**—(612) 824-7270; **San Carlos, Calif.**—(415) LYtell 3-7845; **Syracuse, N. Y.**—(315) 474-7531; **Waltham, Mass.**—(617) 899-0770; **Export**—Cable: Bendixint, New York, N.Y. (212) 973-2121; **Ottawa, Ontario**—(613) TAlbot 8-2711.

Circle 19 on Inquiry Card

World Radio History

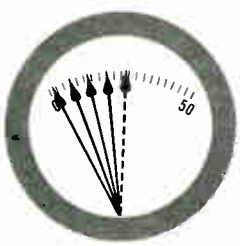
SIMPSON INSTRUMENTS STAY ACCURATE

eight migraine headaches you can't get with a Simpson Meter

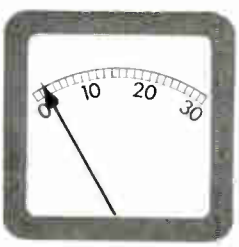
Simpson

SIMPSON ELECTRIC COMPANY 5213 West Kinzie Street, Chicago 44, Ill.

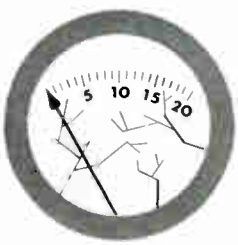
Phone: (312) EStebrook 9-1121
In Canada: Bach-Simpson Ltd., London, Ontario



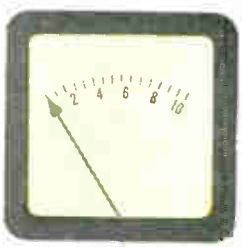
"STICKERS"



SHIFTY CALIBRATION

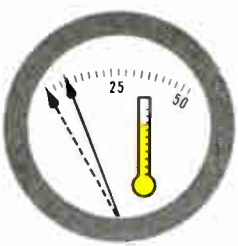


CRAZED CASES



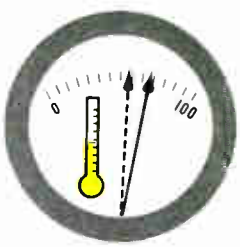
YELLOWING CASES

LINT GRABBER



TEMP. DRIFT (Composition Resistors)

MIDDLE AGE DRIFT



TEMP. SENSITIVE (No Compensation)

If you are an equipment builder, you yourself may not come down with the headaches shown above. But your customers can. The shortcuts in meter quality which cause such malfunctions don't always show up during incoming inspection . . . but just wait 'til the equipment is in use.

That's what makes "price meters" so treacherous. You try to cut costs on one end, but lose your shirt on service calls and returned merchandise at the other.

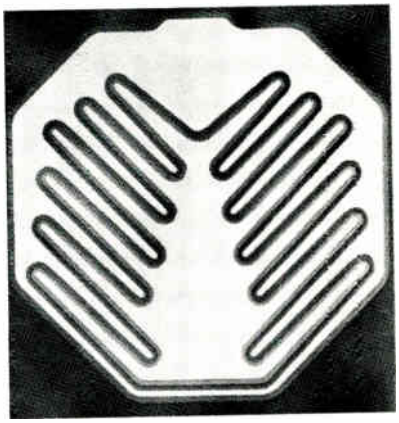
The remedy is Simpson meters. Through experienced engineering, and a policy of no shortcuts in design, Simpson eliminates these meter troubles . . . and the price for this quality insurance is surprisingly close to so-called "price meters."

You can get stock Simpson meters immediately from your distributor in 1300 sizes and types . . . or custom meters from the factory in almost infinite variety. Write for General Catalog No. 18.

Representatives in Principal Cities
...See Telephone Yellow Pages

World Radio History

WHAT'S NEW



Increasing digits to 12 provides larger emitter periphery and area to give higher current capability.

PLANAR EPITAXIAL NPN

THE 2N3016-2N3018 are silicon BIG (for *B*endix *I*nterdigitated *G*eometry) LEAF® planar epitaxial npn power transistors used for h-f, VHF, class-C amplifier and oscillator applications. These transistors are particularly suited for h-f mobile and portable tansmitters.

The larger periphery area results in higher current capability, lower saturation voltage (typically 0.2vdc at 2adc), higher gain and improved Beta linearity at collector currents up to 10a. These transistors achieve class-C power outputs of 25w. and have gain-bandwidth products up to 300MC.

The transistors are free of purple plague because aluminum alloy lead wires are used in bonding to the aluminum base and emitter areas. Welded construction gives a vacuum-tight seal to ensure stable operation. The 2N3016 is contained in the JEDEC TO-5 package, the 2N3017 in press-fit stud MT-27, and the 2N3018 in a double-ended stud modified MF-16. Bendix Corp., Semiconductor Div., Holmdel, N. J.

MICROWAVE MOISTURE METER

IT IS OFTEN NECESSARY TO MEASURE the moisture content of product materials. This may be done either before, during or after the manufacturing process.

A new instrument offered by Associated Electrical Industries Ltd., London, England, makes use of microwave absorption principles to measure moisture with up to ±0.2% accuracy.

Portable and simple to use, it measures the total moisture *through* a structure under the area covered by the meter horns. It measures, at microwave frequencies, the ratio between input and output power transmitted through a solid, in relation to the moisture contained in the solid.

Two types of equipment are now available. One is an S-band moisture meter operating at 2450 MC. It has been designed to measure large samples with a relatively high moisture content.

The second instrument — an X-band moisture meter—has been designed to measure samples too small, or too low in moisture content, to be measured at S-band frequencies. This meter operates at 10,680 MC and is equally suited for lab or factory uses.

Each equipment comprises two separate units, the transmitter and the receiver. With the exception of the microwave oscillator, transistor circuits are used throughout.

The transmitter contains an oscillator tube coupled to a short waveguide, terminating in a horn aperture. The tube is protected from external load effects, and the radiation from the aperture is well below suggested safety levels.

A horn, similar to that used on the transmitter, is used in the receiver, and is coupled by a short length of waveguide to a precision attenuator and crystal detector. The signal from the crystal detector is amplified by a high-gain amplifier, and the output is presented on a meter.

Prototype S-band meter is shown being used to confirm the water content in a brick wall. The meter can be used for more than simply finding the water content in any material. It can provide a system of continuous monitoring on a production line, or allow automatic moisture control of material or products.

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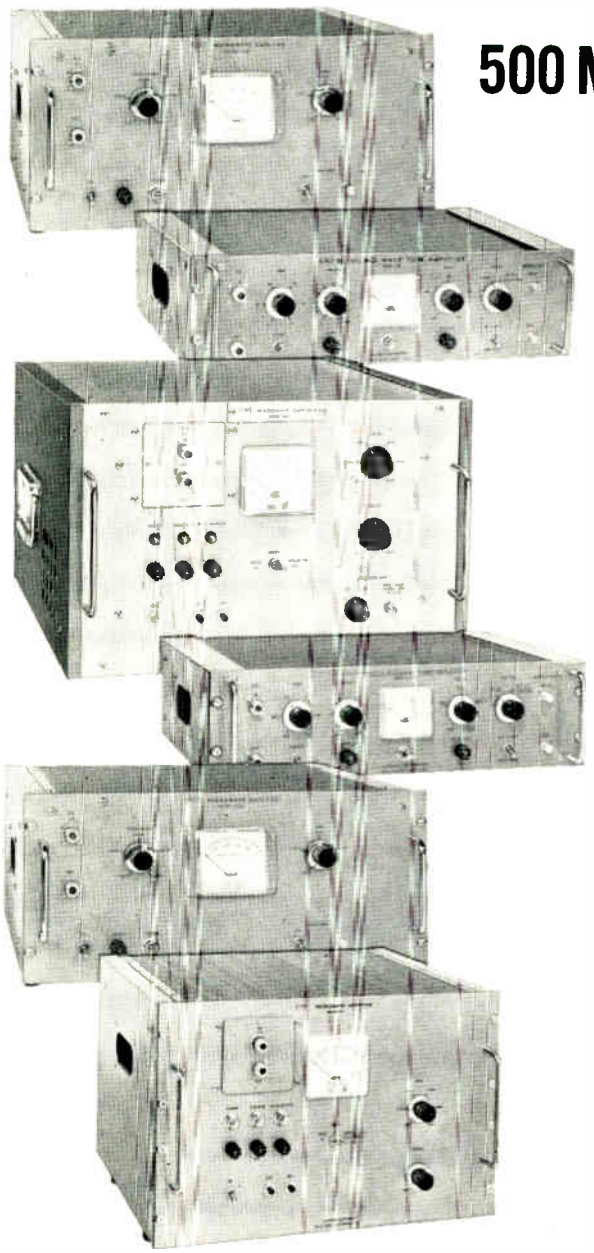
The Complete Line of 1 to 10 Watt

AMPLIFIERS BY ALFRED



500 Mc to 18 Gc

FEATURES

- Rated gain and power output over each range at one setting of controls
- Can provide greater than rated power over limited frequency ranges
- Flat response
- Easy to operate – just connect and turn on
- Alfred ruggedness and reliability
- Rack or bench mounting
- RF connectors on front or rear

APPLICATIONS

- Broadband power amplifiers
- Buffer amplifier or load isolator
- Driver amplifier for high power pulse and CW tubes
- Stable power oscillators using external resonant feedback networks
- Frequency multiplication

For complete information, please call your Alfred engineering representative or write us. All specs guaranteed as stated. Stock delivery in most cases.

Each Alfred Broadband Amplifier consists of a TWT, its focusing magnet, and a completely regulated supply for obtaining optimum performance from the TWT.

ALFRED ELECTRONICS

Stanford Industrial Park • 3176 Porter Drive • Palo Alto, California
Phone: (415) 326-6496

Basic Specifications	508†	5-6752	502A	5-6868†	5-542†	529†	529-S1†	528*	528A*	527*	527-S1*	526*
Freq. Range (Gc)	.5 to 1	1 to 2	2 to 4	2 to 4	4 to 8	4 to 8	4.8 to 6.5	7 to 11	7 to 11	8 to 12.4	8 to 11	12.4 to 18
Power Output (watts-min.)	1	1	1	10	1	10	10	5	10	2	10	1
Gain (db small signal)	30	33	30	33	30	30	30	30	30	30	33	30
Gain (db saturation)	30	30	30	20	30	27	27	30	25	27	30	30
Price	$3290.	$1950.	$1590.	$2550.	$2790.	$3650.	$3250.	$3150.	$3600.	$3150.	$3450.	$3950.

*Can be pulse modulated only. †Can be pulse and amplitude modulated.

17

World Radio History

WHAT'S NEW

PROTECTING FRAGILE TUBES

Inflatable bags are placed between fragile items and filled with air to prevent breakage due to shifting.

"A COMPLETELY NEW LOADING METHOD giving extra protection to freight damageable by normal and abnormal travel shocks," as quoted from the New York Central Railroad describes inflatable dunnage used in freight-car hauling of fragile components such as tubes and other electronic equipment.

This method of taking up voids in carload shipments replaces the usual high-cost methods of shoring with wood, strapping, etc. Users report savings as high as 78% on labor and 46% on materials. A 4 x 4 ft. dunnage bag, when inflated with five pounds of air per square inch, can exert a force of 8,000 pounds in each direction against the lading. The proper application of inflatable dunnage permits almost any cargo to withstand considerably more shock and impact than the freight car itself. The dunnage bag was developed by The Goodyear Tire and Rubber Co., Akron 16, Ohio, and is being used by the Philco Corporation to protect their cathode ray tubes during shipment.

HIGH FREQUENCY LIGHTING SYSTEM

A NEW 3000-CYCLE HIGH FREQUENCY lighting system has been announced by G.E. The new system will increase the light output of 40-watt fluorescent lamps by 5 to 6%, and reduce operating costs by 10% over normal 60-cycle systems.

Heart of the 3000-cycle h-f system is the Low Voltage Switchgear Dept.'s new solid-state frequency converter. This unit statically rectifies normal 60-cycle power and then converts it to the more efficient 3000-cycle level. It will be available in ratings from 20 kw through 100 kw, with input voltage ratings of 208 and 277/480 volts, three phase wye connected, and with output voltages of 300/600 volts, single phase.

Another contribution to over-all system economy is a newly created ballast. The 3000-cycle ballast will be about 50% smaller and 60% lighter than the normal 60-cycle ballasting needed for four 40-watt fluorescent lamps.

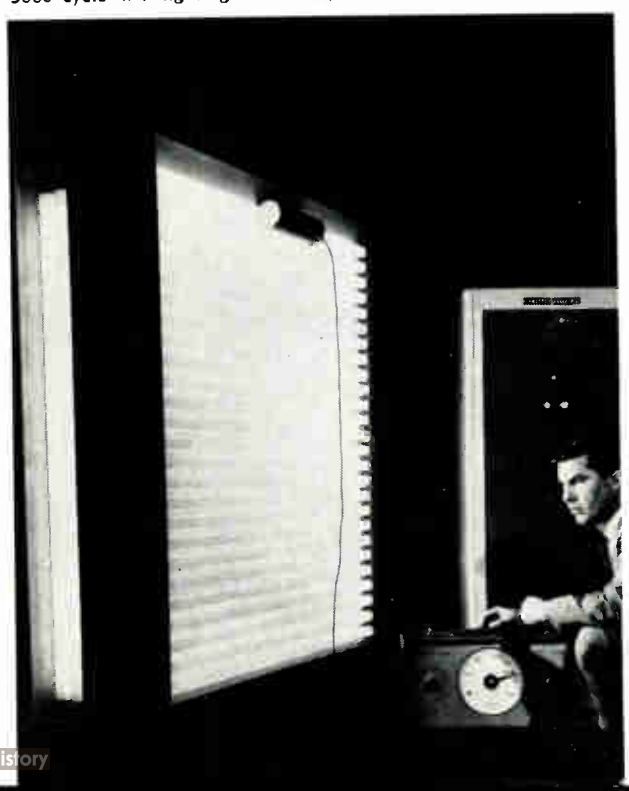
Combination of the frequency converter and the new ballast will offer over-all system power efficiencies of 91% as compared to about 85% or less with 60-cycle systems.

The increased lumens/watt of the lamps and improved ballast efficiency will also result in reduced heat losses in a room having a given lighting level, and in reduced initial and operating costs of air conditioning equipments.

While the concept of h-f lighting is not new, the introduction of the solid state converter, and the new increased efficiency ballast, marks the first time that such a concept is both practical and economical.

A key advantage of the new scheme is that the system uses the 60-cycle distribution system throughout the building in the normal manner. The converter functions from this normal 60-cycle power system at points adjacent to the high frequency lighting system.

Engineer measures lumen output from one of 26 G.E. F40 fluorescent lamps. Instrument being used is a "Lumen Meter," which measures relative efficiency of fluorescent lamps. Powering the 26-lamp demonstration unit is G.E.'s new 3000-cycle h-f lighting converter, shown in the background.



World Radio History

How many types of microwave tubes can you name?

1. _____

2. _____

3. _____

4. _____

5. _____

FXR's new Z817B drives them all

Just name the tube—FXR's new Z817B Universal Microwave Power Supply drives all types. And you get four modes at the flick of a switch: sine, square wave, pulse or sawtooth.

Inside, the Z817B is crammed with extras: six individual, floating power supplies which can be interconnected in various combinations; automatic time delays that apply microwave tube filament and electrode voltages in the right sequence. Provision has also been made for automatic frequency and gain control, and you get complete overload protection and interlocks for personnel and equipment safety.

Outside, digital and dial tuning controls (back-stopped by meter monitors) enable quick, accurate pre-setting of all voltages. Current at each power supply is displayed on individual front panel meters. In short, the Z817B's instrument panel is as fool proof as 4000 volts can be, and almost self-explanatory. (But we do recommend that you read the instruction manual.)

Did we mention complete, easy-access modular construction and the high-stability, long-life components used throughout?

Price? About $10 a pound (or $2950 complete). With off-the-shelf delivery.

Oh, the tubes: triode, tetrode, klystron, TWT, BWO, voltage tunable magnetron, or any of their variants.

Want to see it in action? Call, write or TWX any FXR equipment rep, or Ed McDonald, FXR, 25-26 50th St., Woodside 77, N. Y.

FXR™ THE RF PRODUCTS AND MICROWAVE DIVISION OF AMPHENOL-BORG ELECTRONICS CORPORATION

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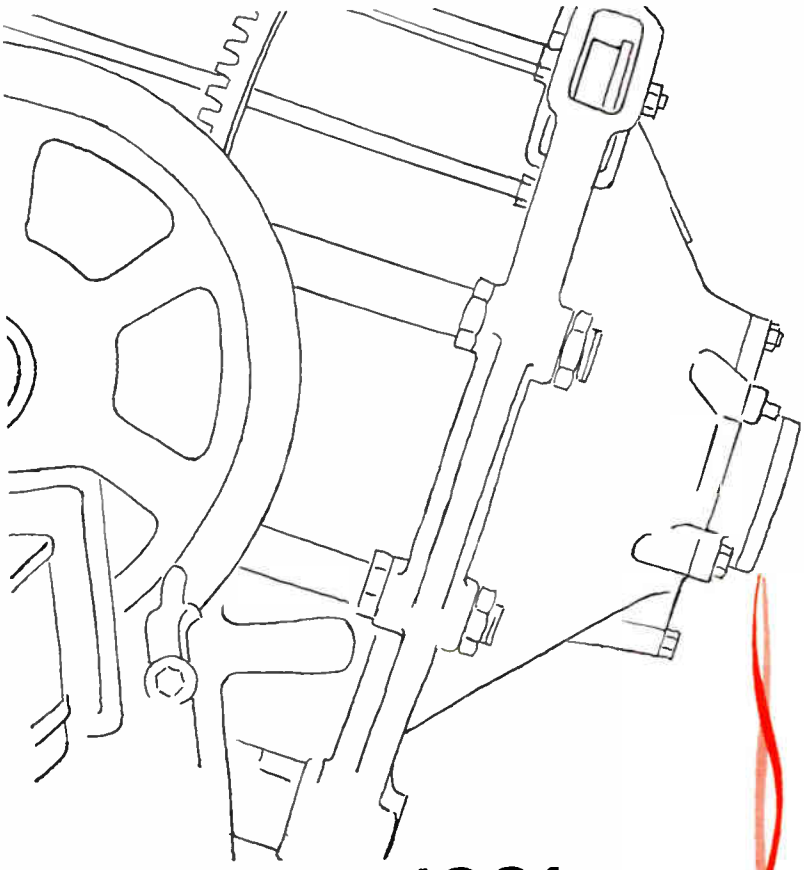


there are 1001 types of industrial glass.

Why does FUSITE make their own?

We could "make do" with glasses from commercial sources. Most other glass-to-metal seal manufacturers find them adequate.

Here's our reason.

All the glass used in our entire industry wouldn't add up to the tonnage of a few trailer loads of beer bottles. But the properties of the several kinds we *do* use in small quantities determine the performance of a given terminal in your whole assembly of component parts.

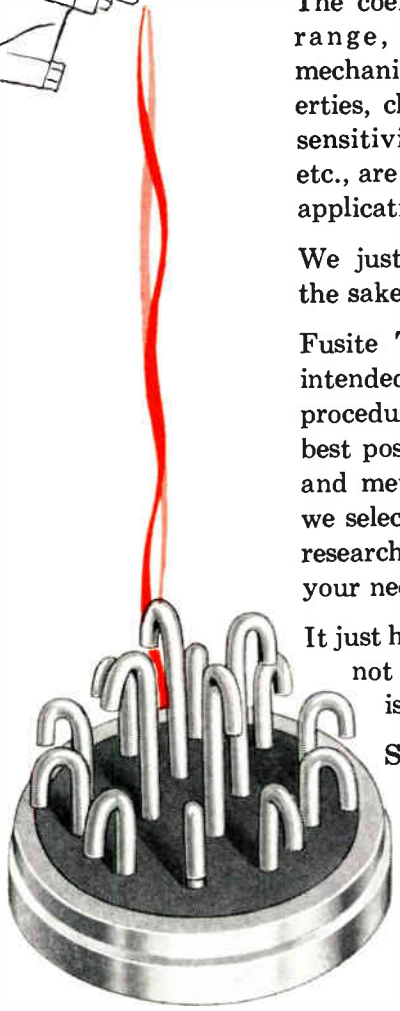
The coefficient of expansion, firing range, insulation resistance, mechanical strength, surface properties, chemical resistance, thermal sensitivity and bubble structure, etc., are engineered for your specific application of the terminals.

We just refuse to compromise for the sake of expediency.

Fusite Terminals start with your intended use and your production procedures. We then recommend the best possible combination of design and metal type, and only then do we select a glass that our extensive research has proven well suited to your needs.

It just happens that more often than not the exact glass you need isn't being made.

So we make it.



INSULATE ELECTRICALLY · GLASS TO METAL · FUSITE TERMINALS · PROTECT PRODUCT PERFORMANCE · SEAL HERMETICALLY

THE FUSITE CORPORATION

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Fusite Corporation, Cincinnati, O.

Woodford Mfg. Co., Versailles, Ky.

Fusite N. V., Konigweg 16, Almelo, Holland

Fusite GmbH, Dieselstrasse 5 Karlsruhe, W. Germany

Fusite-Japan, Gotemba, Japan

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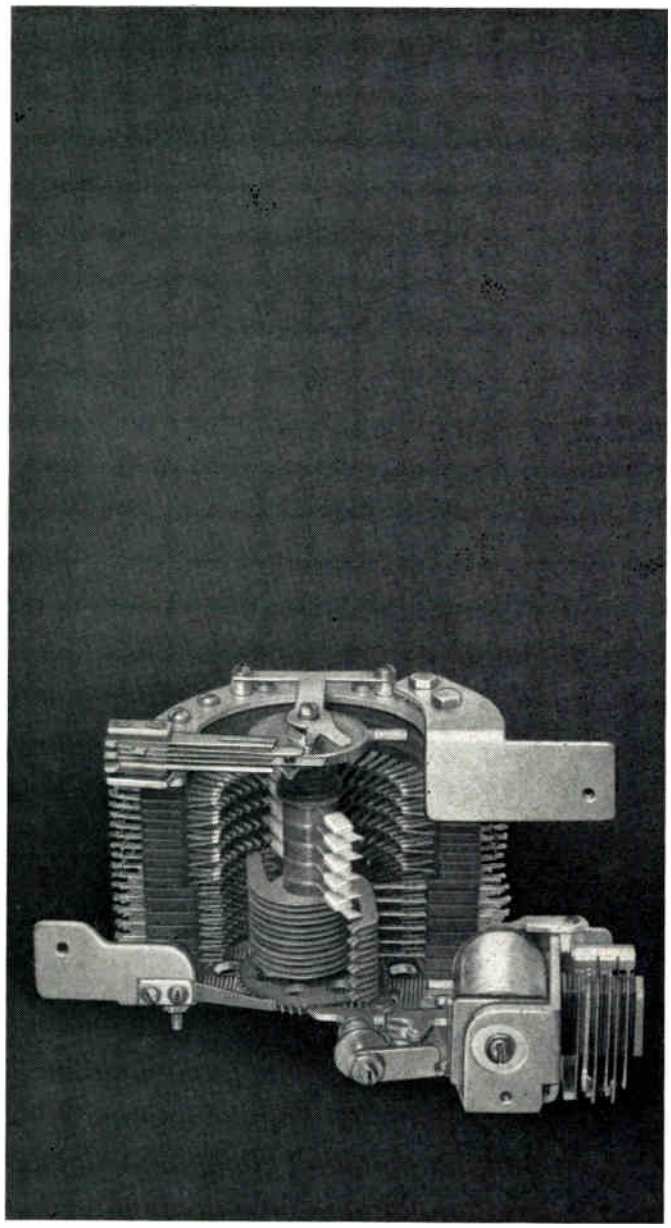

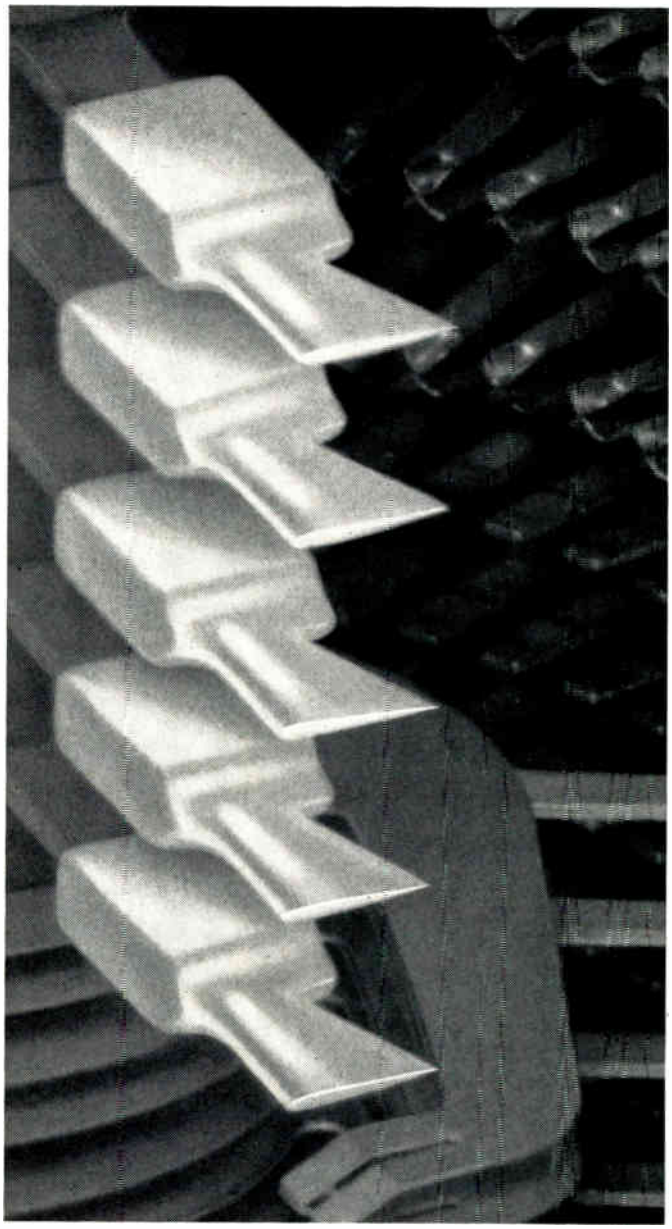

so, what's new?

normally closed contacts, that's what

This is AE's new Type 45NC Rotary Stepping Switch. Each bank is made up of two standard levels tensioned together so that each set of bank contacts forms a closed circuit. The wiper assembly, tipped with a molded Delrin insulator, opens the contacts one at a time as it rotates. Normally open and normally closed banks may be specified on the same switch. ▪ Contacts are gold-plated phosphor bronze, providing contact resistances of only 10 to 20 milliohms measured at 6 volts, 100 milliamperes. ▪ The 45NC is ideal for self-interrupted hunting or testing circuits. In either case, no auxiliary relays are needed to initiate operation. For full information, ask for our "Product News: 45NC." Write Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

AUTOMATIC ELECTRIC

Subsidiary of

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GENERAL SYSTEM

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STATHAM ANNOUNCES
AN EXCITING ADVANCE
IN CONNECTORS AND HEADERS

TEMPERATURE RANGE: —320°F to +1200°F.

RADIATION RESISTANCE: Thermal neutron capture cross section is less than 1×10^{-24} cm².

LEAK RATE: Less than 2×10^{-9}cc He/sec.

PRESSURE SEAL: Withstands greater than 10,000 psi.

CORROSION RESISTANCE: Unaffected by Aqua Regia, Nitric Acid, Sulfuric Acid, and Hydrochloric Acid, in all concentrations. Also unaffected by stainless steel soldering fluxes.

ELECTRICAL INSULATION: More than 400,000 megohms at 1000 volts D.C.

High reliability and the ability to withstand severe environments are achieved through the use of a new Statham-developed insulating ceramic.

For additional information, write or call **Statham Instruments, Inc.**, 12401 West Olympic Blvd., Los Angeles 64, Calif., BRadshaw 2-0371 (Area Code 213).

BRAVO

Statham®

World Radio History

MAKING USE OF SALES ENGINEERS

Sales engineers can do more for the design engineer than just sell him a product. They can actually aid the designer with his design problems. This article tells how to go about making the most of their specialized knowledge.

A SIGNIFICANT PART OF THE PRICE YOU PAY for electronic instruments and parts represents the manufacturers' selling costs. When you—as an engineer—buy a product, you buy the catalogs and ads that promote it, and you buy the sales engineering that sells it. Figure something between 10% and 20% of the price tag for selling costs. You can consider the money thrown away, or—if you know how—you can get it back with interest, in the form of expert advice and service from sales engineers.

To the manufacturer, the sales engineer is not only a salesman but also the company's chief link to the customer—a feedback path vital to the planning of company policy and new-product development. A valuable tool, the sales engineer—to his employer and to you, the customer, if you know how to get the most out of him.

Five simple rules will guide you to a profitable relationship with sales engineers:

1. Find sales engineers whose specialties are of interest to you.
2. Determine whether the sales engineers are qualified.
3. Describe your work to the sales engineers in enough detail for them to know your needs.
4. Require that the sales engineers make appointments to see you.

(Continued on page 50)

". . . and in addition, we can give you any engineering assistance you may need in your circuit designs that include this component."

By LEO J. CHAMBERLAIN
Manager, Syracuse Sales Eng'g. Office
General Radio Company
Syracuse, N. Y.

A REPRINT OF THIS ARTICLE CAN BE OBTAINED BY WRITING on company letterhead to The Editor ELECTRONIC INDUSTRIES Chestnut & 56th Sts., Phila., Pa. 19139

World Radio History

SOLID STATE IN Electronics

Men of vision thrive here. And it takes men of vision to cope with today's electronics and space problems. Space in more ways than just up. Space problems of a different nature plague the manufacturer who must expand, but hasn't the land to expand on.

Here in Florida we have the space, the climate, the work force. Florida has more to offer electronics firms than any other area on earth. Men think better where life is pleasant, where off hours can be devoted to just plain *living*—and to just plain *thinking*.

Yes, Florida is a Solid State in Electronics. Already the sun, Mother of Life, shines on over sixty thriving electronics firms in our busy state.

Cape Canaveral is here, too, with its massive, awesome missiles blasting off to make space history. Electronics makes possible every thrust into the universe. Every hope of getting to the moon depends upon electronics—and the first American to the moon will definitely soar to history from Florida.

Engineers and their families dream of living here in Florida. Give them this dream by moving your plant here. Nurture the brains that will give your business a greater and greater stature in this, the Electronics Age.

For complete details of the many advantages Florida offers the Electronics Industry, write us. Let us tell you why some of the greatest names in electronics have impressive plants here in Florida.

FLORIDA'S ASSURANCE POLICY

"You have my personal assurance of a sunny business climate here in Florida. You have positive assurance of every aid and assistance possible from our Florida Development Commission and from the overwhelming majority of our businessmen, industrialists, and financiers. We have everything to make your large or small enterprise healthy and successful. Write, wire, or phone us TODAY. The only thing better than a FLORIDA vacation is having your plant here."

FARRIS BRYANT
Governor

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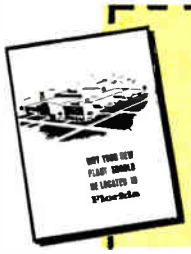
...AN 11 BILLION DOLLAR MARKET

Ask about free film "Profile of Progress"

FLORIDA FOR CONVENTIONS— *Write for free information on Florida's wonderful facilities for your group meeting.*



Mr. Wendell Jarrard, Chairman
FLORIDA DEVELOPMENT COMMISSION
Box 4321B • Tallahassee, Florida

Please send me brochure, "Why Your New Plant Should Be Located In Florida," containing the facts about FLORIDA's opportunities for New Industry, the 11 BILLION DOLLAR CONSUMER MARKET, Labor, Climate, Schools, Natural Resources, Favorable Tax Structure.

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City.....Zone..State.....

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USING SALES ENGINEERS (Concluded)

5. Demand a complete story.

1. *Find sales engineers whose specialties are of interest to you.*

The field of electronics has expanded so quickly that an engineer cannot maintain technical competence in all areas. The answer is specialization, and this is as true of sales engineers as it is of those in development. The best sales engineer for you is one who is a specialist in your field of interest.

Finding such a sales engineer may take a little time. A lot depends on your company. If it is very small, you may have more of a problem than if you worked in a big company. Sales engineers are apt to concentrate on the large companies with large budgets. On the other hand, there may be so many development engineers in the large company that the sales engineer assigns priorities within the company. The point is, don't wait for the right man to call you; call him.

If you have been involved in purchasing, chances are you already know the sales engineers in your area. If you do not know any, you represent a "new contact." Either way, you shouldn't have much difficulty in attracting sales engineers if you try.

2. *Determine whether the sales engineers are qualified.*

Fortunately, most electronics sales engineers are well qualified. But there's no sense in wasting time with one who isn't. An engineering degree is a step in the right direction; but it's certainly no guarantee of technical competence. There are, moreover, many non-college graduates whose military or work experience makes them highly qualified. There is no sure-fire way of instantly sizing up the sales engineer, but a few well-designed questions (no curve balls, just honest questions) at the outset may help you detect a non-technical sales engineer who will be of little value.

3. *Describe your work to the sales engineers in enough detail for them to know your needs.*

If the sales engineer is to be of help, he must know in some detail what you are working on. This information will enable him to point out new approaches on a continuing basis, and will help him to steer you to the proper equipment. Also, he should be kept advised of any changes in your basic work.

The sales engineer's first visit is an information-gathering occasion, and you should not expect many specific recommendations from him at that time. He will probably spend most of the time asking questions. The second, third, and subsequent visits will indicate how well the sales engineer understands your work, recognizes your problems, and is equipped with solutions.

4. *Require appointments.*

Your time is valuable; so is the sales engineer's. Only if the sales engineer is prepared to offer information of value, and only if you can talk to him without distractions, can the discussion be worthwhile. The best way to ensure such an environment for your meeting is to require an appointment. And an appointment should be granted only when a preliminary phone call indicates that the sales engineer has information of interest.

5. *Demand a complete story.*

You have a right to expect complete, accurate answers to all questions that deal with the sales engineer's service or product, or even with competing products. If there are any questions that can't be resolved on the spot, an enterprising sales engineer will list them and leave a copy of this list with you so that you can both check up on loose ends later. Don't hesitate to press the sales engineer, even if some research is required on his part. It's all part of his job.

On the other hand, if you can't get a complete story, you may have run into one of the few unqualified salesmen. Your recourse is to refuse to deal with sales engineers who aren't technically competent. You might even consider writing a note to his company, pointing out the lack of service.

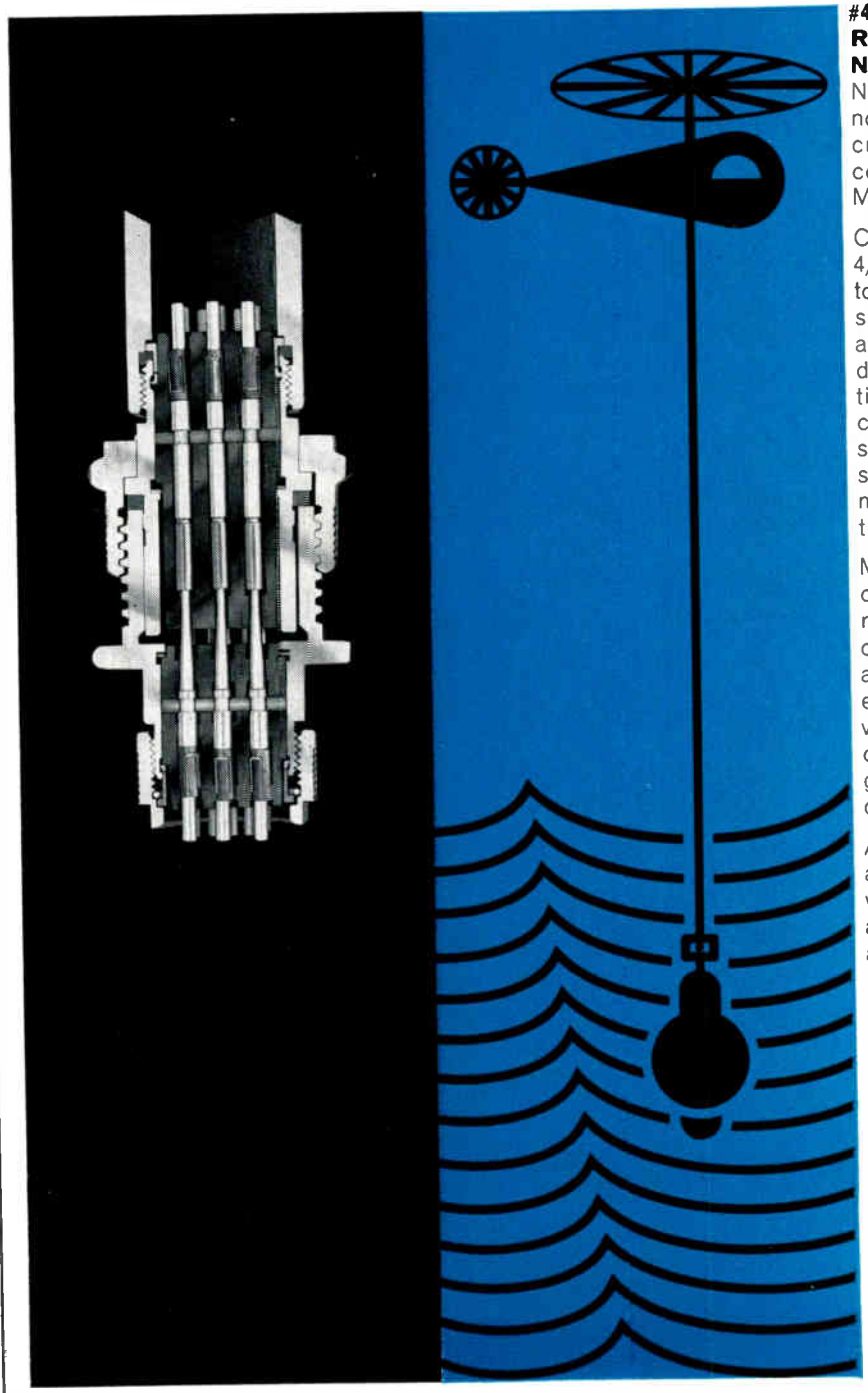
Sales engineers, to sum up, can help you do your job better. Just learn how to use them.

MICROWAVE TUBES

1962 Factory Sales
(In Thousands)

	TOTAL UNITS	TOTAL SALES
Klystrons	181.3	58,855
Reflex Oscillators	173.8	21,565
Other	9.3	37,290
Continuous Wave	6.5	21,956
Pulsed	2.8	15,334
Magnetrons	70.9	40,481
Continuous Wave	21.9	11,767
Pulsed, Fixed	17.7	7,362
Pulsed, Tunable	31.3	21,532
Forward & Backward Wave Tubes	33.1	55,065
Forward Wave, Continuous Wave	18.1	27,310
10 Watts or Less	14.9	22,841
Over 10 Watts	3.2	4,469
Forward Wave, Pulsed	4.5	13,809
Backward Wave	10.5	13,946
	287.1	$154,401

World Radio History



#4/0 to #18 CONTACTS, COLLET-RETAINED, REAR-RELEASED . . . NOW AVAILABLE. Pyle Star-Line® Neptune Series plugs and receptacles are now available with Mod. III inserts having crimped, collet-retained, rear-released contacts. They are intermateable with Mod. I and Mod. II Inserts.

Contact sizes are available from #18 to 4/0 for applications ranging from telemetry to power. The crimped contacts are snapped-in from the insert back-side, and are positioned and stabilized by collets designed for low insertion and high retention forces. Female contacts are of the closed-entry type. Controlled spring tension of the contacts insure minimum insertion and separation force. The contacts may be easily removed from the rear of the insert with an inexpensive plastic tool.

Mod III combines the advantage of the center resilient seal plus front and rear rigid plastic insulators. The three piece contact insulators insure a reliable seal at the periphery of the insert and around each contact to provide unmatched environmental resistance. Socket insulator cavities are molded with a bellmouthed guided entry to prevent mismating of male contacts under any conditions.

A wide selection of insert configurations and accessory hardware—including that with 360° RFI shielding capabilities—is available for your requirement. Learn more about Mod III by requesting Technical Bulletin No. 4.

CONNECTOR DIVISION, THE PYLE-NATIONAL COMPANY, 1334 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

Also manufactured in Canada by: Pyle-National (Canada) Ltd., Clarkson, Ontario

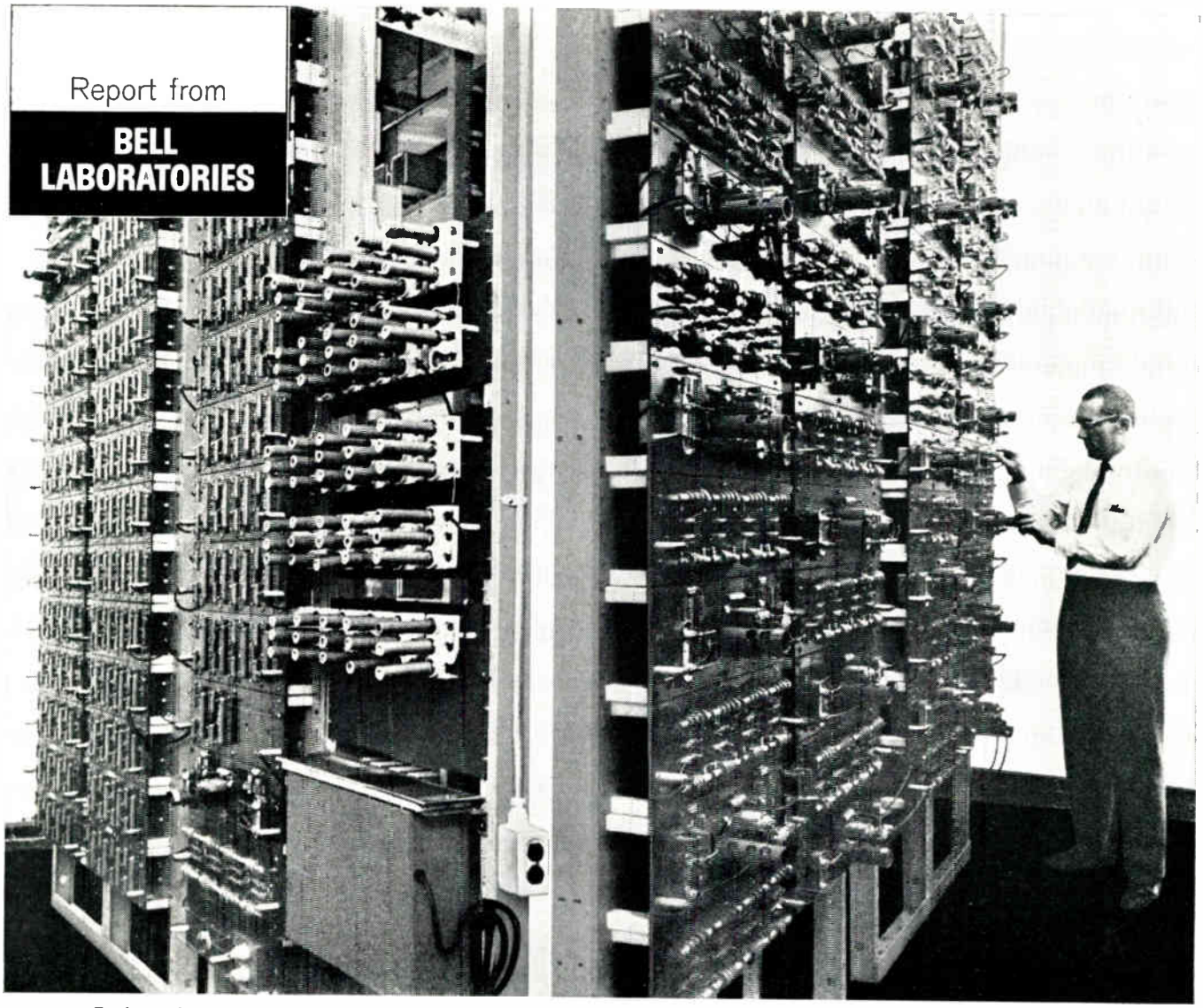
Pyle-National

ELECTRICAL CONNECTORS · LIGHTING EQUIPMENT · CONDUIT FITTINGS

World Radio History

Report from

BELL LABORATORIES



Engineer A. H. Evans measures the effect of voltage surges on Bell Laboratories' simulated undersea telephone cable. Simulating 180 amplifiers and 181 cable sections, with a total length of 3600 miles, the arrangement includes over 1100 electrical components. Photo merges two sides of the simulated cable so that both can be viewed at once.

THE UNDERSEA "CABLE" THAT NEVER GOES TO SEA

In undersea cable systems, electric power for the amplifiers is transmitted along the cable itself. To make this possible, precisely engineered circuits and devices must be designed into the system for protecting electron tubes and other components from sudden voltage surges which may result from accidental damage to the cable.

In systems such as these, the computation of the effects of such surges to establish the needed design parameters is extremely complex. Here, as in many other areas of our work, a solution to the problem has been found through electrical simulation.

Full-scale simulation is achieved by means of networks of electrical components. For the new 128-channel cable scheduled for transatlantic service this year, a network (above) was built to simulate the power path of a 3600-mile cable with its 180 amplifiers.

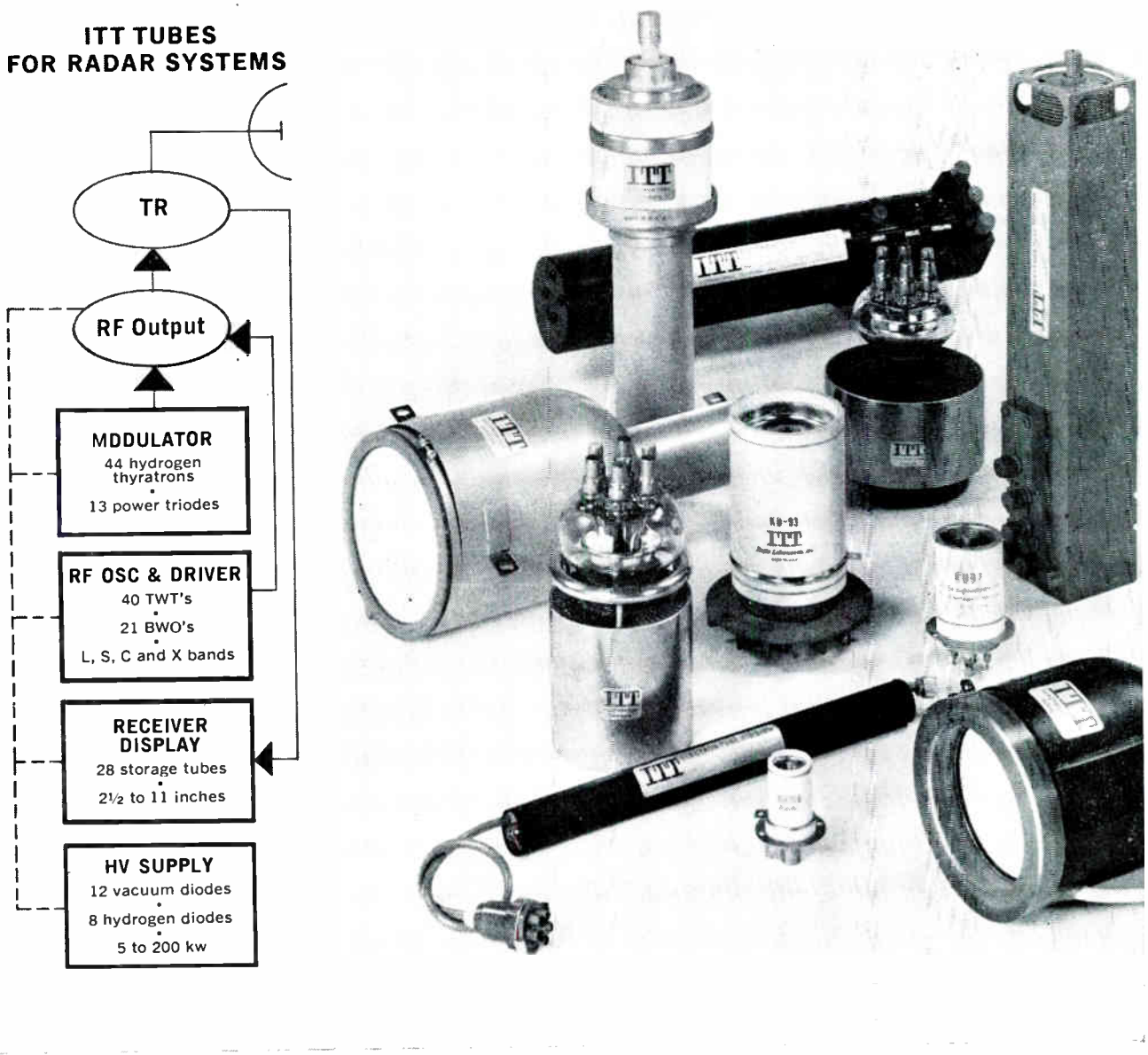
With the aid of this simulator, engineers can study the effects of voltage surges, the operation of electron tube protectors, and the performance of the power supply in the various contingencies that may occur in active service.

This study of unknown factors by means of electrical simulation is an example of how engineers at Bell Laboratories work to assure the performance and reliability of new communications systems before they are committed to service.

Bell Telephone Laboratories

World center of communications research and development

World Radio History



For today's radar and ECM systems...166 tube types by ITT

HYDROGEN THYRATRONS—ITT Kuthe makes the most complete line on the market today . . . 52 basic types including the industry's broadest line of metal-ceramic types designed to operate at high repetition rates and high temperatures in radar pulse circuits.

HV POWER TUBES—ITT offers a full line of basic types from 5 to 200 kw, including the most complete line of coaxial, ceramic, and evaporative cooled tubes available. 25 types are specially designed for radar switching, rectifier, clipper and charging applications.

STORAGE TUBES—ITT offers the industry's most complete line with 28 types from 2½ to 11 inches. Features include ITT's exclusive ring flood gun which eliminates trapezoidal distortion. Writing speeds up to 500,000 ips and erase times as fast as 1 millisecond with high brightness for radar display.

TWT's—ITT has recently added a complete line of PM BWO's to its existing lines of 40 TWT's and 21 BWO's. Latest TWT introduction is series of light, rugged 1 kw metal-ceramic tubes ideal for ECM and radar driver applications in L, S, C and X bands.

These types are available today. Write for complete specs. If you have a unique problem which one of these 166 types won't solve, please tell us about it. We'll be happy to come up with number 167.

ITT ELECTRON TUBE DIVISION

CLIFTON, NEW JERSEY

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

Circle 22 on Inquiry Card

Circle 29 on Inquiry Card →

World Radio History

Objectivity

If you're tired of hearing about the "perfect" printed circuit connector, you're just the man we want to talk to.

We're here to offer you freedom of choice, because that's where objectivity begins. The boy blowing his last penny on candy wants to be able to choose between the 30-second delicacies and the stuff that lasts all afternoon. It's licorice versus jawbreakers, root-beer-barrels versus bubble-gum. They're all good, but none are perfect.

That's why we make such a variety of printed circuit connectors. Each type and style has its own special bailiwick. They're all "perfect" when they're applied properly.

OUR NEW BELLOWS-TYPE

Take the new Amphenol 225-series. This bellows-type connector has the smoothest, gentlest, most efficient mating action you'll find anyplace. Even after thousands of insertions, the delicate conductive surfaces of the printed board are unscathed by the 225.

The 225-series has remarkably low contact resistance, too. For the solder terminated style, it's under 25 millivolts at 5 amperes.

The bellows-type contact on the 225-series is split down the middle. You get two contact points for every interconnection. This helps keep the contact resistance low, of course, but it also conforms readily to irregular mating surfaces.

The 225 is convex. It meets and mates the printed circuit board with a wiping action that assures contact.

AND, FURTHERMORE

The 225-series contact is self anchored in the connector body. Contact faces will not distort at the slightest pull on the terminals.

The 225-series has twice the flexing range that you'll find on other bellows-type contacts. This means you can rock the board twice as far with no danger of contact distortion.

The 225-series does not waste valuable contact space with a polarizing key. The key is sandwiched in between contacts.

The 225-series can be terminated with solder lugs, taper pins, removable crimps, or Wire-Wrap* terminals.

Contact styles? Contact positions? Mounting provisions? Well, let's just say that there are over 100,000 combinations available in the Amphenol 225-series bellows-type connector.

WHO NEEDS IT?

And now for the facts of life. Some people simply don't need the 225-series. Some printed circuit boards are inserted once and never disturbed again. Some printed circuits are never subjected to pull on the terminations. Some printed circuits are not really so delicate that they must be protected from contact wear. Some printed circuit boards never get rocked. And in some applications, the space taken up by a conventional polarizing key is of no consequence. And so forth.

And that is why Amphenol makes Prin-Cir® connectors, Micro-Edge® connectors, Micro-Min® connectors, and specials that haven't been named yet. They are all printed circuit connectors. They are all "right" where the need dictates their use.

The hero of this story is the Amphenol Sales Engineer. He's the only man who has access to a complete line. Thus he's the only man who can look you in the eye and tell you exactly which printed circuit connector you need. Objectivity.

You won't hear Amphenol Sales Engineers telling you about perfect connectors. They don't have to. They know better.

*T.M. Gardner-Denver Co.

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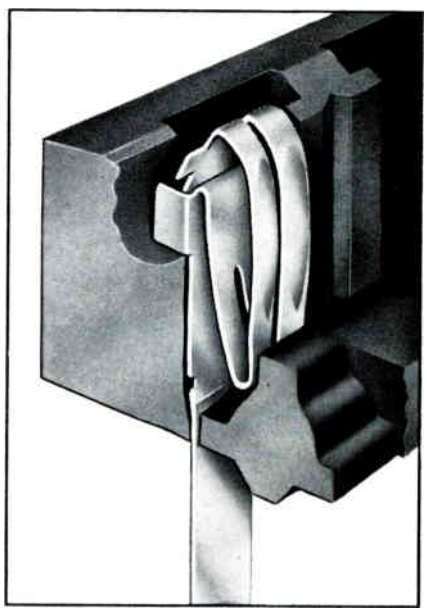
If you're *really* interested in seeing what a complete line of printed circuit connectors looks like, we invite you to write for our new 20-page catalog PC-1. Just contact your local Amphenol Sales Engineer, or write to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.



Problem: To make contacts that give an extremely low millivolt drop, yet do not mar printed circuit conductors, even after thousands of insertions.

Solution: Bifurcated, convex faces for sure contact. Double spring action with wide flexing range. Then double-plate and polish so smooth they caress the mating surface.

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Output sine wave:
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up to 30v p-p, open circuit
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Output into 50Ω: 200mw
Type 1211-C, $325

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Output into 50Ω: 70mw
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Output into 50Ω: 80mw
(typically 400mw over most of range)
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Output into 50Ω: 150mw
Type 1209-C, $285

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depending on klystron used
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Provide highest output at lowest cost.

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Designed for 1210-C
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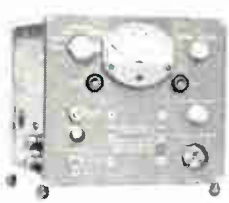

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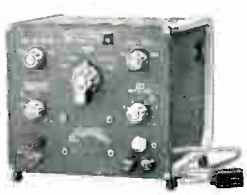

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World Radio History

Microwave is a comparatively young field that is already going through advance stages of change. New technology creates new components and hardware. Makers and vendors clutch at fast waning markets on one hand while trying to foster, woo and balance new customers on the other. Possible answers—build up foreign markets and find new domestic uses.

MICROWAVES— A MARKET IN TRANSITION

THE MICROWAVE BUSINESS, SCARCELY 20 YEARS OLD, keeps growing and changing. Communications common carriers and some private firms are getting deeper into microwaves.

The Government, chiefly DOD, though no longer the foremost hardware buyer, remains the biggest microwave service user. Now, the largest, fastest-growing, and most profitable microwave market is

World Radio History

being pursued overseas. While microwaves is mainly a technical field, future profits may be paced more by management and marketing than by technology.

Microwave market data vary with sources. For 1960, Arthur D. Little, Inc., puts the market at $1.6 billion. Stanford Research Institute charts it at $1.5 billion. However, by 1965, ADL assesses the market at only $2.6 billion, while SRI projects it to $5 billion, based upon the expected power tube market. Electronic Industries Association has a third set of figures, which it has not yet revealed.

However, EIA gathers microwave market statistics on a regular basis for: tubes, solid state devices, components, and systems. EIA still lacks enough cooperation to survey the antenna and instrument fields, mostly because they are dominated by a certain few firms. It should be noted that each microwave company that comes in on any survey by the EIA Marketing Services Department will receive total statistics of its survey group, whether or not the firm is an EIA member.

Must Use More of the Spectrum

Our cramped electromagnetic spectrum drives us to explore new frontiers in the higher microwave frequencies, then exploit them as new microwave markets. To advance the state-of-the-art we must use more of the spectrum.

Serving more of the market can help sell more hardware. But selling hardware requires selling engineered microwave systems, assembled from power tubes, solid state devices, waveguide components—or "plumbing"—and antennas. An integral part of these engineered systems is test and measurement instruments. Dependable service and maintenance support are needed to back up systems and instrument sales.

Different sizes of waveguides are required for every microwave band. However, instruments usually cover all or most bands. Accordingly, plumbing-components markets do not overlap, while instrument markets do. Against this technical mix, each company must decide its marketing mix.

Some firms are set up like systems themselves, since they make many, or most, of the components and instruments required for a system. Smaller firms generally make components or instruments only.

"The U.S. Government has already purchased most of the microwave equipment it needs at present, such as the BMEWS antenna network in Alaska, but is still the biggest user of microwave services."

By SIDNEY FELDMAN,
Associate Editor.
ELECTRONIC INDUSTRIES

RFI Approach Now Positive

A special aspect of microwave marketing is the need to design systems with filters to prevent growing interference among radar, guidance systems, communications links and other systems. The original negative concept was to combat RFI: Radio Frequency Interference. Now the positive approach means cooperation between microwave systems people and the Department of Defense. This is done mostly through the Electromagnetic Compatibility Analysis Center at Annapolis, Md. Failure to cooperate could prevent firms from selling systems.

Microwave systems, though used mainly for military-defense communications, are used as well for consumer-industry communications and automation. Among equipment using microwaves as carriers are telephone, telegraph, and teleprinter. Other special equipment, with big potential growth factors, include: computer and data transmission; remote supervisory control (automation); electronic facsimile, and studio transmission links for closed circuit TV.

Unique microwaves, products and systems are in various stages of use or experiment. Microwave heating is being used for cooking, for drying printer's ink quickly, and for torches. Microwaves are used in scientific and medical research. Yet these somewhat limited or exploratory uses remain to be proven economically before they can be promoted into worthwhile markets.

Common Carriers Buy One-Fourth

Common carriers buy about one-fourth of the known U. S. microwave hardware output. If the amount of microwave hardware Western Electric provides AT&T were known, surely common carriers would reflect a greater recorded percentage of this market. Common carriers covered in the percent figure cited mainly include: Western Union, which designs its systems and procures from outside dealers; General Telephone & Electronics Co., which can call upon Sylvania Microwave Device, Lenkurt and Automatic Electric; and some 3,000 independent telephone companies. General Telephone provides some of its own hardware, and AT&T gets most of its hardware from WE. But they and other common carriers also buy from nearly 400 hardware, component and instrument firms that make up the microwave industry.

Western Union built the first U. S. commercial microwave system in 1945, linking New York City and Philadelphia. Some time in 1964, WU will have completed its 6,800-mile microwave beam system as the "keystone" of its new nation-wide system. It will

World Radio History

include high-speed, high-volume voice, data, computer, facsimile and telegraph facilities.

AT&T's first microwave system linked New York City and Boston in 1947. Paradoxically, the now-retired Dr. George C. Southworth of Bell Telephone Laboratories recalls how he worked in secret with "continuous waves" in the 1920's and the 1930's, while fearing cancellation of research funds during those depression days.

50% AT&T on Microwave

At the end of 1962, about 50% of all AT&T Long Lines communications facilities were on microwave. Nearly 50 million miles of telephone circuits on radio relay represent 40% of telephone circuits on all facilities. AT&T has nearly 450,000 miles of wideband microwave channels, of which more than 92,000 carry inter-city TV. And, AT&T experiments with its own space/satellites, Telstars I and II, to extend microwave capability to other nations. AT&T and other firms work with the Communications Satellite Corp.

Microwaves thus have broadened AT&T facilities. The science also has enabled private industry to compete with the Bell System. This started in 1959 when FCC opened microwave frequencies to the general business community.

The microwave market, once limited to U. S. Federal agencies and right-of-way companies, such as pipelines and railroads, now was wedged open. In came press radio, transportation, and a host of industrial companies. They are served largely by microwave systems suppliers including Collins Radio, GE, ITT, Lenkurt, Motorola, Philco, Raytheon, RCA and tiers of components and instrument vendors, plus a few foreign vendors. These firms had to educate customers before they could sell beam and multiplex systems.

However, this market has not been all profits since a double set of economics remains to be mastered. Many future industry users don't have enough communications volume to justify private microwave systems. For them it seems to be a matter of too much, too soon, too costly. Some microwave systems vendors don't have enough industrial customers to warrant added overhead for engineering, marketing and maintenance. Supplies and suppliers often exceed demand.

Generally, big commercial companies so far are the best prospects along with pipelines and railroads. In 1962 railroads ran, or had approved more than 8,000 miles of microwave facilities. Electric utilities strongly tend to use their own microwave systems for 24-hour control of their operations.

Pipelines Among Biggest Users

Petroleum pipeline firms are among the biggest users of microwave for communications and automation. Such systems serve many of the 800 firms that use more than 50,000 transmitters—which add up to the nation's biggest network. The American Petroleum Institute says experts predict the number of petroleum company transmitters will double between 1963-1973. But by then the petroleum companies' allotted radio spectrum may become saturated. So, oil men are joining electronics researchers to "dig" for ways to increase multiple use of each assigned frequency.

While industrial microwave systems business represents a one-time installation, maintenance, spare parts and possible future extensions, AT&T regards such competition as a continuing threat to its revenues. AT&T has countered private microwave competition by increasing its own facilities and offering special rates and services. These "telephone channel packages" for voice and/or business machines include Telpak, WATS (Wide Area Telephone Service), WADS (Wide Area Dial Service), plus Data-Phone and Dataspeed sets for business machines and teletypes to use telephone lines.

Certain systems vendors, including Western Union, have petitioned FCC to reconsider some of these new AT&T special services as commercially detrimental to systems vendors, other common carriers, and future private system users. Most AT&T new special services and rates continue. FCC has ruled against the proposed WADS tariff and still is considering WATS and Telpak.

Market Depends on FCC Decision

Though the future of the industrial microwave market depends in part upon an FCC decision, this market has slowed down considerably since the 1950's. AT&T's special rates seem to have stopped certain future industry users from going into private microwave systems.

The Federal Government, particularly the DOD, was the original user and today remains the biggest user of microwave systems. Although we here put

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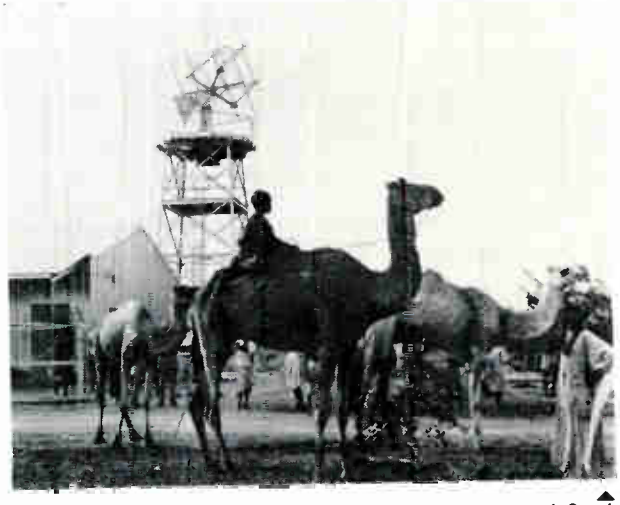
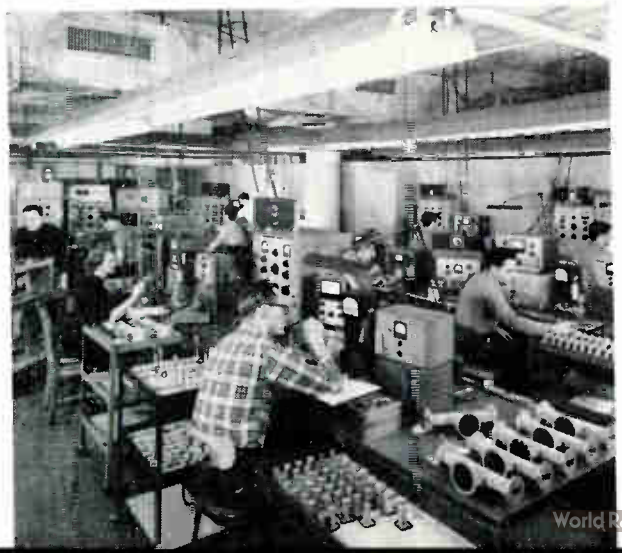
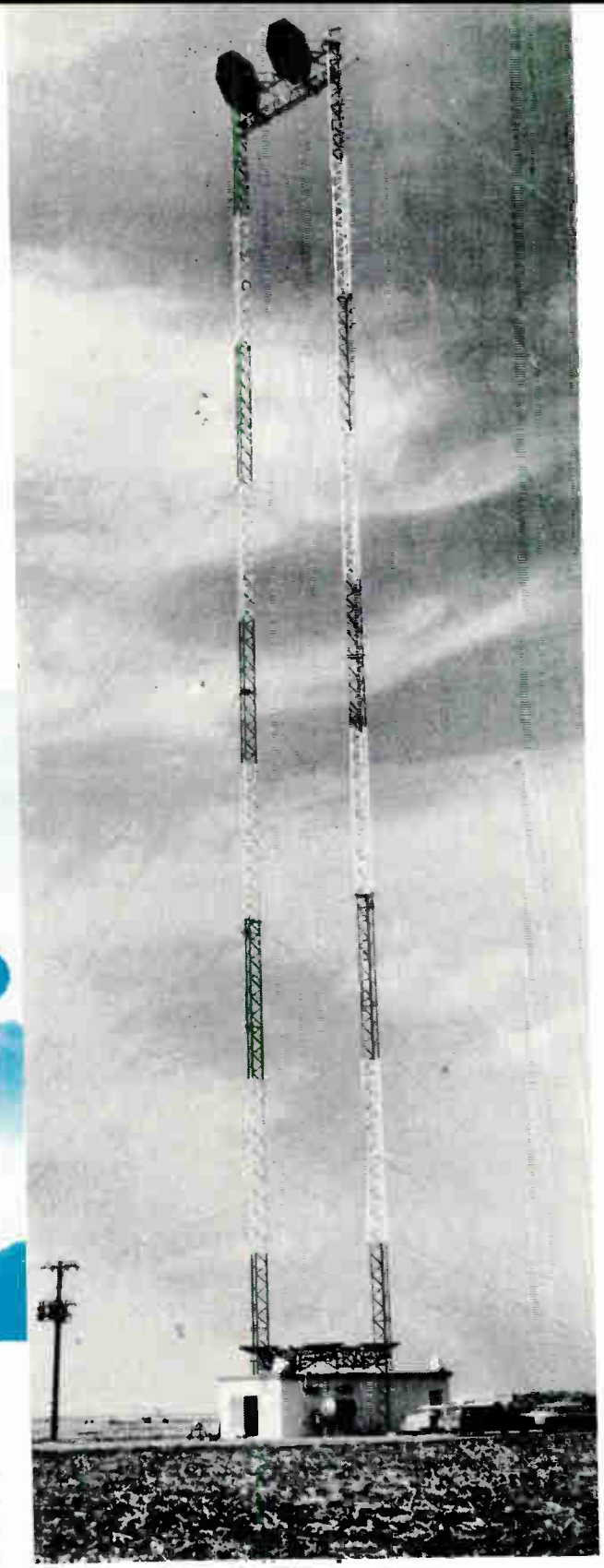


"Newly emerging or reviving nations in Africa, Asia and South America are by-passing telephone and telegraph poles with modern microwave systems."—This antenna is located in Nigeria.

"The U.S. Gov. microwave market may be greatly expanded in the areas of space probes and communications in outer space."





"Common carriers, especially Western Union, which is building a 6,800 - mile system, buy about one fourth of all known microwave hardware output. This could jump to about $1.5 billion by 1965."

"Some 450 hardware, component and instrument firms, such as PRD Electronics, Inc., make up the U.S. Microwave industry. Sources estimate the 1965 microwave market from $2.6 to $5 billion."

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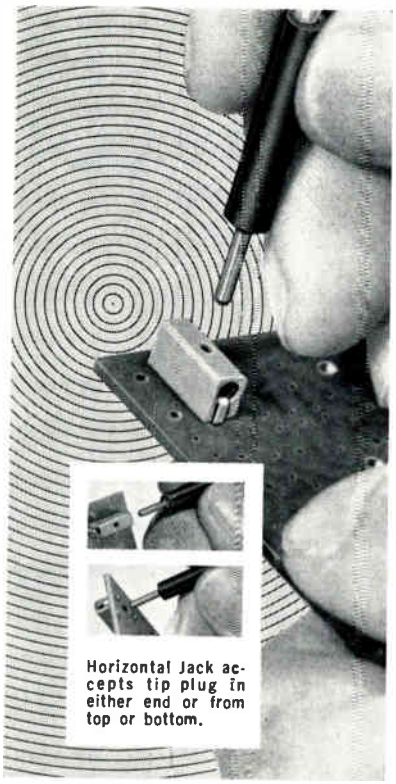

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its share of the hardware market at 15%, this figure should be larger when the bill for leased microwave lines and defense contractor services is added.

Some microwave vendors do not appreciate that most broad and basic defense and non-defense microwave and other systems already have been installed. Now, both DOD and non-defense Government agencies are consolidating, modifying and sophisticating facilities.

In September 1963 President Kennedy ordered all Federal communications operations to combine into the centrally-controlled National Communications System. Included will be microwave links, mobile facilities, underground units, plus duplicate (often hardened) circuits to survive nuclear attack or other emergency. Most facilities are leased from common carriers, while some are Government-owned.

Future markets for microwave equipment will develop as the system is refined and augmented by a presidential aid for telecommunications. Western Union recently set up a department for government communications systems. This group will concentrate in nation-wide and world-wide systems, using all known methods of radio communication plus broader use of engineer and technical aid.

Military Communications Merged

In May 1960 the single-manager authority over communications systems of the three armed services was transformed into the Defense Communications Agency, under DOD. At the same time, the Defense Communications System was established, under DCA. This merged all military world-wide long haul, point-to-point circuitry currently owned, operated or leased. Today 25% of DCS facilities use microwave radio to transfer data, voice, teletype or keying signals.

Each armed service plans, funds, procures, and maintains its own facilities. Since microwave systems are used chiefly to extend long haul point-to-

MICROWAVE SPENDING—HOW MUCH?

Total dollars spent in any year on microwave components, hardware and systems depend largely on what is included under the microwave label.

Arthur D. Little, Inc., puts the 1960 microwave expenditures for microwave equipment for government, industry and commerce at $1.6 billion with a forecast of $2.6 billion for 1965.

Stanford Research Institute, on the other hand, clocked a similar $1.5 billion for 1960 to the same buyers—but pushed the 1965 estimate up to a top-shelf $5 billion.

Electronic Industries feels that the 1965 total will be somewhere in between—say around $4 billion. Our estimate for 1963 sales in microwave gear is already more than $2 billion.

World Radio History

"Sources estimate that export and overseas market totals for microwave products now account for about 40% of the total U.S. output. The export market for 1965 could be around $2 billion."

point circuits, all gear must meet DCS standards to become an integral part of the global system. Major equipment manufacturers who furnished such gear include Western Electric, RCA, Philco, Lenkurt and Collins.

In the U. S., Canada, and Great Britain nearly all DCS microwave systems are leased from commercial sources. Elsewhere in the world, such equipment is owned by military services and may be operated by them or by a private firm.

There's just so much geography to be covered by microwaves; DCA pretty much covers it. At first, the military used fixed microwave radio for short-distances. Later came microwave transfer of radar information from distant sites to base camps.

Originally, microwave was used chiefly for air defense, tactical direction, and communications areas. This was mostly where considered undesirable for military, terrain or technical reasons to lay ground cable, install pole lines, or use high-frequency radio.

Microwave Radio Refined

Early microwave systems were limited in bandwidth. In recent years, microwave radio has been refined to provide high-power multi-channel capabilities with low-noise and high-stability.

Some military systems, such as BMEWS: Ballistic Missile Early Warning System, rearward communications, use a microwave system over 2,500 path miles, mostly over nearly impassable far northern terrain. But, the days of new, big defense projects like BMEWS, White Alice, Dew Line seem over. Most of these systems already are installed, and new areas are being explored out in space.

Although microwaves originated as a 100% defense, 100% domestic business—narrowing defense and commercial-industrial markets at home encourage microwave parts and systems vendors to move into more virgin, more profitable markets overseas. Close scrutiny reveals Government sponsorship of foreign microwaves business. DOD conducts the Foreign Military Assistance Program; Department of Commerce Bureau of International Commerce fosters export expansion; NASA cooperates in foreign aerospace programs, and the State Department sponsors overseas projects.

Newly emerging or reviving nations in Africa, Asia and South America, are bypassing telephone and telegraph poles with modern microwave systems. Even mature nations, such as England and France, use microwave links extensively.

Military Markets Abroad

Various overseas military markets exist. Under a U. S. Air Force Military Assistance Pact, ITT Federal Laboratories is building a line-of-sight and tropospheric scatter microwave system to serve the Republic of Korea Air Force.

Microwaves unite North Atlantic Treaty Organization members from the Arctic Circle to Turkey. DCA has six regional control centers: the Philippines, Japan, Labrador, England, Spain and Turkey.

Views of growing overseas microwave markets are cited by two West Coast executives. William R. Hewlett, executive vice president, Hewlett-Packard Co., says, "For the past five years our sales in Europe have annually grown about two-and-a-half times faster than in the U .S.—about 48% in Europe, compared with 18% to 20% in the U. S." He attributes this growth to a rapidly expanding European

(*Continued on page* 65)

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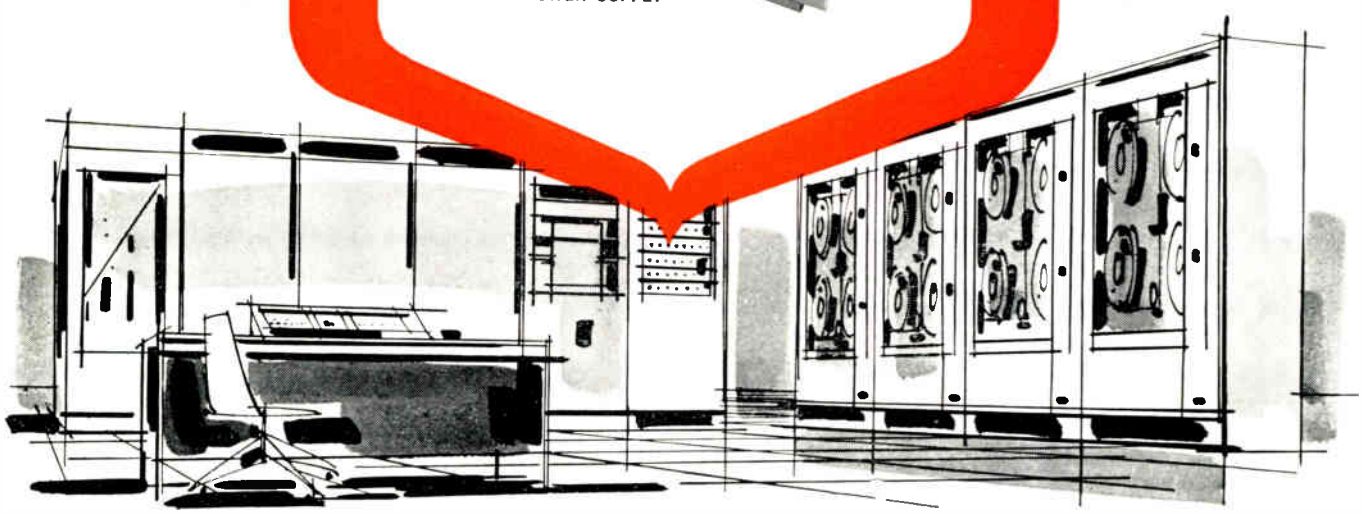

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market for electronic instruments, plus H-P's sales efforts abroad since early 1959.

William E. Roberts, president, Ampex Corp., forecasts that although the U. S. now is the biggest market for microwave components, Europe will become the biggest market within 10 years.

Other activities by U. S. and foreign microwave vendors foretell a two-way world microwaves market. European and Japanese firms, chiefly, export to and buy components and systems from the U. S. C.S.F., a group of French firms specializing in Carcinotrons and other microwave tubes, sells these often-classified components to authorized buyers in the U. S. Last summer, Associated Electrical Industries, Ltd., of England, sent a specialist microwave engineer to the U. S. to promote sales of microwave components and assemblies.

Cooperate with Foreign Firms

Some U. S. firms run factories abroad and cooperate with foreign firms in joint ventures. They serve as licensees making foreign products, export through agents, or participate in special U. S. Government projects to stimulate overseas business.

Back home there are four areas of great interest in R&D and applications, judging by the coming May 1964 *International* Symposium of IEEE's Professional Group of Microwave Theory and Techniques. The areas are: (1) Lasers, stressing microwave-analogous aspects; (2) High-power techniques; (3) Millimeter and sub-millimeter wave techniques and components; (4) Solid state devices.

Domestic microwave business is becoming more competitive and defense procurement is getting less profitable. The emphasis is shifting from technology and production to management and marketing. Front offices are becoming more important as waveguides directing corporate destinies — and profits. Some firms ultimately may be forced to see that if they can't compete, or should not compete, in the defense business, they can quit or get into industrial-commercial, or foreign markets.

Indicative of the management-technology relationship, Varian Associates, Microwave Tube Group recently made a big decision. Instead of pushing for "major breakthroughs" with Government funds, Varian decided to invest company funds "aimed at less glamorous goals, such as increased tube reliability."

Mergers Speeding Up

Stronger competition and tightening DOD procurement patterns are speeding-up company mergers. This is happening, contrary to the opinion expressed last year by microwave pioneer Dr. Wilmer L. Barrow that "it would seem the microwave industry can support an exponentially increasing number of companies." Makers of components and test equipment, particularly, continue to merge or be merged. Singer Metrics Div. of The Singer Mfg. Co., amply funded and astutely managed, within a few months absorbed Panoramic, Sensitive Research Instrument, and Empire Devices to become strong in electronic test and measuring equipment and microwave devices.

Microwave firms, growing by merger or expansion into new domestic and foreign markets, keep broadening their distribution channels.

At the same time a number of companies, recognizing the growing importance of sophisticated and centralized technical and procurement aspects of Government markets, are opening special offices in Washington.

As Defense Secretary McNamara tightens up procurement practices, firms tighten up management and financial controls. Cost-cutting or profit-improvement programs are under way in many firms. Today, while engineers review customers' technical needs, the relatively newest man on the corporate team is the controller who checks on credit ratings of buyers to help cut down or cut out poor credit risks.

Yet optimists cite encouraging trends. They feel certain small microwave firms can thrive as custom suppliers, with high special capabilities matched by low overhead. Such firms perform an economic function, making those products big firms often cannot produce profitably.

Strong finances and management-marketing talent are vital for microwave companies. Such resources should help these firms wait out the FCC decision on industrial microwaves, provide sophisticated technology and services sought by DOD and NASA. They should help to capture new domestic markets, and broaden into international markets.

MICROWAVE DOLLARS IN INDUSTRY

Microwave components spending in industry for 1962 can be put roughly around $150 million, give or take a few. This includes components for industrial communications, telemetry, test instruments, and air and marine radar.

Peripheral parts and equipment would, of course, raise the total considerably, depending on how they are classified.

A mean average from various sources puts the 1962 figures thus:

COMMUNICATIONS EQUIPMENT	$76,000,000
TELEMETRY	36,000,000
TEST INSTRUMENTS	27,000,000
AVIATION RADAR	14,000,000
MARINE RADAR	4,000,000

We expect the 1963 microwave total expenditures for U.S. industry to better $200 million.

World Radio History

HIGHEST ACCURACY IN COAXIAL CABLE FABRICATION

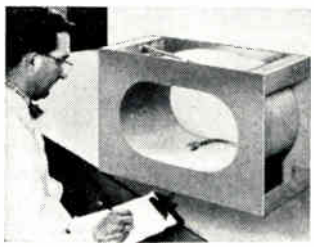
DELAY LINES

■ Fabricating delay lines that possess the superior performance abilities of Phelps Dodge Electronics aluminum sheathed, air dielectric coaxial cable is a currently available capability. Only Styroflex®, Helical Membrane, Foamflex, Spirafil and Corr-O-Foam cables possess the unique construction characteristics which allow shaping into custom configurations without electrical or mechanical distortion.

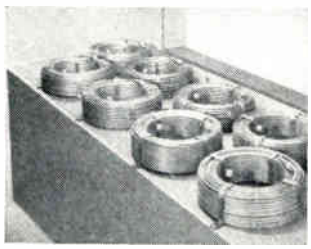
Delay accuracy standards in the order of ±.02 nanoseconds are consistently and uniformly met. Frequencies from 60 C to 12 KMC, power from one milliwatt to many kilowatts, impedances of 50, 70, 75, 100, 125 ohms are parameters. Packaging options include containers, rack mounting, strapping, potting and encapsulation.

Reduction of delay line size, increase in reliability, and extension of delay accuracy standards are the goals of every assignment. Whenever high-frequency performance standards are critical, look to the pure-bred components and systems communications experience of Phelps Dodge Electronics.

Broader band operation, attenuation stability at higher ambient temperatures, lower attenuation per nanosecond of delay, and greater stability at microwave frequencies are established factors. Note uniform cable spacing.



A 6' diameter cable delay line package used in a nuclear application was replaced by this Phelps Dodge Electronics envelope measuring only 26" x 15" x 12". 500' of ½" 50 ohm Styroflex® coaxial cable was used.



Designed for use in missile checkout equipment, this delay line consists of 285' of ⅜" diameter, 50 ohm Foamflex. The small, lightweight package is 16" in diameter by 6" high. Delay accuracy tests to ±.1 nanosecond.

Consisting of 1500' of ¼" diameter, 50 ohm Foamflex, this delay package incorporates 9 individual delay lines. Excellent stability and high accuracy are offered in unit used for ground testing aircraft radar altimeters.

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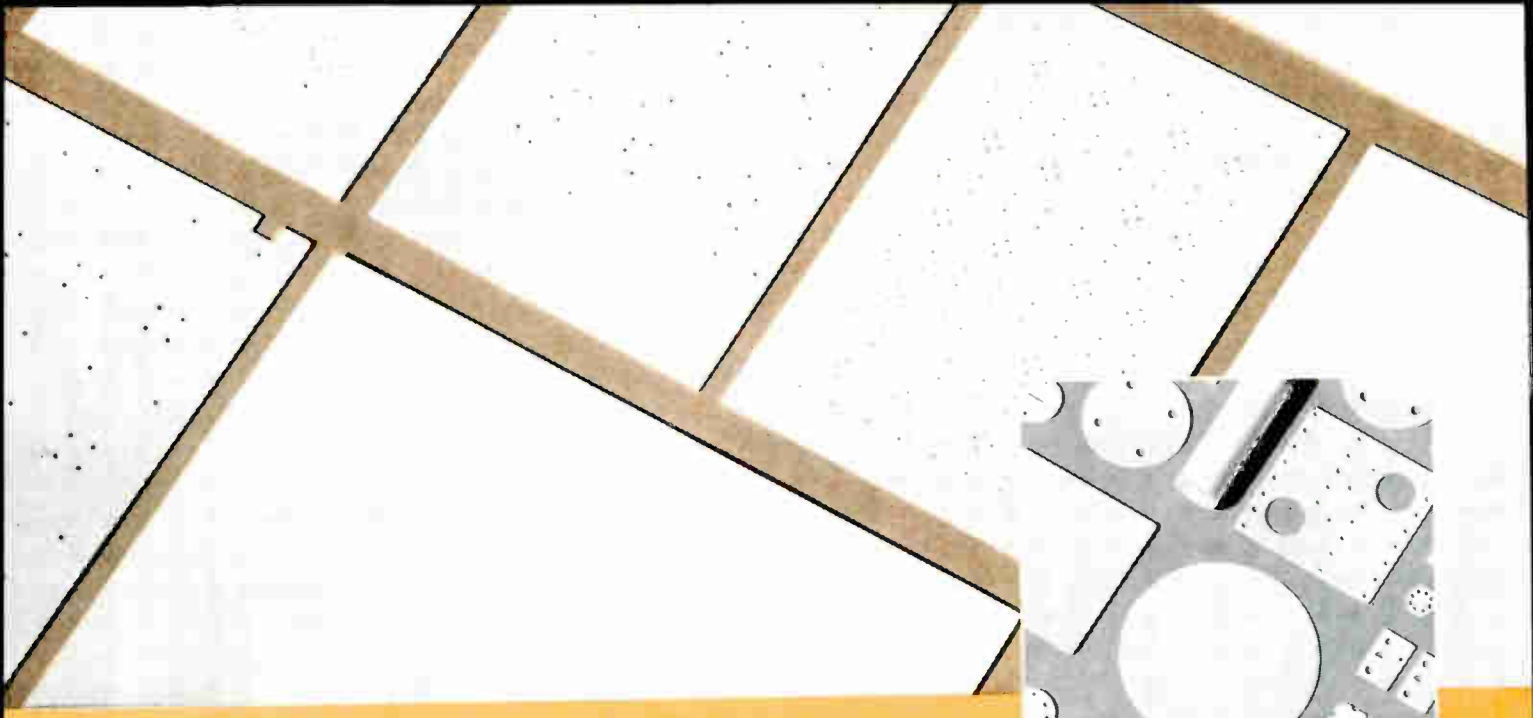

Parts illustrated approximately actual size.

PROGRESS REPORT

ALSIMAG® GLAZED ALUMINA SUBSTRATES

On substrates for thin film deposition, minute voids, bubbles or scratches can create major problems. Great emphasis must be placed on continuity and smoothness of surface. Moderate waves in the surface, if gradual, do not usually create problems.

NOW—A MATCHED GLAZE

Many thin film requirements can now be answered by glazed alumina substrates in AlSiMag 614. AlSiMag pioneered thin, flat alumina ceramic substrates produced by the exclusive AlSiBase® process. Now AlSiMag has developed a Glaze 743 which so accurately matches AlSiMag 614 that these properties were obtained:

1. Thermal shock—no visible defects after:
   a. Room temperature (23° C.) to liquid nitrogen (-210° C.).
   b. Five continuous cycles of immersion in boiling water (100°C.) and ice water (0°C.), transferred directly from one bath to another with a 10-minute soak in each bath.
2. Glaze softening temperature—approximately 725° C.
3. Surface finish of glaze—1.0 micro-inch (CLA) maximum.

MULTI-HOLE OR SERRATED PATTERNS

This AlSiMag glazed ceramic can be supplied with patterns of holes. Notches or serrations on the perimeter are also feasible. Dimensional control is excellent. There is wide latitude in sizes and exterior shape. Quantity production is now available within a practical cost range.

PHYSICAL CHARACTERISTICS

This AlSiMag glazed substrate provides excellent electrical insulation characteristics in minimum space. The alumina gives excellent mechanical strength and high thermal conductivity. Such substrates are stable both mechanically and electrically over a wide range of temperatures.

PREFERRED SIZES

These substrates are custom made for your requirements. The wide and rapidly increasing use of these substrates has suggested some preferred sizes which often speed deliveries especially on prototype quantities. Preferred thicknesses have been established as .025" for the unglazed and unground substrate and as .030" for the glazed substrate.

UNGLAZED SUBSTRATES

The "as fired" finish of unglazed AlSiMag substrates has proved highly satisfactory in a wide range of applications and continues to be produced in volume for these less critical applications.

PROTOTYPES

Data sheets giving preferred sizes will be sent when requested on your business letterhead.

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"A-OK" FOR PPM-FOCUSING OF TWT's... ALNICO VIII from ARNOLD

For periodic permanent magnet focusing of traveling wave tubes, Arnold offers you Alnico VIII rings in the finishes you require, as illustrated below, and in sizes as small as ½" diameter or less, weighing a fraction of an ounce.

They're characterized by highly uniform magnetic properties from front to back and from piece to piece. You're assured of more constant flux density and more uniform field patterns from end to end of the stack required to accomplish the needs of your structure.

Use Arnold Alnico VIII for its high coercive force (*in excess of 1400 oersteds if required*), for relatively high energy product, and for lowest temperature coefficient (*you can eliminate temperature-compensating elements and hold down TWT size*). It's available from Arnold in production quantities, and in various shapes and sizes to meet your requirements.

Also use Alnico VIII for other microwave applications, such as tubular-type straight field focusing magnets, and in backward wave oscillators, etc. In addition, Alnico VIII is your logical choice where length is a premium, or where strong demagnetizing fields are encountered —such as in two-pole rotors, motors, generators, and torque transmission through an air gap.

● Let us help you engineer it to your needs. For more information, ask for Bulletin PM-119. *The Arnold Engineering Company, Marengo, Illinois.*

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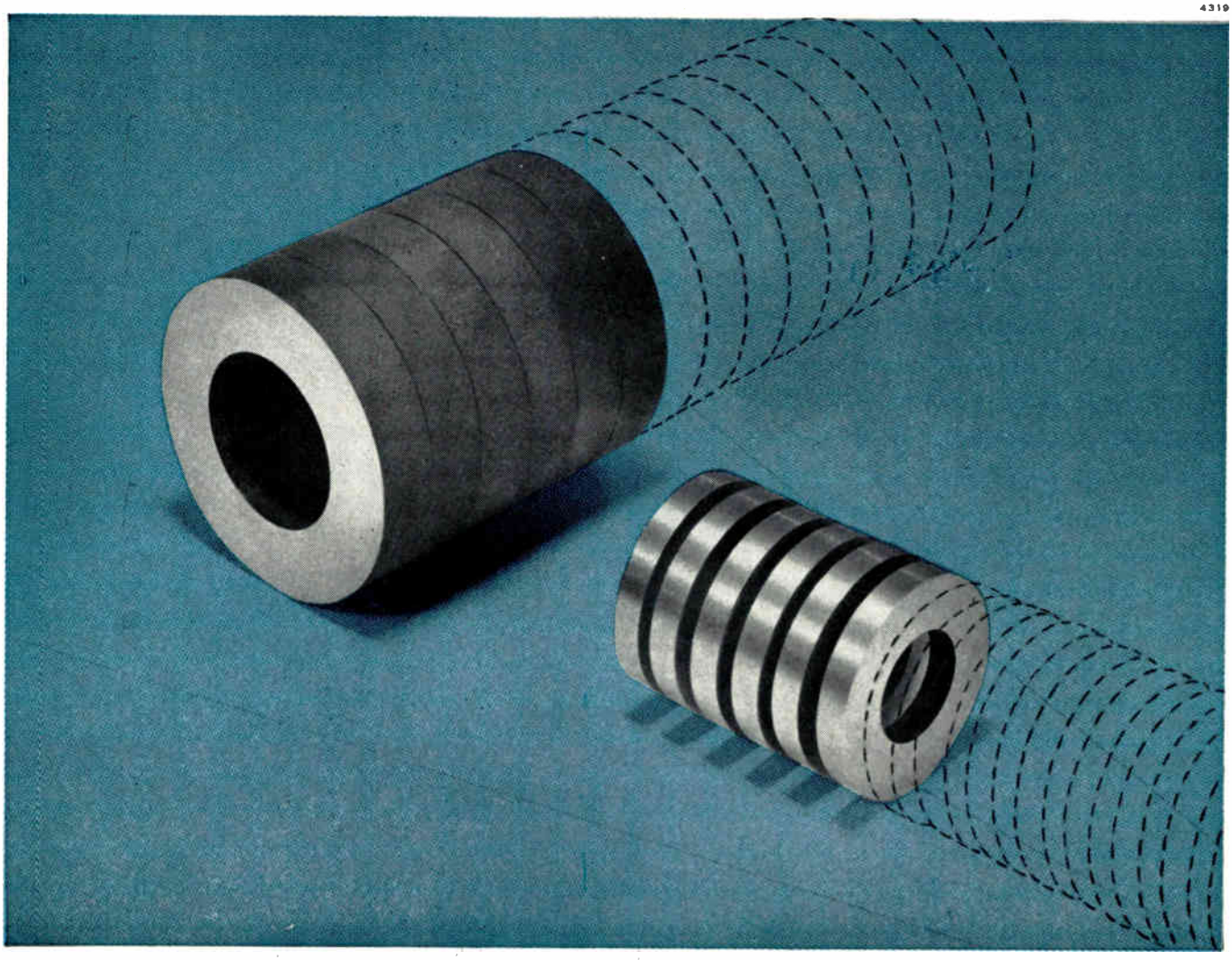

World Radio History

The Office of the Secretary of Defense is exercising decisive influence in source selection. The Services, the Joint Chiefs of Staff, the Congress and the White House find their influence channeled through new canals marked "cost effectiveness," and "performance evaluation." The prominence and success of OSD has profound meaning to everyone involved in system design and selection both in Government and industry.

NEW SHIFT IN PURCHASING TO AFFECT INDUSTRY

A SHIFT IN AUTHORITY IN THE PROCUREMENT PROCESS has become evident to the defense community and to Congress. This shift has been away from the military services to the Office of the Secretary of Defense (OSD). Evidence of this shift includes the McNamara reversal of the service recommendation on TFX and V/STOL, the OSD cancellation of Skybolt, the imminent termination of RS-70, the OSD reduction in Navy attack carriers, and failure to implement the Army-approved Howze report.

Direct involvement of the DDR&E in R&D in some programs has gone far beyond "a friend of the court" or staff advisor. It has assumed instead the form of line direction. The Secretary of Defense has explained that this is the natural function of his job. He and his staff are directing the defense effort. There is evidence that the move toward centralization will continue. Implications of this move are discussed in this article.

* * *

Five-Year Forecasts

Asst. Secy. (Comptroller) Charles J. Hitch requires the services to submit a full 5-year funding forecast with each new program. These programs are reviewed for cost effectiveness by Mr. Hitch's Deputy Alain Enthoven. They are also reviewed for technical soundness by Director of Defense Research and Engineering (DDR&E) Harold Brown's staff. Since requests for funds from the Services exceed the supply (a critical figure established by Secy. McNamara on unknown criteria), decisions must be made by the Secretary. The alternative to this centralized approach was used during the Eisenhower Administration. Each service was told its budget in advance, so most program decisions were made before they reached OSD. Now, a defense contractor or government project manager must sell not only the Service line of command, but also OSD. This must be done on a continuing basis since programs stay under a dynamic review, one against the other.

The 5-year forecast also forces the Service, OSD, and defense supplier to smoke out real costs. Despite the rise in expenditures, fewer programs have begun and fewer will begin, because each is shown by such projection to be more costly. Thus, defense suppliers will have to bear a greater share of major system exploratory R & D costs. The threat implicit in this "reasonable approach to the problem" is becoming clearer. DOD has failed to start any major R & D program (other than the C-141 and Sprint) based on efforts begun in the last two years. It has been living on R & D stored up in the past, a depleting reserve.

Implicit in the mission analysis required of OSD's cost effectiveness are two important additional decisions affecting weapon system selection. The first is the service's role and missions. The second is the criteria for measuring effectiveness. While designing the model of a war, governing assumptions are made: war objectives; duties and supporting resources available to the level of each command; probable opponent response, etc. Also added are criteria like: cost in the air or space per lb./hour, etc. Since criteria selection is usually the key to the result, those who do the analysis tend to be those who select the program. If the same people must also assume the

By CHARLES W. IRVEN
Lecturer in Market Analysis and Control
University of Southern California
Los Angeles, California

World Radio History

objectives of the war (lacking policy guidance from Congress or the State Dept.), then by choosing weapons, they tend also to set the restraints on foreign policy.

Methods of Procurement

OSD, sparked by Secy. McNamara and former Asst. Secy. of Defense, John Rubel, began the intense study of procurement methods. This is resulting in a centralization in decision on such contract questions as: proper type by program (Incentive and Program Definition Contract originate from this effort); contract reporting system (PERT cost and new internal govt. programs review procedures) and shortly an OSD and a source selection board review of past contract performance to find probable future performance.

A national contractor performance history maintained by OSD will soon be completed. It will be used both by the services and OSD to evaluate recommendations of the source selection boards. At this time there is no intention to create a ranked numbered merit-rating, nor an OSD source selection board pre-empting all service decisions, as suggested by Mr. Rubel before his departure. But the availability of past performance history may encourage more moves in this direction.

The centralization in operation of DOD is having a profound effect on many other governmental institutions involved in the creation and operation of the defense effort.

Implications to The Congress

Congress may continue to surrender its prerogatives to the executive in the manner now familiar in the RS-70 and TFX cases. Mr. Vinson will focus his Committee on military "pork barrels," arsenals, hospitals, reserve forces, the National Guard and military pay, rather than decisive military system selection. The House Appropriation Committee will continue its practice of cutting the Defense Budget nominally. But it will, at the request of the Secy. of Defense, restore in Supplemental Appropriations most or all of what was "cut." The Senate counterparts will generally add a bit to the House Appropriation Committee and investigate alleged abnormalities or inequities in procurement procedures, but do nothing. Congress will, by default, force the Secy. of Defense to make decisions usually without clear

Cancellation of the Skybolt missile program by the Office of the Secretary of Defense serves to call attention to the shift in authority in the procurement process. Two Douglas Skybolt ballistic missiles are shown mounted on the Boeing B-52H bomber.

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COULD YOU CONTRIBUTE TO THE DESIGN OF A SYSTEM THAT CAN SURVIVE?

481L. A self-healing system for post-attack recovery and re-establishment of command structure in case of direct nuclear bombardment.

It's MITRE's job to design such a system and make sure it works.

It's just one of MITRE's jobs. Among others are the development of a new aerospace communications system, a nuclear detection and reporting system, a hardened underground command post for NORAD, and a system to help end mid-air collisions.

MITRE needs men for this work. It is probably the most challenging work of its kind in the field of military command technology.

MITRE is located in Bedford, Mass., a country town 25 minutes from Boston, one hour from the White Mountains, a half-hour from the ocean.

Engineers and scientists — preferably with advanced degrees and at least five years' experience in electronics, mathematics or physics — write Vice President, Technical Operations, The MITRE Corporation, Box 208 AN, Bedford, Mass. Openings are also available in Washington, D.C. and Colorado Springs, Colorado.

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Pioneer in the design and development of command and control systems, MITRE was chartered in 1958 to serve only the United States Government. The independent nonprofit firm is technical advisor and system engineer for the Air Force Electronic Systems Division and also serves the Federal Aviation Agency and the Department of Defense.

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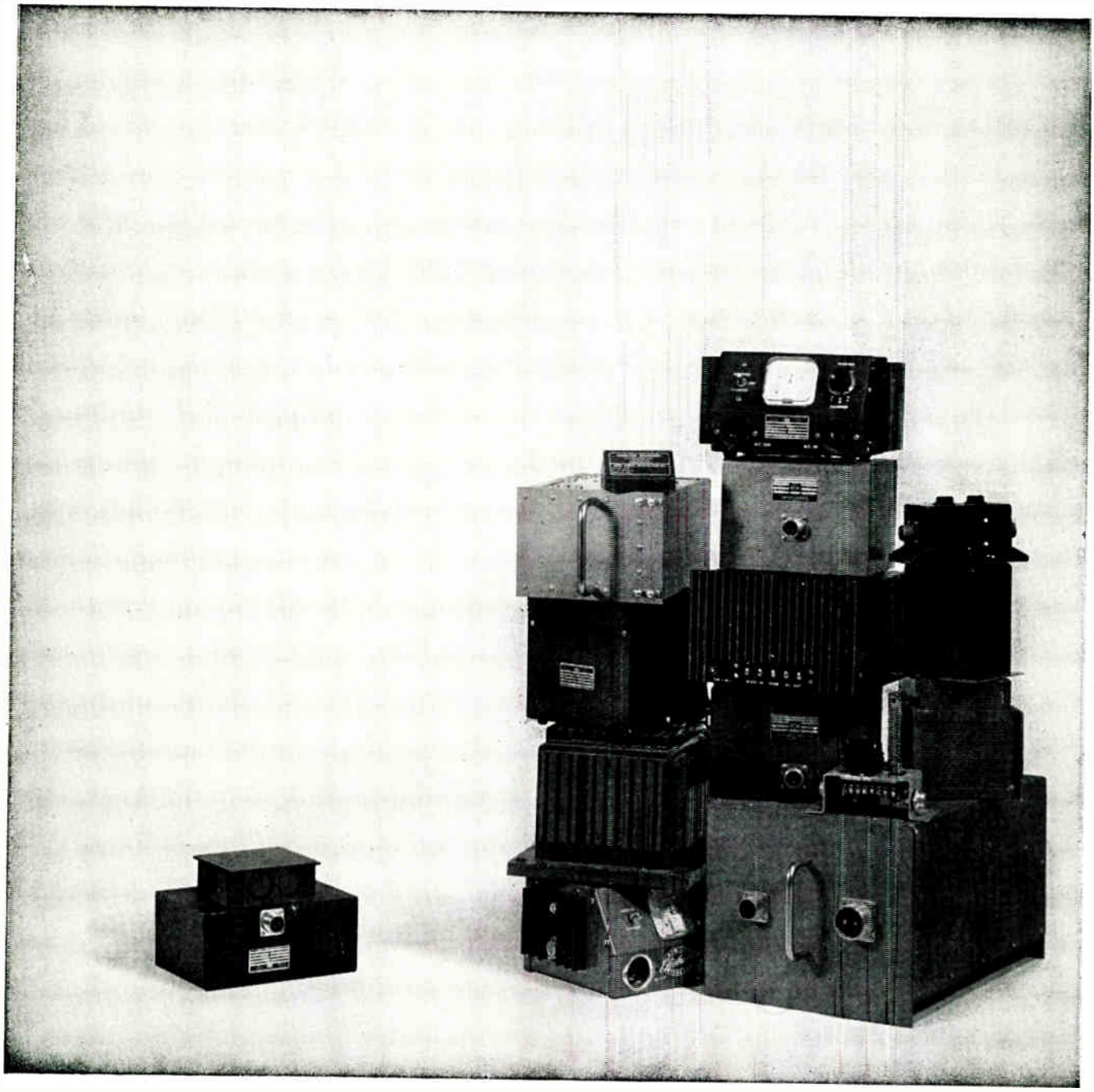

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If you're looking for one of the most complete lines of static inverters for military and industrial applications, you'll find it at Hamilton Standard.

From models in production, you can mix a limitless combination of characteristics to match your application—perfectly.

The variables: output rating (from 25 va to 10 Kva), number of phases, wave form, conversion efficiency, operating temperature range (−55°C to +125°C), size, weight, design life, vibration (10 to 5,000 cps at 30 Gs), overload protection, operating shock performance (10 to 400 Gs).

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guidelines. While the demise of parliamentary government effectiveness in dealing with the defense problem is viewed as dangerous by many, it is still real. Already government officials do not seek to brief Congress. They are asked to do so.

Implications to White House & State Dept.

The centralization process will probably have the opposite effect on the White House, by strengthening the President's real, rather than nominal authority in defense affairs. Secy. McNamara has built a central staff machine, which has toned down, or in some cases silenced, service dissent. Fearful of nuclear escallation, he has removed the nuclear option from theatre commanders. It has been concentrated solely in the hands of the chief executive. He has supported the President's efforts for disarmament by absorbing first, civil defense, and now genuine disarmament projects like Project Cloud Gap, funded through ARPA. The Secretary seems to have put himself in close working harmony with the President, although the Secretary seems to dominate the relationship. Should he retire, many believe the replacement will be a weaker man who will be more willing to use DOD to support the President's internal political objectives.

The close relationship between the President and the State Dept. in defense affairs is changing. We have probably passed into a period where weapons and technology determine policy rather than the reverse, an odd paradox. The State Dept. has not caught on to the new game of cost effectiveness and in the short term will not.

MICROWAVES FOR THE U.S. GOVERNMENT

The U.S. Government in 1962 spent about $1.8 billion for all radar equipment. This figure includes systems used in the air, in space, on land and sea, for both the armed forces and civil agencies.

Radar totals are:		
Aerospace		$1,410,000,000
Aviation	$170 M	
Missiles	$1,180 M	
Space	$60 M	
Sea		80,000,000
Defense, Detection		105,000,000
Armed Services Command and Civil Agencies		150,000,000

The U.S. Government's share of microwave buying in 1963 should be around $2 billion, according to an Electronic Industries estimate.

Implications to the Services

Implications to the services are already visible, but not complete. Procurement will be separated from military operations with increased authority. Procurement activity will be built on strong major project organizations. In this developing pattern, the Air Force is the model. In making the necessary changes, the Army is about two years down the line and the Navy is just beginning. The services will continue to award contracts but under increased restraint and restriction. Service criticism will be kept in the context of the new DOD methods, as the old channels for protest, the press and the Congress, dry up. Accent will be on young officers, inexperienced in war but "well educated," who can adapt to the new environment.

Implications to Industry

Implications to industry are very important, especially to those who fail to get the message. OSD has emerged as a prime customer and must be satisfied if programs are to be sold. OSD will require 5-year program cost forecasts, cost effectiveness of the proposed system against alternatives and documented evidence of a contractor's contractual performance history. OSD will want this information to flow up through the services, but it will usually be put together originally by the prime contractor. Since OSD has become so important to the contractor, it will take on special trappings. Field officers will have OSD reps who understand the language. Cost effectiveness departments will emerge as distinct functional organizations. Contract groups studying past promises against actual performance will emerge. And all these will be superimposed on the existing marketing/design organizations as needed.

Finally, centralization will increase the importance and burden of top management. It will demand better knowledge, preparation, and understanding. The Vice President of this or that will be required to present the company's story to new high ranking military and civilians now involved in the system selection process. Conversely, many middle and lower management marketing positions will wither away for lack of responsibility unless they train themselves to serve the new requirements. Thus, there will be a tendency for customer contact operations to centralize to meet the centralized buyer.

The changes introduced by Mr. McNamara are usually well thought through, based on a reasonably coherent vision of the job of the Secretary and his staff. They are likely to survive many years.

● **A REPRINT of this article is available from ELECTRONIC INDUSTRIES Reader Service Department**

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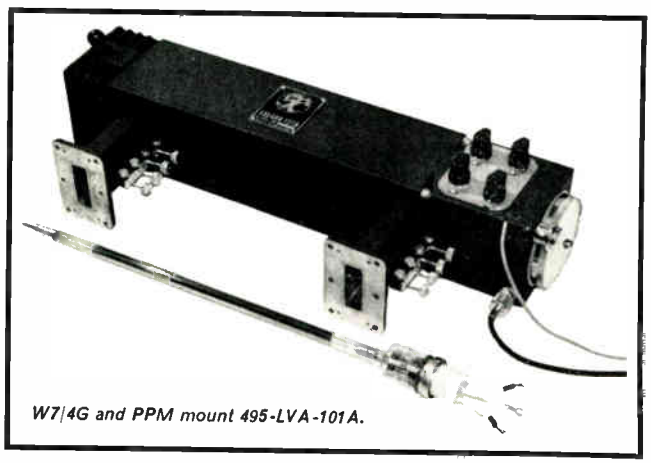
WORLD-WIDE ACCEPTANCE of STC MICROWAVE TUBES

New tube development continues

STC have been leaders in the design and production of microwave communications for many years. Microwave tube development and production programmes have resulted in: improved gain, lower noise factor, higher synchronous saturated output level and phase modulation distortion, together with a high degree of reliability and simplicity of operation.



W7/4G and PPM mount 495-LVA-101A.

W5/1G and PPM mount 495-LVA-105B.

S-band

For the communication frequencies of this band (3.6 to 4.2 Gc/s) there are two STC travelling wave tubes:

Type W7/3G performance has been proved in national and international microwave systems in fourteen countries.

Type W7/4G is a higher gain version of the W7/3G. It is provided with a periodic permanent magnet mount which incorporates simple mechanical adjustments for obtaining the very best performance from any tube of this type.

ABRIDGED DATA

Tube Type	Mount Type	RF Connexion (W.G. Flange)	Frequency Range (Gc/s)	Sync. Sat. Output (W)	Gain (db)	Noise Factor (db)
W7/3G	495-LVA-104	12A*	3.6 to 4.2	8 to 10	28	27
W7/4G	495-LVA-101A	12A*	3.6 to 4.2	10	42	27

**Transition pieces to WR 229 available.*

C-band

Travelling wave tube type W5/1G has an established reputation in microwave link repeaters operating at about 5.0W output level in the 6.0 Gc/s band. A modified tube type W4/1G can be used in the *same* periodic permanent magnet mount as the W5/1G to cover the upper frequencies of this band (7.0 to 7.8 Gc/s). Type W5/2G has been especially designed for 1 800 channel link systems and is intended for operation with a 10 to 15W output.

ABRIDGED DATA

Tube Type	Mount Type	RF Connexion (W.G. Flange)	Frequency Range (Gc s)	Sync. Sat. Output (W)	Gain (db)	Noise Factor (db)
W4 1G	As for W5 1G	As for W5/1G	7.0 to 7.8	8 to 11	37 to 40	26
W5 1G	495-LVA-105B 495-LVA-105C 495-LVA-105D	UG344/U CMR137 UG344 U	5.85 to 7.2	8 to 11	35 to 39	26
W5 2G	495-LVA-107B	UG344/U	5.925 to 6.425	16	37 to 41	27
LS985	WM108	UG51 U	7.0 to 8.5	8 to 11	36	26

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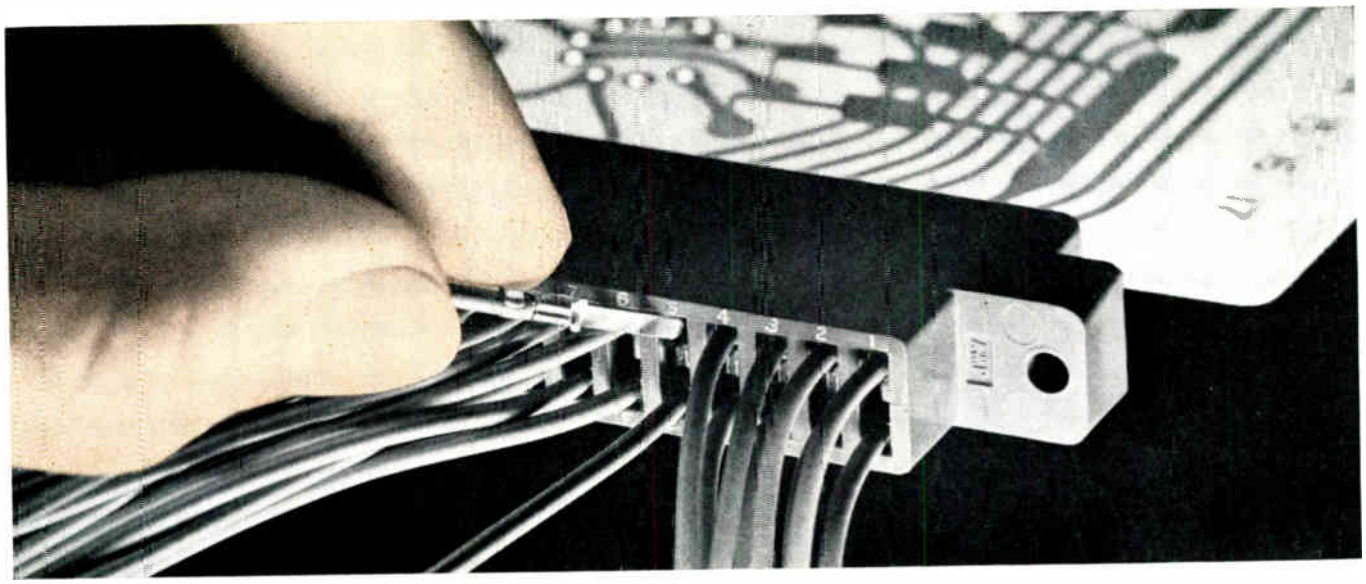

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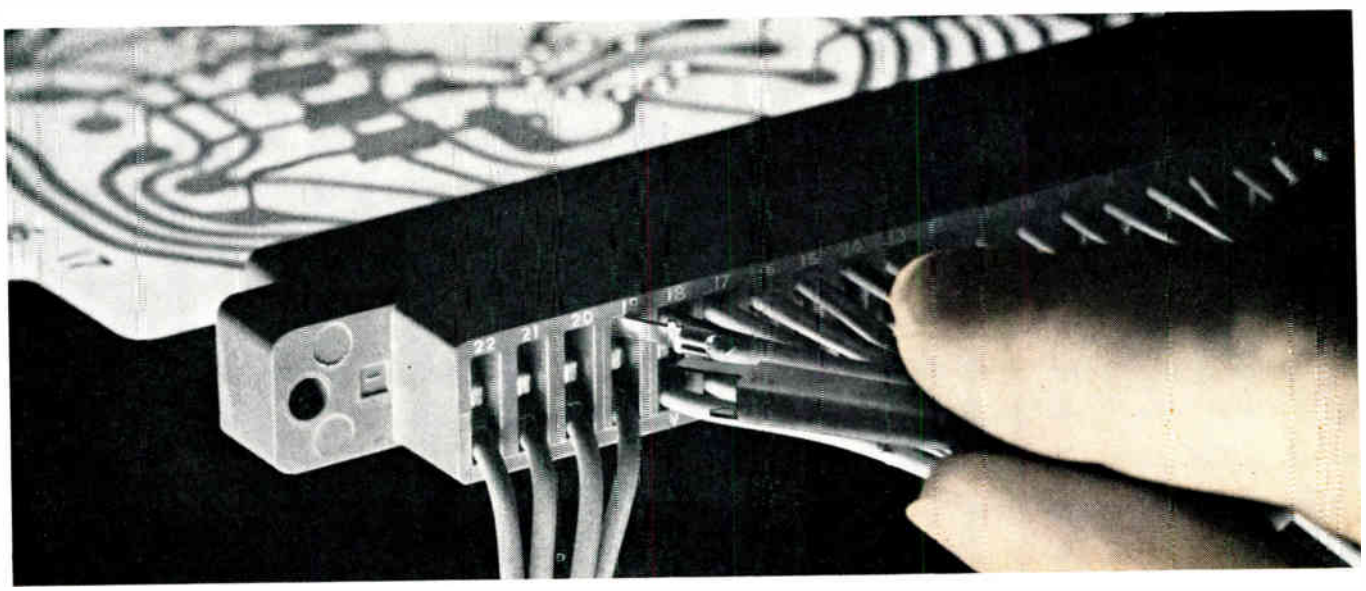

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All this is what's different but, you still get other premium AMP-line features. Contacts and tabs of phos-bronze base material with standard gold over nickel plating. Our reliable "F" crimp for maximum conductivity, near-wire tensile strength and built-in insulation support. And . . . automatic application of leads to tabs at rates of up to 3,000 per hour for the lowest possible applied cost anywhere.

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- available in 10, 15, 18, 22, 31, 41 and 43 positions for wire ranges—#18 AWG thru #26 AWG

And, there's still more! Just send today for the complete story on our new AMP-TAB Connector for Printed Circuits.

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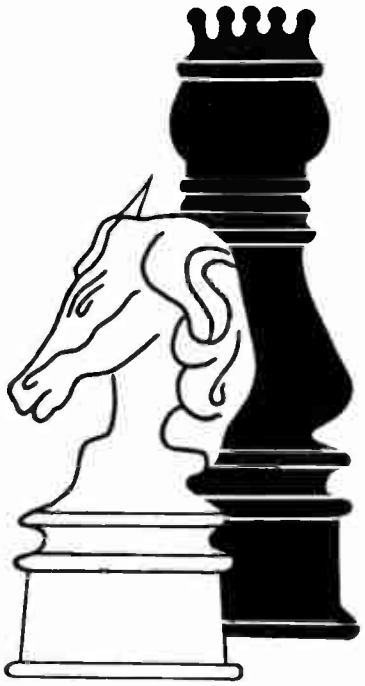

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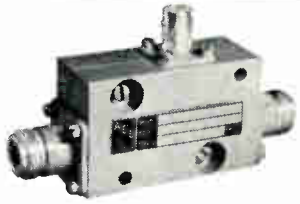

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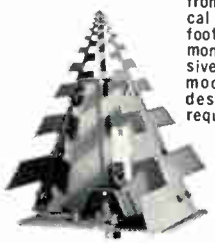

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AEL

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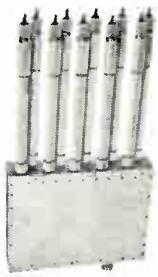

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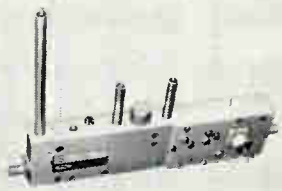

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- Parametric amplifiers
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- Solid state limiters
- Solid state continuous phase shifters
- Voltage variable attenuators
- and many others

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Circle 42 on Inquiry Card →

World Radio History

How Reliable Are Relays?

Reliability is the key word when over 230 users and manufacturers discuss relays at 11th National Conference.

The demand for higher reliability is pinpointed by this report of the recent conference on Electromagnetic Relays,* co-sponsored by NARM and Oklahoma State University. Reprinted below are significant excerpts together with marginal notes by our Guardian engineers.

**as published in Electronic Evaluation & Procurement, May, 1963.*

Guardian engineers are working with this committee.

Since November, 1961, the Reliability Committee of NARM has been working on developing an industry specification for high reliability relays. Formal presentation of the [illegible] was a necessary first step. Most users interviewed by EEP felt some of the spec's shortcomings must be overcome before it could be effectively and universally used to buy relays for their equipment. Its most serious drawback, they felt, was that there was no allowance for different environments or for environmental testing. Others felt some of the most severe conditions for contacts (low level tests at temperaure extremes were called for by one user) were not even considered. Burn in re[illegible]

Guardian tests under conditions more rigid than those proposed.

We're very high on low-level tests.

Include Guardian

It is estimated that 10-15 percent of the relay makers can now supply items that meet these specifications.

Effect of the NARM spec on relay procurement will be tied to what the soon-to-be-released MIL specifications for high-reliability relays says. An official spokesman for the military said the specification will be released "within 6 months." One industry spokesman said it probably will be issued much earlier, within the next month or so. Whatever the timing, there will be a MIL specification on high-reliability relays. New interest [illegible] the NARM. Some manufacturers whose relays are not being tested, feel release of the information may hurt them competitively. The "manufacturers selected as vendors have been chosen on the basis of competency, approval status, and production capability for the types of relays chosen for the test, as determined by the Bureau of Ships," reported Brooks and Schochet.

We've anticipated these requirements and strongly favor the new MIL Specs.

Guardian will participate

A relatively simple dc test circuit described by Thomas N. Lockyer of Philco Western Development Laboratories determines the susceptibility of relays to the formation of a parasitic to their grounded cases. He also found the parasite breakdown voltage is exponentially related to the current-tine integral of the main arc. John [illegible]

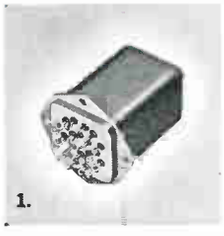
Right! our quality control has recognized this -- and it has led to many design changes and tests for reliability.

[illegible] acceptance tests currently in existence and proposed for use are only capable of determining the reliability of the relay with respect to the test procedures and are not capable of determining the reliability of the relay in the end use operational environment unless the tests exactly simulate the end use environment. It must be proved that a positive correlation exists between the acceptance test procedures and the operational environmental stresses before the failure rate derived from the acceptance tests has any meaning. Rejection or acceptance of a questionable lot should be an engineering decision based on analysis of acceptance test data and the application.

Absolutely! we do all we can to "marry" acceptance test and operational environment

Theme of presentations by manufacturers was "give us exact and detailed information on your application and we will tell you what relay to use." Users generally responded that they don't know the exact contact rating, the exact input circuit, the exact environmental conditions, the exact cycling rate, etc. What the user wants is for manufacturers to give operating and reliability data that is good over a stated range of contact load, cycling rate, etc. Then let the user be responsible for applying the relay within the given limits, otherwise relay buyers will be forced to treat each application [illegible]

Yes, this is a common problem. But the people at Guardian will knock themselves out to give you the information you want -- the way you want it!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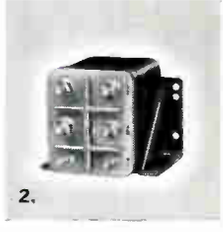
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World Radio History

Lasers provide an exciting "quantum jump" for weaponry. Weapons of the brute force, searing-heat variety can be expected soon. There will be more refined laser guns that rely on resonance effects or interactions with the target. Here's what they look like and how they work.

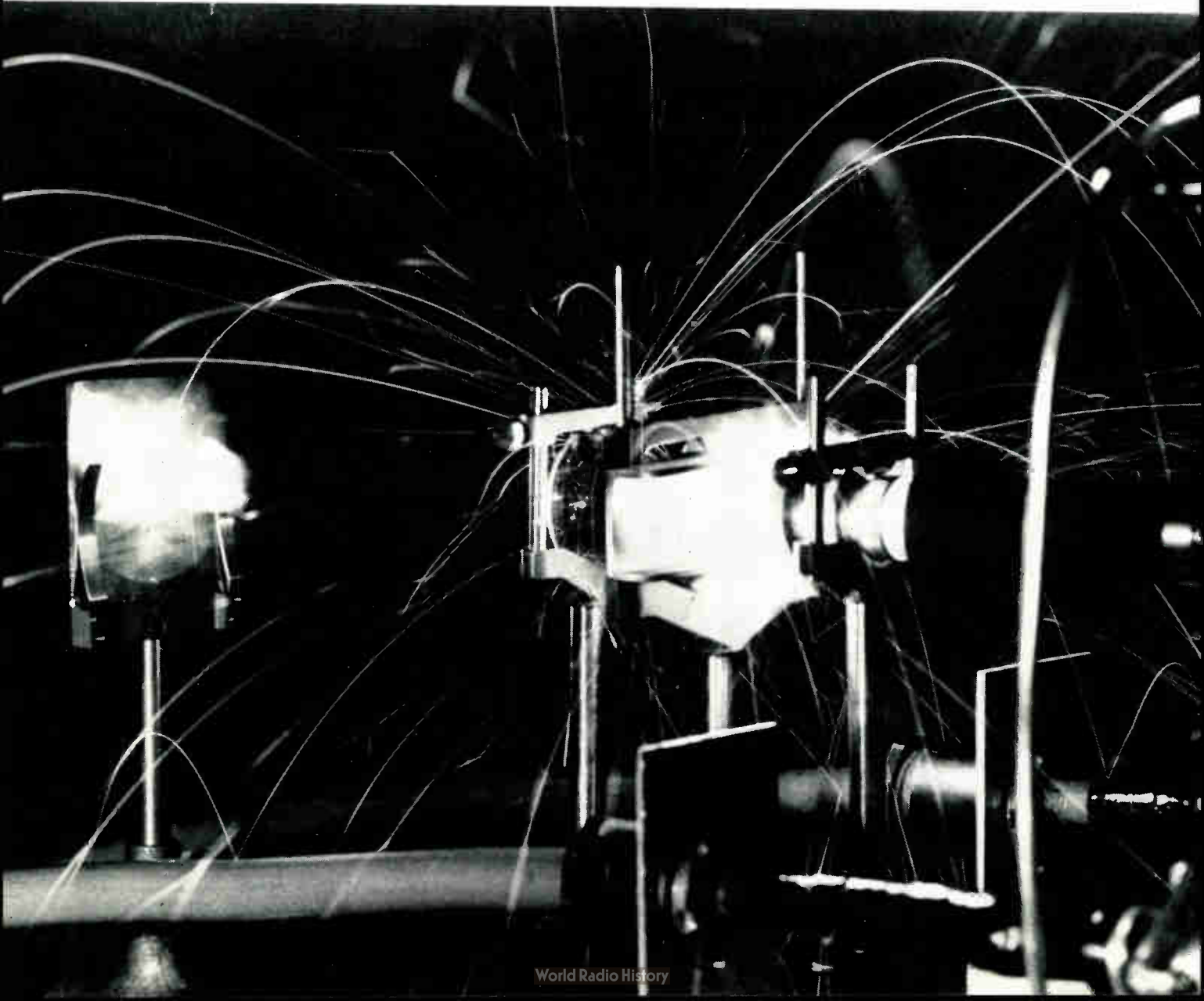
NEW DEVELOPMENTS IN LASER WEAPONS

OF THE SEVERAL ENERGY-DELIVERING SYSTEMS that qualify, the laser is the hottest candidate for a directed energy weapon (DEW). They are, at times, wrongly called focused energy weapons or radiation weapons. DEW are now in a state of the art which exceeds the atomic bomb technology of 1943—not only feasible, but soon to be handy in primitive form for limited weapons uses.

What does all this mean to those in the electronic industries? First, there is now a need—and it will be growing—for improved hardware of many kinds:

a. Better capacitors of smaller volume.

Power to burn—powerful laser developed by Raytheon Co. blasts through a ½ in. thick steel girder, then is refocused by a secondary lens to strike the protective shield. It delivers 350 joules. Maximum output of previous ruby lasers was about 50 joules.



World Radio History

b. All sorts of high voltage components.

c. Superbright electronic flash lamps and power sources.

d. Electro-optical gear.

e. Protective electronic-type goggles of a kind not yet developed.

f. Temperature measuring instruments. Present resistance, thermocouple and thermistor thermometers burn up, so light pressure has been proposed.[5]

g. Better furnaces for growing larger crystals.

h. In general, devices which cross from electronics into many details in physics, chemistry and engineering for their operation. Many will have to be developed.

Second, the electronics man has to realize that the whole laser field is moving ahead at an amazing pace. It does not consist of do-it-yourself gadgets for kids. Instead, the electronics man must recognize that lasering in the high-energy realm and in the exotic electro-optical circuitry yet to come (or now here, but not openly available) will result from teamwork. This, of course, does not knock down the role of the individual, if he has an electronics specialty with a bearing on a unified laser effort. In a few instances, the loner can maverick his way to a laser breakthrough. So let us look at some aspects of laser weaponry.

Kinds of Laser Weapons

Whatever the effect of a laser weapon on its target, it is important to look upon the device as a member of a family. This ranges from concepts for a side arm—already being investigated in this country and abroad—to rather far out stuff orbiting in space. One proposed space system weighs about 15 tons, is pumped by nuclear energy, and has a laser resonator complex about 30 ft. long and 10 ft. in diameter.

There are 3 kinds of laser weapons:

1. The brute-force, heat-beam.
2. The true "death ray."
3. That which combines directed energy with directed matter (DEW-DMW) for its kill ability (see below).

By DR. JACK De MENT

De Ment Laboratories
1717 Northeast 19th Ave.
Portland 12, Oregon

Each may be pulsed or CW (continuous wave). Of the 3, the pulsed heat-beam is presently the most attractive to pack the needed punch. But the situation could change overnight.

Effects of pulsed Lasers

The output of pulsed lasers has risen almost exponentially, with recent values of 350 joules (by Raytheon Co.). See photograph of its effect. A 2000-3000 joule system is anticipated for this fall by Paul A. Leavy of Sanders Associates. Contracts have already been let for a number of feasibility studies by the Navy (mainly ONR). Studies sponsored by the government are under way on heat-beam weapons which aim at 10^9 joules output. If this ever comes about, it would correspond to a thermonuclear-type breakthrough.

Compare the above values to that of a 50-joule lason (laser light slug) which can cause incendiary damage to wood and similar materials at a distance of 1 mile.[16, 15] A photograph shows this unit demonstrated on a strip of steel. The 10,000° temperature record reached is now old hat. See Fig. 1. C. H. Townes of the Institute for Defense Analyses says that in terms of temperature, optical and infrared radiation is now available which can be described as at 10^{20} °K or 10^{30} °K rather than at temperatures near 10^4 °K (Ref. 3).

At the Quantum Electronics Conference in Paris in Feb. 1963, Gersie and Scovil of Bell Telephone Labs predicted a peak power of 10^6 megw. (1 terawatt (Tw) or 10^{12} w) in a pulse of 10^{-11} sec.

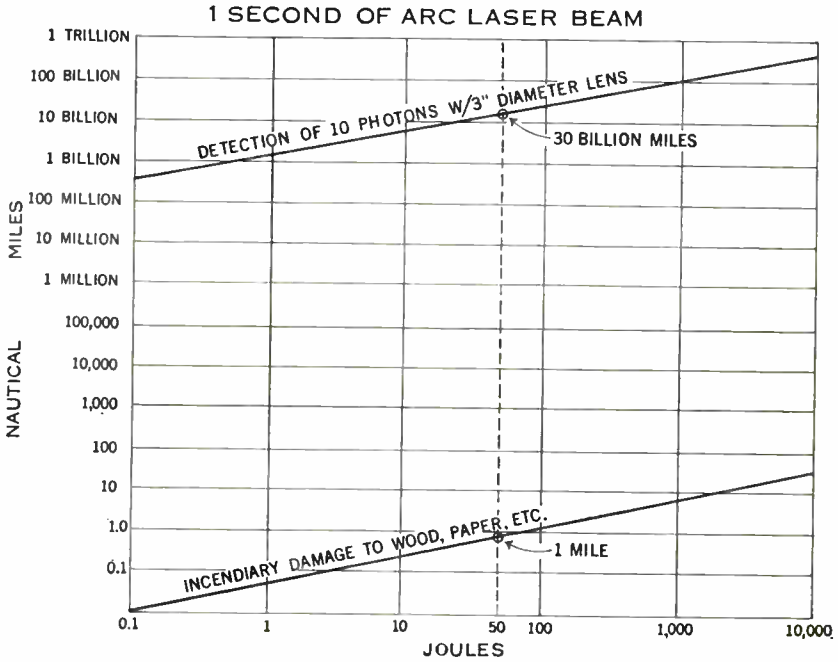
"Death Ray"

Little can be said about the true "death ray." But in this realm there are doubtless many surprises in store. By definition it is not primarily the injection of searing heat into a living system, an electronic circuit or other inanimate object or structure, though secondary thermal effects may be involved.

Among other things, it presumably will involve destructive resonance or beat effects with the target, such as heterodyning when the target itself is a source of electromagnetic radiation. Results of energy fed back may range from simple jamming of an active missile or satellite to certain secondary thermal effects. In the latter, instead of causing the target to vaporize from insult by tremendous heat, the target spalls or violently explodes because it contains adsorbed gases and fairly low volatility components (e.g., solder, plastics, antiradar coating, pottants, traces of water, etc.).

World Radio History

Fig. 1: Laser beam effects. 350 joule lasers are now reality. 3000 joule lasers are contemplated by late 1963, possibly giving incendiary effects to reach 10 miles.



Note:
The field is moving exceedingly fast; since this article was written, Maser Optics, Inc. (Boston) has announced a high power laser with output of more than 1500 joules per pulse and input of 120 kilojoules. Korad Corp. (Santa Monica) has an experimental unit, with a peak power output of 500 megawatts; the beam ionizes air and creates a visible flash of light.

LASER WEAPONS (Continued)

At the Institute of Optics of The University of Rochester it is found that a laser beam, upon striking certain crystalline materials, makes them explode off as relatively cool, finely divided debris.[10] Semiconductors and target laser crystals would be susceptible. The spraying of material struck by a high energy laser beam, especially in space, may well involve Newton's third law in a new role—that of reaction to the very substantial laser light pressure. Mixed dark and light material often results in the lighter part taking up the laser energy absorbed by the darker stuff, with the lighter substance being vaporized. The heat transfer mechanism is as yet little understood.

New High Energy Systems

Energy output from a laser (or an array of them) increases with energy pumped in (other things being equal). Pumping can be done in a number of ways. The xenon flash is the most popular at this time. Pumping by electrons and various explodable light sources (chemical, explodable conductors, or high tension sparks) show promise.

In 1937 it was found that certain phosphors (which laser resonators are when solid) could be made to emit over 1.4×10^6 foot-lamberts of light when excited by 70 kv. electrons.[14] Leverenz[12], long a pioneer in the field, calculated, in 1940, that a very thin phosphor layer, hit by 10 kv. electrons, would emit light equal to 900 kw. per sq. cm. (1340 horsepower). How close he came to the laser will never be known. Remember that this is not laser light, but incoherent light. So we see a new way to lasering should be feasible when high-energy electrons (which do not penetrate too deeply, in contrast to pumping light) are used in a vacuum with one-shot, thin-layer laser resonators that are fired successively through the electron beam.

Explodable light sources can involve the discharge of low-inductance capacitors through fine wires, foils or air to give in 0.1 μsec. light brightness of 40×10^6 candles per sq. cm. of plasma surface.[15] But just how to separate the shock from the light so the laser is not crushed, let alone fire in rapid sequence so that there's plenty of pumping? One answer is "velocity sieving," where the difference between light and shock velocities is taken advantage of.[7]

Shock-Sink Weapon

Another way to do it, with or without velocity sieving, is with my shock-sink system (Fig. 2). A strong T or Y or other similar tube has an explodable light source (explodable conductor, chemical mixture, one-shot xenon flash cartridge, etc., in its end). This gives a very fast series of light-emitting explosions when quickly passed through the end of the tube. On explosion, light and shock and source debris travel down the leg. The light first strikes a breakaway reflector (mirror, grating, etc.), to throw only the light into the "light leg," which has a laser or other irradiable target on its end. Shortly thereafter the shock and debris hit the frangible reflector, which is broken and, along with the shock and debris goes down the shock-sink leg. Meanwhile, a magazine of fresh breakaway optics and a feed mechanism injects another mirror into place just before another

World Radio History

explosion occurs.

The shock-sink system can be varied from the generic design shown in Fig. 2 in many ways. Some of them are as follows. The breakable reflector can be plane or curved or in various combinations, and in different mountings corresponding to spectrograph mountings (Rowland, Wadsworth, Eagle). The system can be operated at any desired pressure, from a pretty hard vacuum (limiting shock travel) to atmospheric to high pressure with or without gases like argon present. A venturi throat can help in sucking the reflector debris into the sink leg, and the pressure differential can be used for reloading both reflector and explodable light source. Electronic actuation means can be used for very fast operation of mirror and light source replacement. The whole system can be the size of a mortar or as large as Big Bertha.

Pumping Light

One way of chemically pumping a laser is with a "light engine" (Fig. 3). A spheroidal envelope has a laser mounted inside. A suitable gas-dispersoid, an explodable light source "fuel," is introduced into the envelope through an injector, to be exploded by the ignitor. Laser light is emitted when the pumping threshold is passed, and exploded debris is exhausted. The fuel can be solid particles (like metal), liquid or vapor, together with oxygen or other gases. The laser can be sheathed for protection, but the geometry of the envelope tends to minimize shattering by equalising the pressure.

The pumping light produced within the sphere is very great. In 1935 Michel-Levy and co-workers produced up to 10^7 lumens by exploding small amounts of tetranitromethane - toluene mixture in argon.[13] Just recently, Air Force people exploded sheet explosive in argon to get about 10^5 lumens of light.[8] The burst of light from a powdered metal explosion in oxygen or otherwise "unreactive" gases like carbon dioxide or nitrogen is often very great.

A torch using the traits of laser energy acting upon matter is interesting from a weapons standpoint. Both the ultrahigh light energy and the light pressure, which may run into several thousand psi, may come into play (Ref. 10 and 5). Feed material (gas, liquid or solid) is put through a laser (Fig. 4). The beam emerges into an interact region where there is formed anything from a heat-augmented flame to the explosion of gas or solid to a radiation-impelled plasma glob. While the laser torch has

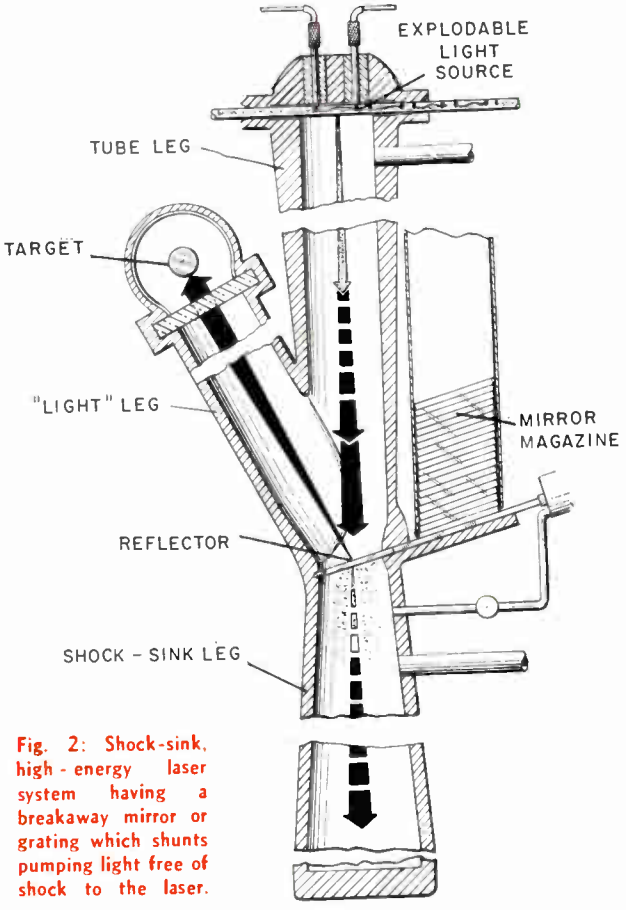


Fig. 2: Shock-sink, high - energy laser system having a breakaway mirror or grating which shunts pumping light free of shock to the laser.

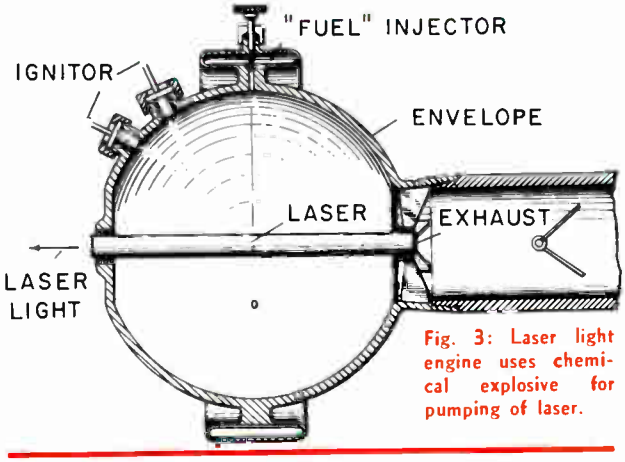
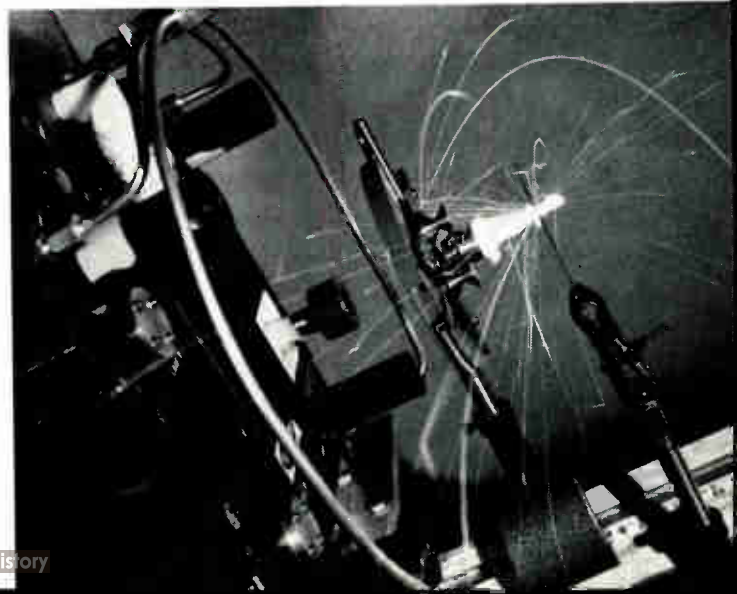


Fig. 3: Laser light engine uses chemical explosive for pumping of laser.



Powerful 50-joule beam of Raytheon's 4-barreled laser (the model used by M.I.T. for the "moon shot") instantly burns a hole in a strip of steel producing a shower of white-hot molten metal.

World Radio History

LASER WEAPONS (Concluded)

more immediate uses for peacetime welding, cutting. etc., perhaps it would be of limited value in the atmosphere. Such an instrument should be of interest in outer space, in view of the statement by Levy. He says that a several kilojoule laser pulse could cause a "breakdown, as in a lightning flash, creating a tremendous explosion in which the air turns blue."

Molekulyarnyy Usilitel' i Generator

In the Soviet Union, where laser research is well planned and organized, the device is called a MUG (molecular amplifier and oscillator).[1] In early 1961 Soviet developments were about two years behind those in this country. It is a safe bet that both theory and hardware efforts in the weaponry end of it have been stepped up and the gap closed some.

The U.S.S.R. has long been active in subjects having a direct bearing on lasers. Thus, the study of luminescence and luminescent substances has long been a very strong area in Soviet physics. The bulk of the papers published have the signature of the Lebedev Institute of Physics, Academy of Sciences of the U.S.S.R., with some two dozen other institutes and universities making significant contributions.[2]

There is no doubt of a growing Soviet effort in laser weaponry. What is available in the open literature adds little to the picture, except by implication. Krasnaya Zvezda in July, 1962, published an article on an antimissile beam.[11] This turns out to be a rehash of material published in the U.S.A., with interesting and often amusing overtones. According to Krasnov, it would seem that the Soviet MUG benefits by that important quantum-mechanic parameter of dialectic materialism which "aggressive imperialist circles" have not designed into their lasers.

Lasers and Security

During the last year—more so over the last six months—there has been a very definite tightening up on theoretical and applied information relating to laser weapons. Industry is more security minded for proprietary reasons if for no other. And, of course, the government classifies its studies on such weaponry.

In the U.S. patent applications are systematically screened "in the interest of National Defense" (just how many secrecy orders have issued is naturally not available for publication). Licenses to file in foreign countries may be suspended pending completion of a review in accordance with Title 35 U.S.C.A. (1952) Sec. 181. The same situation obtains in the U.K. (Official Secrets Act, 1911 and 1920, Sec. 18). The many titles, e.g., of bibliographies, which refer to the "open literature" clearly implies the existence of a substantial body of classified material in the laser field. It can be expected that the security situation will tighten up in the foreseeable future.

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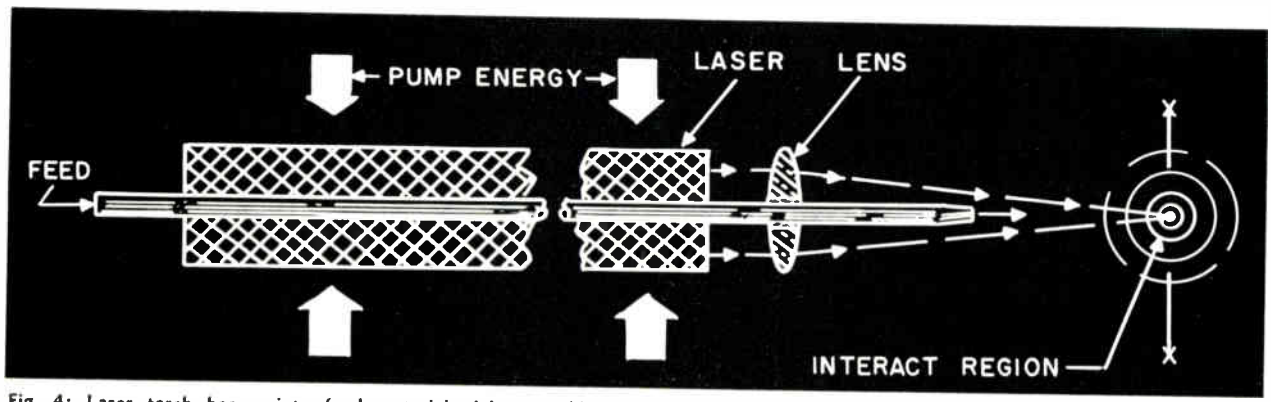

Fig. 4: Laser torch beams into feed material giving anything from a flame to explosion to a radiation-impelled plasma glob.

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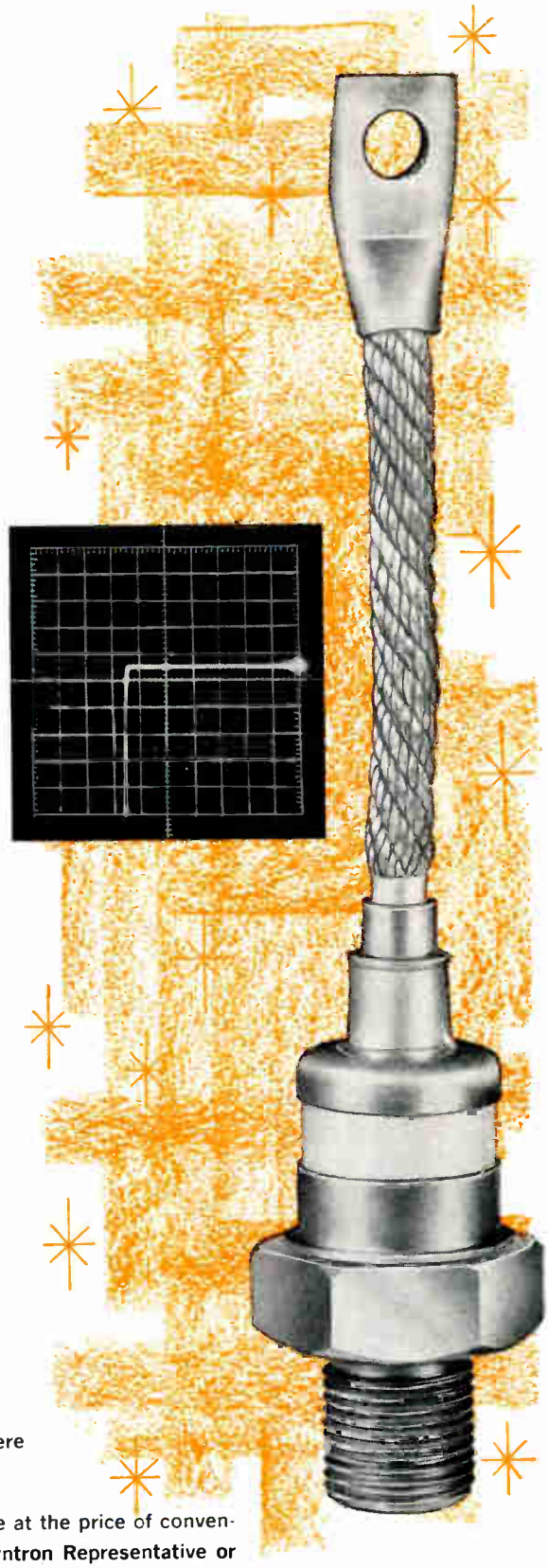

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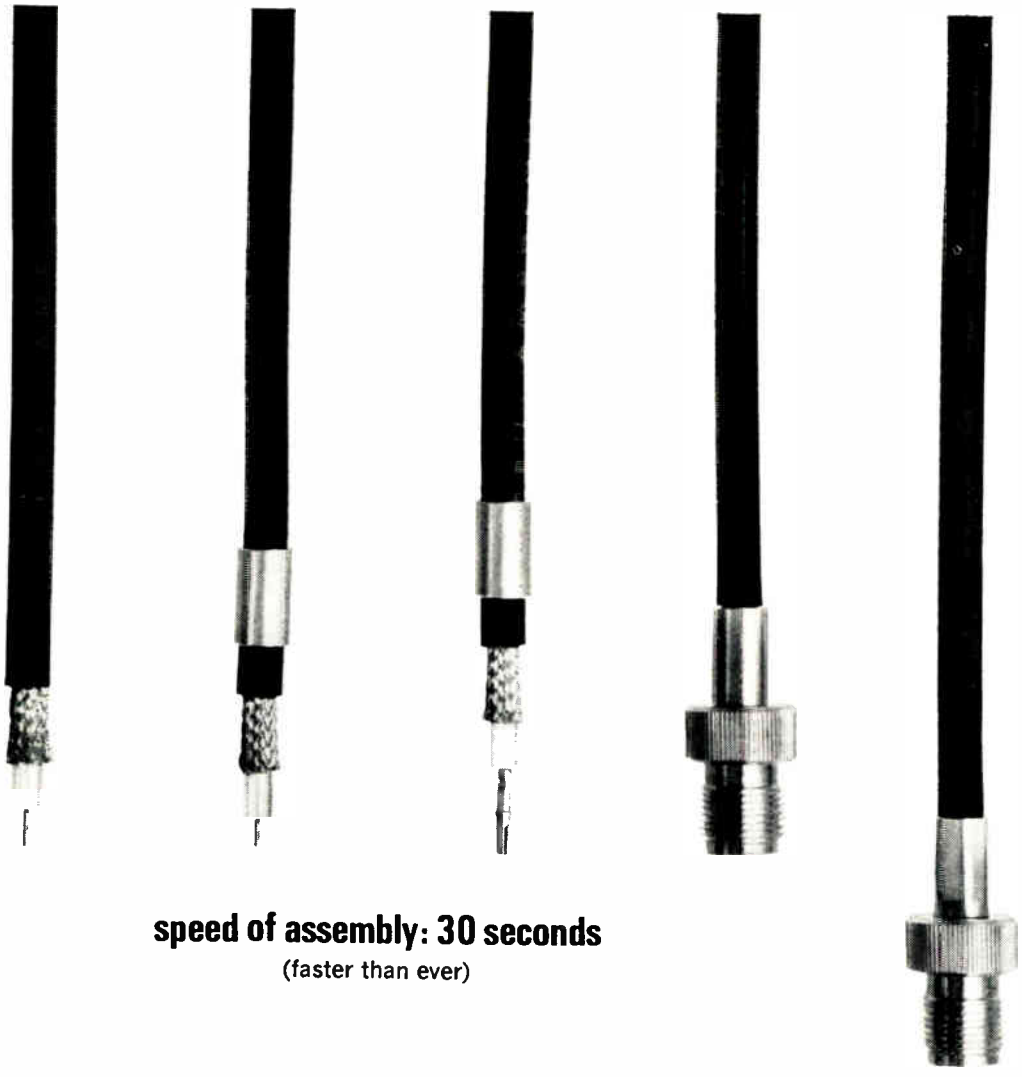

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Resistance Range: Linear, 500 ohms to 2.5 meg; 10% log, 5000 ohms to 2.5 meg.

Vibration: Meets characteristic "X", MIL-R-94B.

Moisture Resistance: Meets characteristic "X", MIL-R-94B.

Insulation Resistance: Meets characteristic "X", MIL-R-94B.

Electrical Rotation: 260° ±3%.

ATTENUATORS

75-300 ohms: 45DB maximum attenuation, 1/2 DB insertion loss, Tolerance: 0—95% of rotation, ±20%; 95—100%, ±30%.

Above 300 ohms: 20-25 DB maximum attenuation, 1/2 DB insertion loss. Tolerance ±20%.

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Rating: 2 watts at 85°C, derated to 0 watts at 150°C per MIL-R-19A.

Resistance Range: 4 ohms to 30,000 ohms.

Vibration: Meets MIL-R-19A.

Moisture Resistance: Meets MIL-R-19A.

Insulation Resistance: Meets MIL-R-19A.

Electrical Rotation: 250°±3%.

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World Radio History

MICROWAVE DIODES— A PROGRESS REPORT

The field of microwave diodes is making rapid advances. Higher cutoff frequencies, lower noise figures, and longer life are some of the advances, with more to come. Here is a report of today's technology and predictions of advances to come in the next year or two.

THE TECHNOLOGY OF MICROWAVE DIODES is currently in a rapid state of advancement in all areas. Certain types of diodes (i.e., point contacts) in which improvements have almost ceased for many years, are now moving ahead again. This is due to a better theoretical understanding of the underlying phenomena.

Because of the large number of private laboratories working in this field and the highly competitive nature of the resultant product, it is not easy to obtain up-to-date information on the state-of-the-art. This article covers known research and development work. The discussion on each type of diode will cover advancements made during 1963 and attempt to predict what can be expected during 1964.

* * *

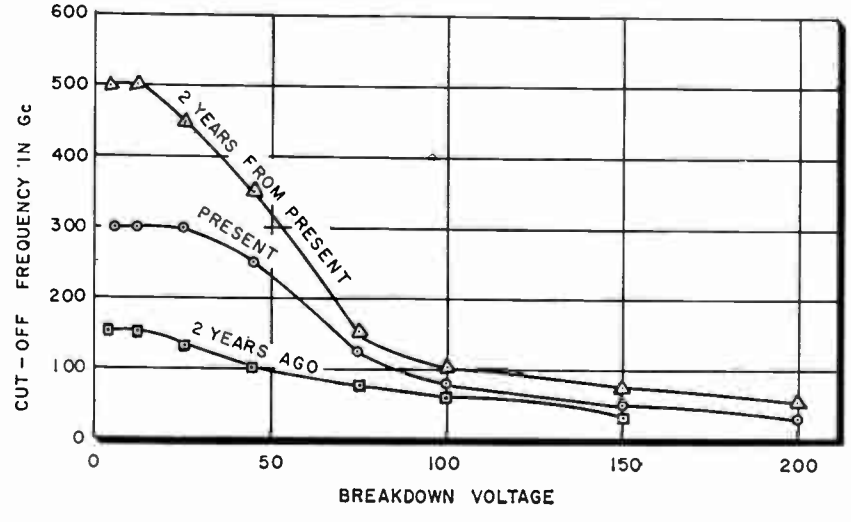
Varactor Diodes

The varactor, or variable capacitance diode, represents the most important gain in microwave diode technology since World War II. The basic physical difference between the varactor and the point contact and bonded diodes is its diffused junction.

Diverse varactors, exhibiting a wide range of diode characteristics, have been produced through varying the density and time of impurity diffusion, the substrate resistivity, and the bulk resistivity. The needed diode's characteristics continue to be a joint function of the using device's needs and the physical constraints in the diode structure. The quality of varactors, reflected by such basic aspects as cutoff frequency and reliability, is improving sharply.

Recent and future progress is shown in Fig. 1. Two years ago, the cutoff frequency of commercial "off-the-shelf" varactors was 150 GC. Within the past year, both silicon and gallium arsenide (GaAs) diodes having a 300 GC cutoff were introduced on a commercial basis. Besides the increase in cutoff frequencies, these diodes exhibit lower resistance, lower capacitance, and greater amenability to low temperature operation than previous varactors. Improvement of the cutoff characteristic is assured by better diffusion technology, package construction advances which greatly reduce contact losses, and further improvements in available semiconductor material.

Fig. 1: Cut-off frequency vs. breakdown voltage for high quality varactors.



By Dr. LEON RIEBMAN
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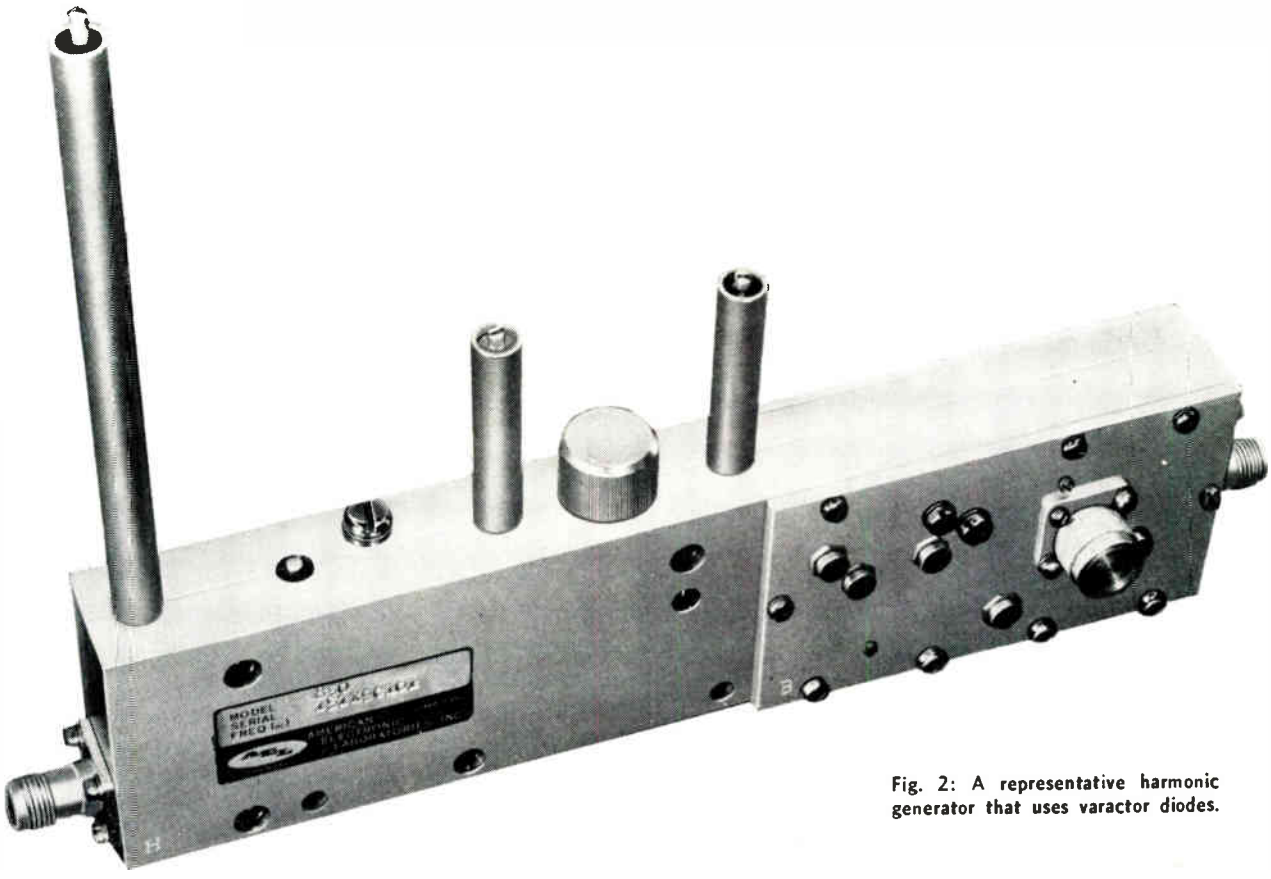


Fig. 2: A representative harmonic generator that uses varactor diodes.

Of equal significance is the big increase in MTBF under great mechanical and electrical stress. A very few years ago, varactors were mainly lab toys. They have grown in reliability to the point where they are now widely used in military hardware. Very shortly, a large number of varactors will qualify on very demanding space efforts, such as Apollo.

These improved varactor diodes are reflected in advances in many microwave devices. Several of these will be described.

Harmonic Generators

Critical need exists for stable microwave sources of moderate power (1-1000 mw.) for use in microwave receivers and as pumps for paramps. It is now possible to generate microwave signals having a stability of one part in 10^9 by use of a crystal controlled oscillator, a few stages of transistor amplification and a varactor harmonic multiplier chain . . . all solid state. The cost of such devices, in quantity, operating from a typical 28 vdc is quickly approaching that of commercial reflex klystrons. Within the next few years, reflex klystrons may be replaced by harmonic generators for local oscillator and paramp uses through K_u and C bands respectively.

Moreover, harmonic generators are not only highly stable, possess an extremely good MTBF and require modest dc power, but they have still another major attraction . . . a wide instantaneous output bandwidth capability. A new device now marketed possesses a 12% instantaneous bandwidth in X-Band and develops a minimum of 60 mw. over that band!

With the steady increase in power handling capability of varactors, output power from harmonic multipliers is steadily increasing. One can obtain 300 mw. in X-Band over a 1% band and as high as 60 mw. over a 12% band. A representative unit is shown in Fig. 2. Harmonic generator technology is tied very intimately to the varactor state of the art. From the cutoff frequency versus voltage chart (Fig. 1), it can be seen that an improvement for higher breakdown voltage diodes will occur in the next year or two. We expect the output power obtainable from harmonic generators to correspondingly improve by 30%-40%.

Phase Shifters

Another microwave device using varactors is the high speed, voltage controlled phase shifter. Here, once again, the variable reactance characteristic is used. This time, the reactance is varied to move the apparent location of a short circuit so that a simulated change of a transmission line length is achieved. This device finds use in frequency modulation systems, polarization diversity, interference cancellation, phased arrays, and other uses.

The critical requirement here is that the varactor possess a very low series resistance so that the diode losses are no more than 70-80% of the total cavity losses. For example, the cutoff frequency for

World Radio History

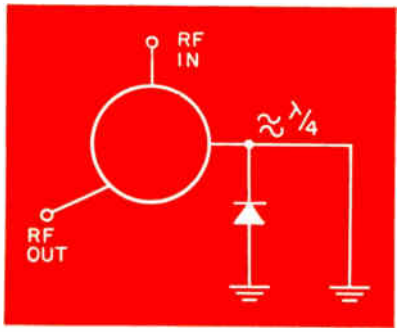
a varactor used in an electrical phase shifter should be at least 12-15 times above the operating frequency to assure no variation in insertion loss during the full 180° (or greater) phase shift cycle. Phase-insertion loss-VSWR characteristics is shown in Fig. 3.

Such a device, using a varactor, can adjust phase through a full 180°-200° register in a few nsecs.

Parametric Amplifiers

The basic theory of parametric amplifiers operation has been known for some time. Parametric amplification was noted during World War II when investigators overpumped 1N21 point contact diodes in mixer circuits. But, the high Q, variable reactance diode (varactor) was needed to realize the low noise, high stability trait of these amplifiers.

In the design of diodes for paramp applications, special attention must be given to the particular diode characteristics required, just as in the case for the other microwave devices using varactors. Effort today leans toward low breakdown voltage diodes (4-6 volts) possessing a very thin, abrupt depletion layer. These diodes can be pumped from zero bias to yield a "B"* factor of from 6-8. Such a diode needs very little pump power to achieve stable amplification as compared to graded junction diodes. Another plus arises from this situation—since noise is directly related to pump power, these abrupt junction diodes are also desirable because of the low noise.



Circuit sketch of a typical varactor phase shifter.

Work is progressing toward still thinner layers, so that pump power as low as 10-20 mw. may be adequate for frequencies up to C-Band and 20-30 mw. in X-Band. Present GaAs diodes with a "B" factor of 6, cutoff frequency (@0v) of 300 gc will operate in a C-Band paramp pumped at 26 gc and yield a noise temperature (at room temp.) of 200-260° K. Using still thinner layers and the expected higher cutoff diodes, the pump power next year may be reduced to 20-30 mw. The amplifier noise temperature will then approach the cryogenic maser.

$$* B = \frac{C\,(+\,1\mu A)}{C\,(-\,3V)}$$

Another first in 1963 is the practical usage of varactor-tuned helical resonators as frequency selective elements. They have been used in passive r-f tuners and also, along with transistors, as frequency governing components in UHF oscillators.

Figures for loaded Q as a criterion for tuned circuit quality are meaningless without also a specification for the insertion loss. The reverse is also true, since one parameter can be traded for the other. Values of loaded Q on the order of 60, with an insertion loss of about 1.25 db, have been achieved for single resonator sections in the region of 1 gc. This represents an unloaded Q of about 450, which is quite a respectable figure for devices other than a complex and costly cavity resonator.

Here, again, the varactor contributes to the total loaded Q of the helical resonator cavity and in such capacity influences the degree of selectivity attainable. Loaded Q's of around 60 are being obtained in resonators by using high "Q," abrupt junction varactors (Fig. 4). With the increase in diode cutoff frequency reported above, we expect the loaded "Q"s of these novel resonators to go to 100 or greater in the next one to two years.

Fig. 4 shows a laboratory model of a voltage tuner recently developed.

Switching Diodes

There are 3 basic diode types in use today for switching: 1. The gold or silver bonded quasidiffused junction diode; 2. The PIN diode; 3. The PN varactor. Each type satisfies a particular set of general requirements. For example, the bonded diodes are designed to satisfy broad bandwidth needs at moderate signal power levels. The PN junction device is generally employed in circuits processing high r-f power over narrow bandwidths. The high power diodes have a barrier reactance somewhat below that of the transmission line impedance and must be resonated for optimum performance.

We are now experiencing an industry-wide effort toward the further improvement of the switching characteristics of these special diodes. A recent advance in miniature bonding technique paved the way for a better C-Band switch. Care must be taken with bonded diodes at high frequencies when the diode dimensions become a tenth or more of a wavelength. Miniaturization techniques that result in the designer being able to treat the diode as part of the distributed network must be used.

In the high power diode area, the principal work being done is toward improving the instantaneous bandwidth. Present high power diodes possess a large junction area and, therefore, require the use of resonating techniques for good switching action. Bandwidth can be greatly improved by reducing the bar-

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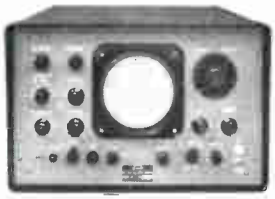

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MODEL AND DESCRIPTION	TUNER MODEL	FREQUENCY RANGE, GC	MINIMUM SENSITIVITY, dbm	NOTES
MODEL R 0.4-84.2 GC	**STANDARD MICROWAVE RECEIVER**			
	RR-T	0.40-1.0	−85	
	RL-T	0.95-2.04	−80	**Bandwidth:** 3 MC @ −3 db
	RS-T	1.90-4.34	−80	**Linearity:** ±1 db over 60 db. range.
• AM, FM, CW, MCW Receiver	RM-T	4.20-7.74	−80	**Meter Scales:** 0-20 db linear, 0-30 db relative,
• Pulse Receiver	RX-T	7.30-11.26	−80	0-70 db relative
• Field Intensity Receiver	RKS-T	9.50-15.6	−65	**Outputs:** audio, video, 40 MC IF, trigger, recorder
• Power Meter	RKU-T	14.70-22.0	−65	**Image Rejection:** 60 db
	RQ-T	20.26-46.7	−65	
	RE-T	45.30-84.2	−55	
	RW-T	2.00-75	−75 to −85	
MODEL TR 0.95-21.0 GC	**TRANSISTORIZED MOBILE RECEIVER**			
	T-RL	0.95-2.04	−90	**Bandwidth:** 1 MC, 5 MC, wideband impulse
• AM, FM, CW, MCW Receiver	T-RS	1.90-4.34	−90	**Linearity:** ±1 db over 60 db range
• Pulse Receiver	T-RM	4.20-7.74	−87	**Sensitivities** given are for 1 MC impulse bandwidth
• Field Intensity Receiver	T-RX	7.30-11.26	−87	**Meter Scales:** μv, db above 1 μv/mc, db above 1μv/5
• Power Meter	T-RKS	9.85-15.35	−80	mc, 0-70 db relative, 0-20 db linear
	T-RKU	14.80-21.0	−77	**Outputs:** audio, video, recorder
				Image Rejection: 60 db
MODEL FIM-2 1.0-21.0 GC	**STANDARD RI/FI METER**			
	FIM-L2	1.00-2.24	−81	**Bandwidth:** 5 MC @ −6 db, 3 MC @ −3 db
• Calibrated Receiver	FIM-S2	2.14-4.34	−81	**Maximum RF input,** 3 Volts
• Calibrated Signal Generator	FIM-M2	4.20-7.74	−81	**Signal Attenuation:** 0-80 db in 1 db steps
• Calibrated Antenna System	FIM-X2	7.36-10.0	−81	**Measurements:** Average, Slideback Peak, Peak, and
	FIM-KS	9.85-15.35	−73	Quasi-Peak
	FIM-KU	14.80-21.0	−70	**Calibrating Signal:** CW, 0.2 v RMS to 5 μv, 0 to −95 dbm
				Meter Scales: μv, db above 1 μv, db above 1 μv/mc
				Outputs: audio, video, recorder
				Image Rejection: 60 db
MODEL CFI 1.0-21.0 GC	**TRANSISTORIZED MOBILE METER RI/FI**			
	CFI-L	1.00-2.04	−90	**Bandwidth:** 1 MC, 5 MC, wideband impulse
	CFI-S	1.90-4.34	−90	**Maximum RF input:** 3 Volts
• Calibrated AM, FM, CW,	CFI-M	4.20-7.74	−86	**Signal Attenuation:** 0-80 db in 1 db steps
MCW, and Pulse Receiver	CFI-X	7.30-10.0	−85	**Measurements:** Average, Slideback Peak, Peak, and
• Calibrated Impulse Generator	CFI-KS*	9.85-15.35	−80	Quasi-Peak
• Calibrated Antenna System	CFI-KU*	15.0 -21.0	−77	**Calibrating Signal:** Impulse, 1 MC to 10 GC; 60 db
	*With self-contained impulse calibrator.			above 1 μv/MC; flat within ±0.5 db
				Meter Scales: μv, db above 1 μv/mc, db above 1 μv/5
				mc, 0-70 db relative, 0-20 db linear
				Outputs: audio, video, recorder
				Image Rejection: 60 db
MODEL DM-1*	**SPECTRUM SIGNATURE MONITOR**			
140 ±12.5 MC *DM-2 160 MC	DM-1	140 ±12.5 MC	−120	**Resolution Bandwidth:** 1 kc to 80 kc. variable
• Converts 140 MC IF Receivers				**Spectrum Display:** Lin & log on vert. vs freq. on horiz.
Into Spectrum Analyzer				**Sweep Rate:** 1 to 30 cps, variable
				Dispersion: 150 kc to 25 MC, variable
MODEL IC-120 A/B	**ULTRA-BROADBAND IMPULSE GENERATOR**			**Frequency Spectrum:** 1 MC to 10.0 GC, flat within
1 MC to 10 GC				±0.5 db
• Stable Broadband RF, VHF,				**Pulse Repetition Rate:** 1KC
UHF and Microwave Source				**Output Impedance:** 50 ohms
				Power Level: 60 to 70 db above 1μv/mc in 1 db steps

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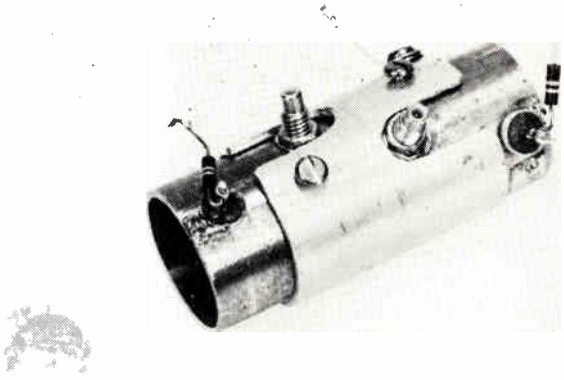
rier capacitance—but, immediately one is faced with reduction of the junction area and, hence, a drop in power handling ability. So, what is being done now is mainly in the realm of material study. Diodes are being made using alternate layers of heavily doped material containing regions of high resistivity sandwiched between. Using this method, it is hoped that the barrier capacitance can be largely reduced.

Crystal Video Detector Diodes

Very little improvement in crystal video detector diodes has been realized since World War II. In the late forties, much R&D activity was directed toward improving the sensitivity and the burnout capability of the point contact diode for this use. The major result of this work was an improvement in the yield of good diodes, but not the intended breakthrough. Because the results were meager, activity was reduced to a low level. Indeed, the misconception developed

Fig. 4: Laboratory model of a recent voltage tuner.



that further improvement could not be expected.

About four years ago, an important breakthrough occurred. It was shown that proper r-f and video matching networks used with existing diodes improved sensitivity as much as 8 db. Developments related to the crystal mount yielded an added 4 to 6 db in sensitivity.

The increased knowledge of how to achieve the maximum signal-to-noise ratio from a crystal video detector has renewed interest in the possibilities of improving the basic device. During 1963, R&D activity has increased with respect to improving both the sensitivity and the power handling of the crystal video detector. Fig. 5 shows the improvement in sensitivity accomplished during the past year in the detector and a prediction of further improvements to be looked for during the coming year. Fig. 6 shows the state-of-the-art of high power crystal video detectors.

Obviously a tradeoff must be made between sensitivity and high burnout capability. High power crystal video detectors (i.e. 500 watts peak power, ½ watt average) with good signal-to-noise sensitivity first appeared on the scene this year. Under the impetus

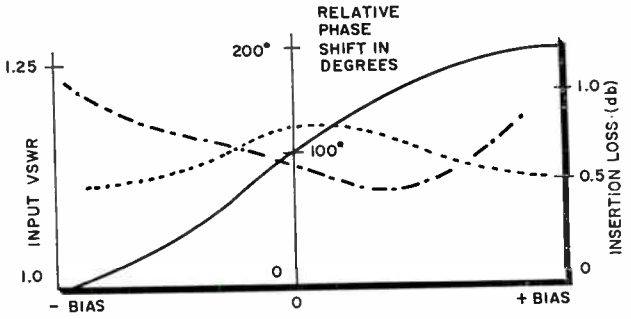


Fig. 3. Characteristics of an X-band varactor phase shifter.

of much research activity, greater improvements can be expected during 1964.

During the past year, improvements in manufacturing have resulted in better yields of the most sensitive diodes. In addition, through an increased theoretical understanding of point contact diode technology and research into new materials, further important developments are anticipated. The improved sensitivity, power handling, and ruggedness of modern day crystal video detectors will create a renewed interest among designers using these devices.

A particular military equipment using crystal video receivers, and currently in wide use, will serve as an example of the rapid improvements occurring.

Fig. 5: Improvements in tuned crystal video detectors.

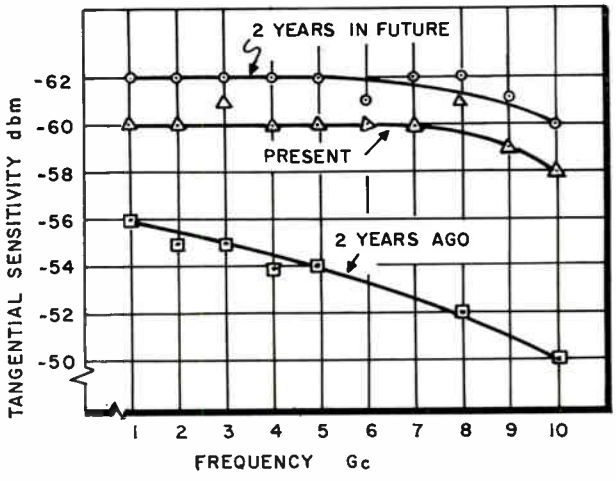
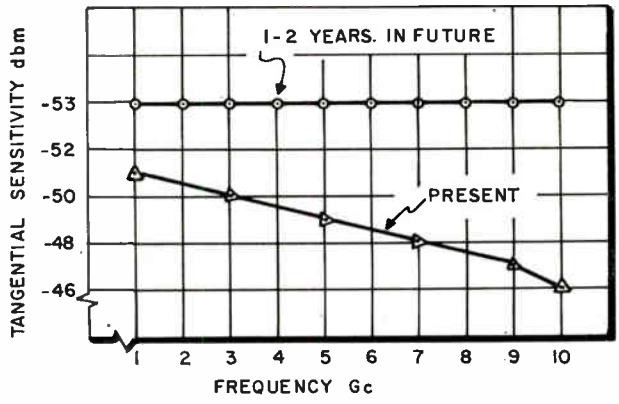


Fig. 6: State-of-the-art of high power crystal video detectors.



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MICROWAVE DIODES (Concluded)

This equipment does not use r-f preamplification and as recently as four years ago had to meet a specification of only −40 dbm for tangential sensitivity. Last year this same equipment could readily meet a −50 dbm specification, primarily due to better crystal video detector mounts. Within a few months, this specification can be raised to −55 dbm as a result of further improvement in crystal mount design and better detectors. Improvements that appear highly likely to occur during 1964 should permit this same specification to approach −60 dbm tangential sensitivity. Further, this improved sensitivity will be achieved with no increase in size or weight of the basic equipment.

The improvement in crystal video detector sensitivity has occurred over the full spectrum of microwave frequencies. As an example, earlier this year, industry announced the availability of broadband crystal video detectors useful from 40-110 GC and providing a 10 to 15 db improvement in sensitivity.

Superheterodyne Mixer Diodes

Improvements in mixer diodes for superheterodyne applications occurred in the first decade after World War II. Very few further improvements have been made in recent years and a plateau appears to have been reached in this field. Recent advances have been in terms of fractional db's in noise performance. These advances were realized mainly by selection and improved yield, rather than on basic theoretical advances. Very little of significance has been announced thus far in 1963 in the way of improved mixer diodes. However, improvements occurring in the crystal video detector field have influenced the rebirth of much research activity in the mixer diode field.

During the coming year we think that the following developments will be announced:

1. Mixer diodes will become available that require much lower oscillator power than present mixer diodes, and yet provide similar sensitivities. These diodes will be usable with tunnel diode local oscillators.

2. Significant effort, already under way to improve the burnout capability of mixer diodes, should yield some results during 1964.

3. Some further improvement in conversion loss and over-all noise performance should also result in 1964 due to a better theoretical understanding of point contact rectification and due to improved manufacturing techniques.

Microwave Amplifiers & Oscillators

Both transistors and tunnel diodes are well known devices and research effort is continuing to raise the maximum useful frequency, maximum power capability, and improve the available noise figure of these devices. Available transistors are currently useful up to 1 GC. During the coming year we expect that transistors will become available for use up to 2 GC. Tunnel diodes are now useful as amplifiers up to X-Band, and their useful frequencies can be expected to be extended into the K_u band in the coming year.

The noise figure in the tunnel diode amplifier is equal to or less than that of the equivalent transistor amplifier in their frequencies of overlap. The transistor, on the other hand, will usually provide more power in the frequency range where it is useful and needs less associated hardware to operate stably. Thus, both devices are making steady progress, with improvement by a factor of 2 expected during the coming year in their useful frequency and perhaps a factor of 3 improvement in power output.

Moreover, many other solid-state devices appearing on the horizon show promise as amplifiers and sources of microwave energy. Recent work with GaAs infrared radiators has indicated microwave oscillations superimposed on the infrared radiation. Two further new types of diodes produced from relatively unknown materials have been discovered and are under study in AEL's Laboratory. These diodes exhibit negative resistance effects in the microwave region that are not now understood. Although noisier than the tunnel diodes, these diodes show promise for producing much higher microwave power outputs. It is very possible that during 1964, the underlying mechanism of these diodes will become better understood.

Another exciting area of research is the generation of microwave oscillations in bulk semiconductors. It has been known for some time that at temperatures below 77° K, microwave oscillations can be generated by cyclotron resonance and plasma oscillations. Recently, coherent oscillations up to 6.5 GC have been reported at room temperature. As much as ½ w. of peak power at 1 GC has been reported from such a device.

Considerable progress can be expected during 1964 on devices that should compete with the tunnel diode as a source of microwave power and gain. Some of these new devices should begin to appear as commercial items during 1965. These devices particularly show promise in providing solid-state sources of high power microwave energy.

● A REPRINT of this article is available from ELECTRONIC INDUSTRIES Reader Service Department

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Ultrasonics is pushing the state-of-the-art by generating and propagating ultrasound at frequencies in the gigacycle range. The energy can be transmitted using waveguide and transmission line techniques. Some of the methods and problems involved in generating and handling these microwave sounds are discussed.

GENERATING ULTRASONICS AT MICROWAVE FREQUENCIES

By now most of us are aware that ultrasonics is widely used for cleaning, metal joining, machining, etc. We know that both piezoelectric and magnetostrictive transducers are used, and that most of these operations take place in the kilocycle range. However, if someone mentions ultrasonics as being in the gigacycle range, eyebrows raise.

A fair amount of research in this frequency range is quietly taking place in several laboratories. Most of this work is highly classified. Through this article and other non-classified sources we know that these studies should lead to a better understanding of some materials. Some researchers expect to have delay lines that will have bandwidths in the order of 900 mc and microwave amplification may take place through using ultrasonics.

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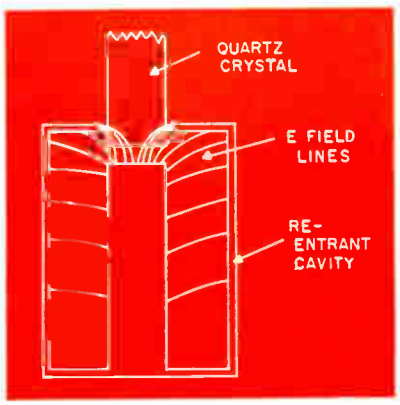

Fig. 1: A piezoelectric drive cavity used to generate microwave sound.

In the last few years, the upper frequency limit at which sound can be generated and propagated in solids has been extended to several gigacycles. Although microwave ultrasound is essentially the same as the sound waves used at lower frequencies in delay lines and in the testing of materials, the techniques for its generation, propagation and detection must be adapted to the shorter wavelengths and higher frequencies that occur.

At 10 gc longitudinal waves in quartz, along the X axis, are about 5000 angstroms long. Thus, the surfaces of transducers and propagating media must be finished to optical precision and bonds between transducers and other media are much more difficult to fabricate. The attenuation of sound in most materials increases about as the square of the frequency, so that material losses can be quite large. These problems can be circumvented by careful construction and attention to details. Attenuation in many materials can be reduced by cooling them to cryogenic temperatures.

As at lower frequencies, microwave ultrasound can be generated by using the piezoelectric or the magnetostrictive effect. The extremely short wavelengths would lead to severe scattering losses in poly-crystalline materials, so that single crystal material must be used for transducers and propagating medium.

Quartz Transducers

Quartz has been widely used as a piezoelectric transducer material. At lower frequencies, this material can be cut into blocks with one dimension equal to half a sonic wavelength. In this form quartz has long been used for delay line transducers and, of course, for control elements in crystal oscillators. At microwave frequencies, waveguide and transmission line techniques must be used for the transport of electrical energy from signal source to the quartz.

In generating microwave sound by the piezoelectric effect, the most common method is shown in

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World Radio History

Fig. 1. A quartz X-cut rod is inserted into an aperture in a re-entrant cavity resonator so that its polished face is at the end of the resonator post. Coupling into the cavity is done either by a loop from a transmission line, or by an iris from a waveguide. There is a large component of electric field normal to the end of the quartz rod through which the piezoelectric effect generates sound waves in the quartz. Other cuts of quartz can be used to generate shear waves in the same manner.

If the sound waves are to be used in some other material, then it must be bonded to the quartz. This can be done in many instances by using a very thin layer of indium, which will wet many materials when molten. The indium can be squeezed very thin by using enough force while it is molten. In cases where the experiment is to be performed at cryogenic temperatures, the bond can be made with stop cock grease, which becomes rigid enough at liquid helium temperatures to transmit sound with low attenuation.

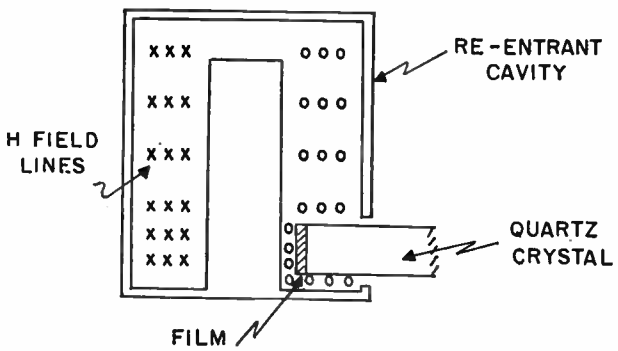

Fig. 2: A quartz crystal is inserted in a magnetostrictive cavity so that it is almost tangent to wall of cavity.

Using a Cavity

Microwave sound is detected by an identical method. Sound waves impinging on the free surface of a quartz crystal, in a resonant cavity, generate an electric field. This field excites the cavity and generates an electromagnetic signal. The coupling between the sound wave and the field is rather weak. An insertion loss of about 35-50 db per transducer is typical for the cavity setup shown in Fig. 1. A very high field is needed to generate an appreciable amount of sound energy. The cavity acts like a transformer with a high step-up ratio. This is done by using cavity Q's of several thousand with corresponding small bandwidths.

To generate microwave sound by magnetostriction, thin films of magnetostrictive metals are deposited on the surface of a transmission medium. Metallic nickel may be deposited by evaporation or by electrodeposition onto a surface which has a thin (100 angstrom) sputtered layer of a conductor, such as gold, placed on it. Alloys of iron and nickel with higher magnetostrictive coefficients may be deposited in a like manner. If properly done, the films adhere very tenaciously, so that there is no bonding problem. This is a very real advantage when it is necessary to generate sound in a medium which is not piezoelectrically active.

The magnetostrictive films must be excited by using an alternating magnetic field. Since they are reasonably good conductors, it is difficult to excite a rapidly oscillating field normal to their surface. Hence, a structure is chosen which generates a magnetic field parallel to the film surface. A typical structure is shown in Fig. 2. Here, a re-entrant cavity is also used. But in this case the sample is inserted in the side of the cavity wall so the film is almost tangent to the part at its base, where the largest currents and magnetic fields exist. An external bias dc field is also applied. By varying the orientation and magnitude of the external field, both shear and compressional waves can be generated.

In magnetostrictive generation of sound, large magnetic fields and hence large currents are used. This again implies using a cavity as an impedance transformer, but now as a step-down device. In this case too, the large transformation ratio is obtained by high Q cavities with narrow bandwidth. The insertion loss from such devices is comparable to that in the piezoelectric case.

In many experiments, the same cavity is used as both input and output transducer along with a circulator as hybrid. Fig. 3 shows a set-up for testing quartz rods. Short pulses from a generator are directed *via* a circulator to the cavity, which is immersed in liquid helium. At the cavity, some of the energy is connected to sound and some is reflected to the circulator to be absorbed in the TR switch. Sample rods for these tests must have accurately parallel end faces.

Sound generated at the face of the crystal in the cavity passes through the crystal to the far face where it is reflected, due to the large mismatch in acoustic impedance, and returns to the first face. At this face a small amount of energy is reconverted to electrical energy with most of the acoustic signal being re-

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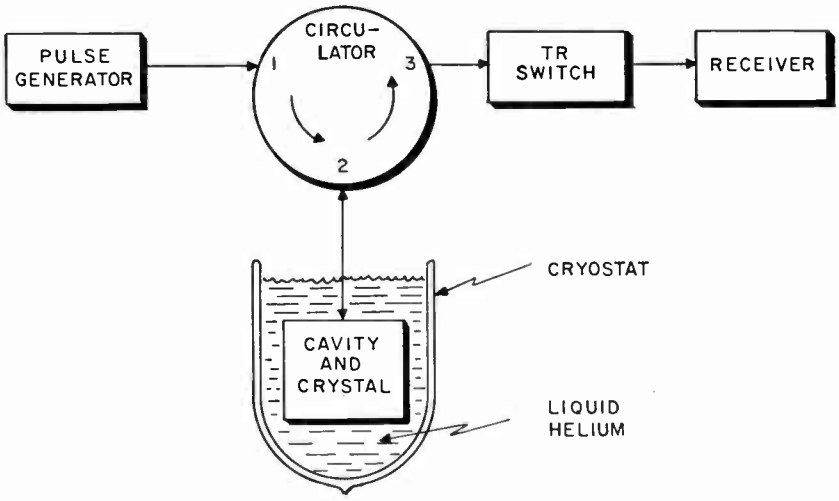

Fig. 3 (above): Test setup is used for testing quartz crystal rods.

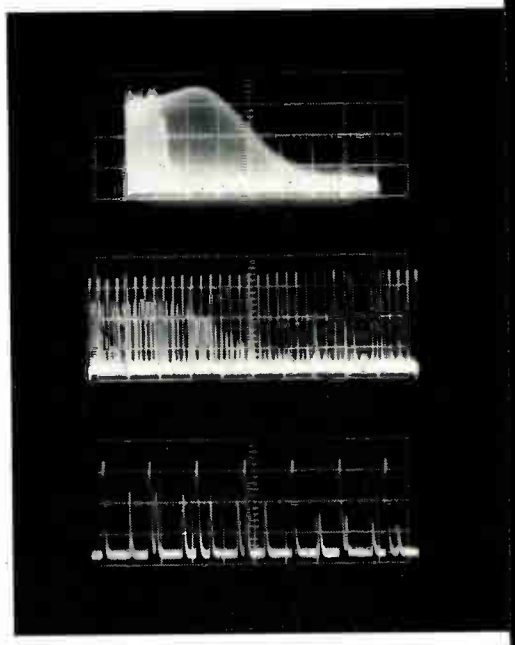

Fig. 4 (right): Echoes from x-cut quartz at liquid helium temperature.

flected again. The electrical signal goes through the circulator, and being too low to fire the TR switch, passes through to the detector and display.

Fig. 4 is a photograph of an oscilloscope trace from such a test. In this figure, the upper trace represents the successive echoes from an X-cut crystal. The upper trace was taken at a sweep speed of 1 msec/cm, the center trace at 50 μsec/cm and the lower trace at 10 μsec/cm. Shear and compressional waves can be seen in upper trace. The compressional waves persist for about 6 msec. They had enough amplitude to block the receiver for the first 2 msec. The lower expanded traces show details of the echoes. Due to the blocking, the compressional echoes are all the same amplitude.

Crystal Anisotropy

In using single crystals of various materials as propagation media, one must consider the effects of crystal anisotropy. In general, it can be stated that sonic energy cannot always be propagated in any arbitrary direction in the medium. There are always three wave modes possible. These are the compressional or longitudinal waves and the shear waves with two states of polarization. The particle motions corresponding to these three modes are mutually perpendicular, but for most directions in a crystal such as quartz, the longitudinal motion is not strictly parallel to the direction of propagation, and the shear motions are not quite perpendicular to the direction of propagation. Also, the direction of energy flow is not necessarily parallel to the wave front normals for plane waves. The magnitude of the wave velocity also varies with direction.

These effects make the calculation of the behavior of a wave upon reflection very complicated. Similar effects are found in optics in birefringent material, and the analysis of the optical case is better known. Despite these difficulties, it is often possible to find axes along which waves can propagate and be reflected for normal incidence. In quartz these have been extensively studied for use in crystal-controlled devices, and the modes that are commonly used for these crystals are all useful. Of course, the effects in single crystals are not peculiar to microwave frequencies, but at lower frequencies polycrystalline or amorphous materials, which are isotropic, are usually used for delay lines.

Although microwave ultrasonics will likely lead to applications in delay lines, working systems are not now available. The large mismatch losses which occur at each transducer impose a minimum insertion loss, which in the present state-of-the-art is some 80 db. This is prohibitive for most uses. There is available, however, a very large bandwidth potential. Experimental lines have been constructed operating at room temperature with observable operation over about a 900 MC bandwidth, and a delay of 5 μsec. This line has the same delay-bandwidth capability as a 1 msec. line with a bandwith of 5 MC. By proper design of the line and cooling to liquid helium, the delay could be increased several fold without increasing the insertion loss appreciably.

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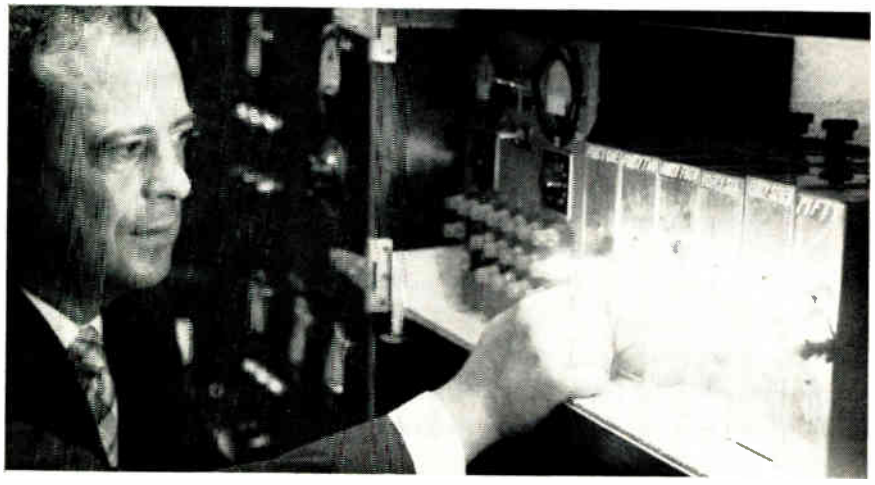
TIPS *(Technical and Product Service)*

5 NEW G-E DEVELOPMENTS



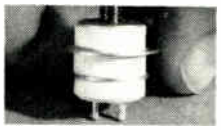
Torture tests show why G-E ceramic tubes flew with Mercury

Even a 1,200% overload doesn't faze this pea-sized powerhouse. Ever since last February, the people in one of our labs have been trying to torture to death a batch of type 7486 ceramic tubes—like those used in Mercury capsules. But these rugged 7486's keep right on delivering 4 full watts of 485-megacycle CW output.

Actually, the maximum operational *rating* for the 7486 is only 150 plate volts, 8 milliamperes plate current, and 2 milliamperes grid current. *However*, month after month the 7486's under test have taken a *continuous* 350 volts, 20 ma. plate and 8 ma. grid current. And one tough little specimen is still going strong after 68 days of 50 ma. plate and 20 ma. grid current.

Like all G-E ceramic tubes, the 7486 also assures superior resistance to shock, high temperatures, and nuclear radiation. It can take steady-state radiation above 10^{11} roentgens and 10^{19} NVT.

The Y1223—a tiny developmental triode that delivers over 40 watts at 400 megacycles.



All this out of a one-half cubic inch tube! In lab tests, one Y1223 was driven to deliver *53 watts* at 400 mc. before the anode rod in a coaxial amplifier turned blue with heat and forced a power drop-off. It's a good bet that Y1223's and other ceramic tubes will find many missile and defense applications. (Perhaps in one of *your* upcoming new designs.)

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This new 6T9 triode-pentode compactron packs more audio output in a lot less space

The 6T9 is a welcome new member of the growing compactron family. Their rapidly increasing uses are sure to include lots of jobs for this new audio preamplifier and power output compactron.

The pentode section of the 6T9 is rated at 12 watts plate dissipation. A relatively large cathode in the pentode contributes to easy driving—about 8 volts peak signal (compared with 12 volts needed by the 6AQ5) readily obtainable from the triode section. The triode features an amplification factor of 90 and transconductance of 3,000 microhms.

This one compactron, standing barely two inches above its 12-pin socket, offers the designer a 5-watt drive/power output combination. He can use it for all the audio applications ever found for the 6AQ5 plus 12AX7 duo . . . *and then some.* For example, how about a lightweight (but heavy-duty!) single-tube phonograph? We are quite sure that you can think of plenty of jobs for the versatile 6T9—and, of course, they'll all involve less wiring, less labor cost, more compact design, and above all—*better performance.*

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PUT NEW "ACCENT ON VALUE"

New ICAS and CCS ratings for transmitting compactrons raise the 175-megacycle performance level for communications equipment

Additional ratings for compactron types 7984 and 8156 beam pentodes have now been established—for their expanded application in both mobile and fixed station transmitters. Operated at 175-megacycle UHF, here's what a 7984 will deliver:

ICAS (Intermittent Commercial and Amateur Service)—32 watts
CCS (Continuous Commercial Service)—26 watts
IMS (Intermittent Mobile Service)—46 watts

What a boost in performance over the old standby type 6146! At 175 mc., the 7984 delivers 28% more power with far less drive. Not only that. By eliminating the top cap and the composition base, the 7984 compactron saves ¾" in seated height and gets rid of a chronic mobile communication trouble spot—the long, loose plate lead. Mechanically rugged, yet lighter in weight than the 6146, the compactron is less susceptible to shock and vibration.

The compactron design, with 12 pins, also makes possible multiple plate, cathode and screen connections at the socket. This eases the work of the equipment designer in orienting tube sockets in the most efficient locations.

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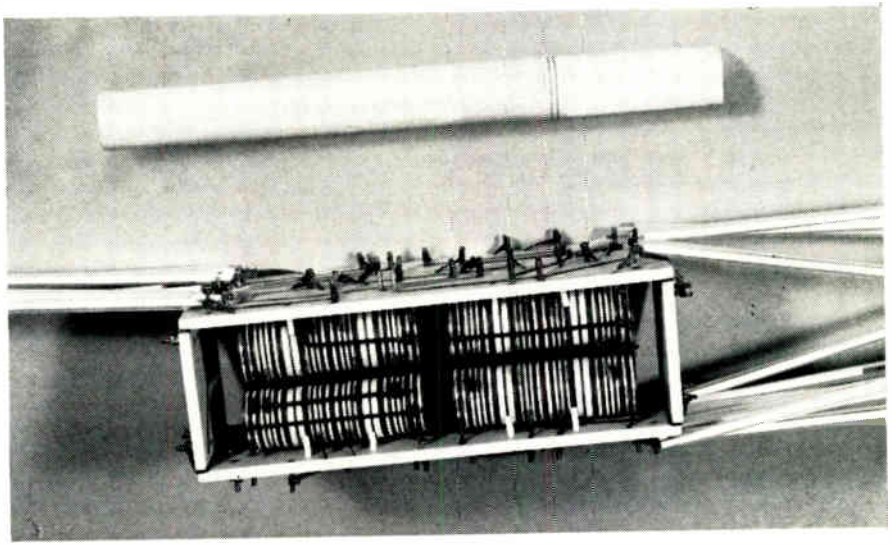

G.E.'s "hard" TIMM 3-bit parallel adder uses new packaging technique

A new high-density packaging technique has enabled G.E. to build a rugged 3-bit parallel adder . . . "hardened" against high-intensity radiation. This development, using G.E.'s TIMM (*thermionic integrated micro module*) circuitry, provides a 3.6 cubic inch package that weighs a mere 2.18 ounces—yet contains 15 NORS and 1 OR in eight compact modules.

The adder's components total 107 triodes, diodes and resistors . . . all designed to operate flawlessly at 580°C. with one simple, low-voltage power source. Required primary power is only 15 ma. at 16 VDC—and the package performs well even when the supply is varied between 12 and 19 volts.

This developmental computer component was built at the G-E Tube Department's advanced development laboratory. It's another good example of the Company's continuing, intensive effort to achieve extremely compact, high temperature and radiation-tolerant modules for missiles, space vehicles, reactor installations, and other highly sophisticated systems.

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For more information: Write G-E Tube Dept., Technical Information and Product Service (TIPS), Room 7018B, Owensboro, Kentucky. Please specify product(s).

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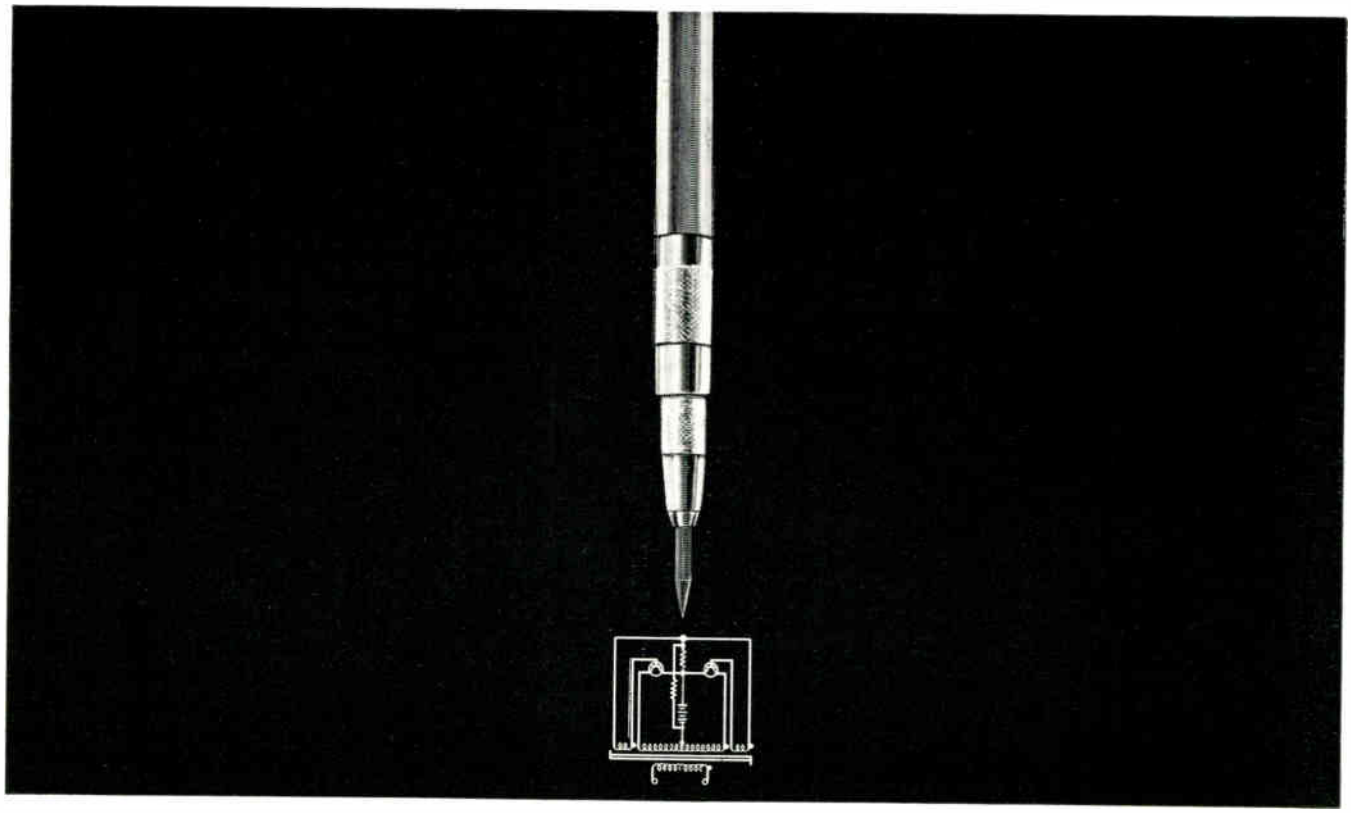

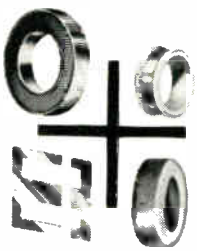

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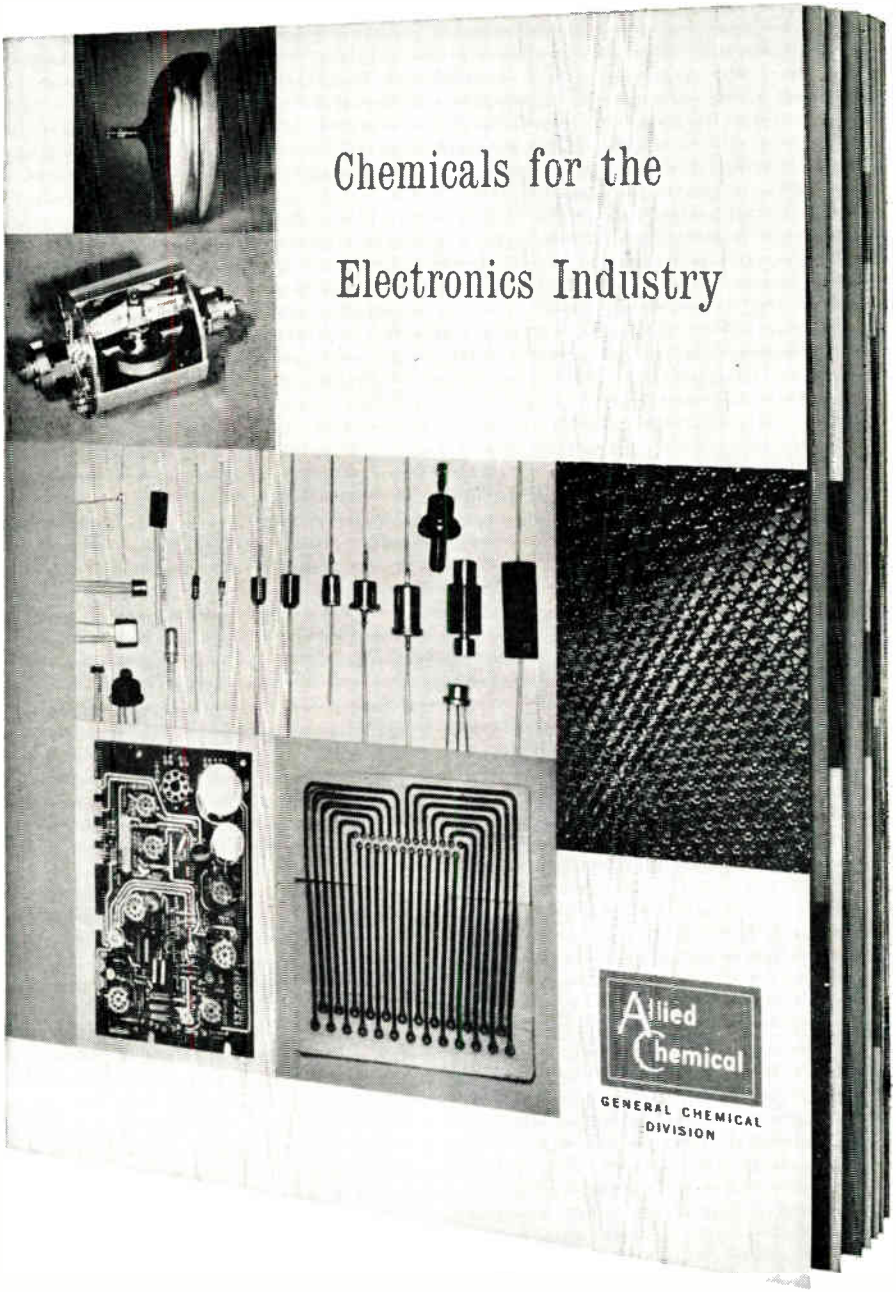

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In the area of microwave antennas, a good deal of significance is being attached to lens-type construction. The Luneberg lens described here offers unusual multiple-beam and scan capabilities. It is being included in the specifications for a number of pieces of sophisticated military equipment.

NEW DEVELOPMENTS IN LUNEBERG LENS ANTENNAS

DIELECTRIC LENSES ARE USEFUL as secondary radiators in microwave antennas. The Luneberg lens is an ideal radially-symmetric lens which can be made from plastics or metal-loaded plastic materials. Very efficient artificial dielectrics have recently been contrived and they make possible planar and spherical lenses having the required continuous gradation of refraction index. Most previous lenses have been step-graded and contain reflection-producing interfaces.

* * *

As the input-output device in radiating systems, the antenna is an important factor in radar, telemetry and communications. Antenna art governs somewhat the design of an overall system and, in some cases, influences conceptual design of the system. This view places in perspective the antenna's role in modern radiating systems.

In the area of lens antennas[1], the Luneberg lenses have been of particular interest because of their inherent multiple-beam and scan capabilities. Both variable-dielectric and waveguide structures have been devised. One recent two-dimensional (2-D) lens design of the latter type consists of a pair of circular

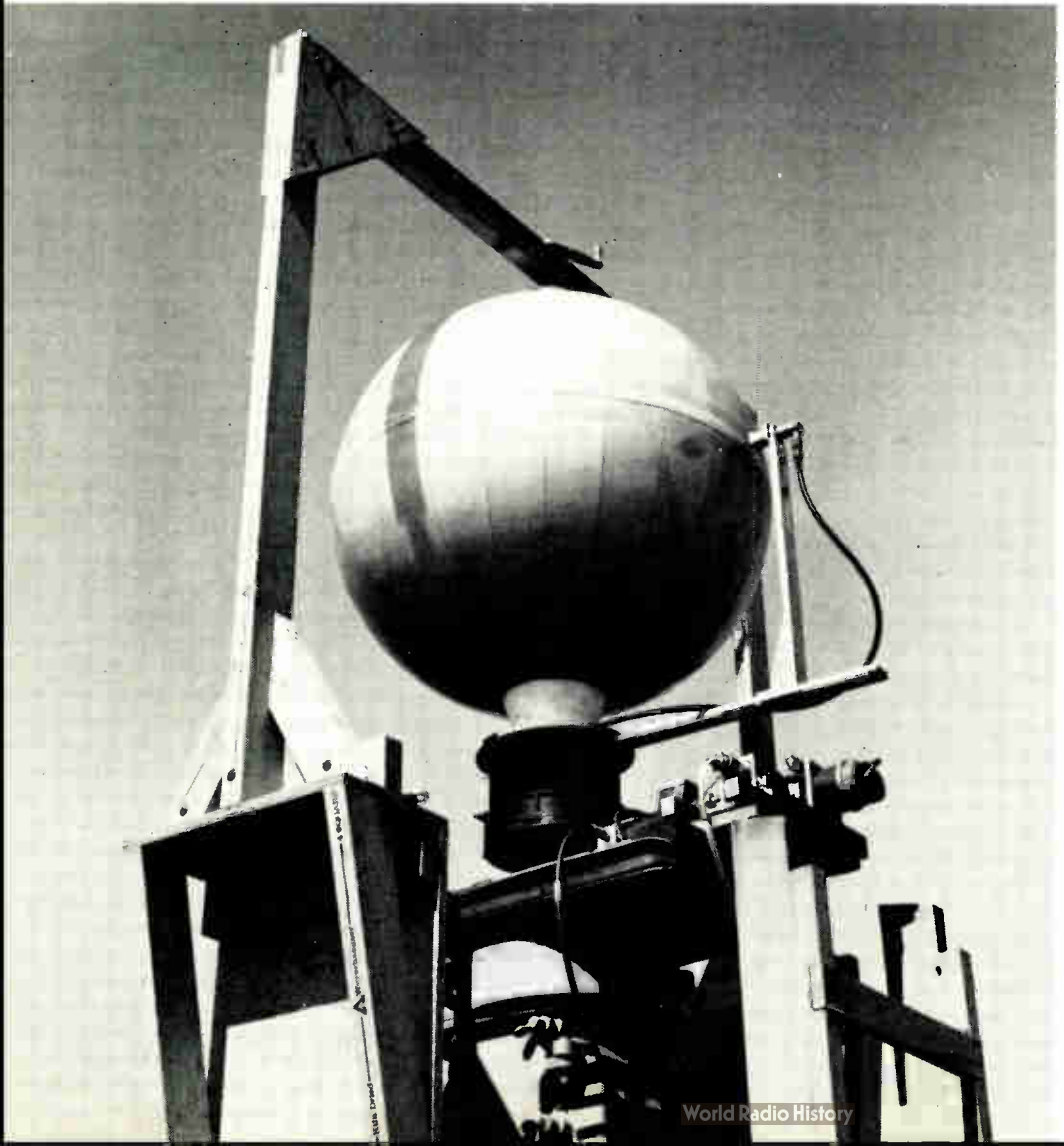

Fig. 1: Ray diagram of Luneberg Lens (right) shows Conjugate Foci. In general, an object at some radius R' is exactly imaged on the surface of a lens of smaller radius R.

A Continuous Parameter Luneberg Lens is shown in the photograph at the left.

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Electrical Research Unit, Physics Dept.
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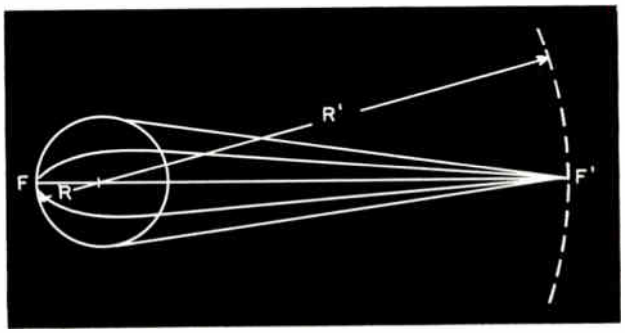
World Radio History

nonplanar plates.[2] The needed refraction index radial variation is achieved by appropriately contouring the plates while maintaining circular symmetry. The design reduces to a simple planar lens when the medium (air) is replaced by a radially-graded dielectric.

Until recently, the art of microwave dielectrics had not been advanced enough to permit economical construction of 2-D lenses to the same degree of precision achievable using the nonplanar conductive spinnings. Research efforts in continuously-variable artificial dielectrics have now provided rotational lay-up methods which make possible the building of dielectric cylinders of arbitrary radial gradation. Smoothly-graded cylindrical lenses may be readily formed in sizes up to several feet in diameter.

In addition to their utility in planar lens antennas, variable dielectric cylinders are useful as modules in the building of lens antennas of other geometries. A continuously-graded spherical Luneberg lens has been designed and built using 15° cylindrical wedges: the wedge modules were processed from cylindrical lenses, and are used as spherical wedges.



Theoretical Considerations

During the last decade there have been many attempts to build lens antennas for use at radio-frequencies, and particularly at frequencies in the microwave portion of the spectrum. In 1944 the theory and functional design of a graded dielectric lens were set forth by Luneberg[3] for a radially-symmetric device. The refraction index requirement makes the construction of such a lens for use at optical frequencies virtually impossible. Materials transparent to r-f and meeting the needs are available, however, and several schemes have been used in the building of practical lenses.

A dielectric Luneberg lens may take the form of either a cylindrical 2-D lens or a spherical 3-D device. The form it takes depends upon the nature of the focus desired and the feed antenna configuration. In

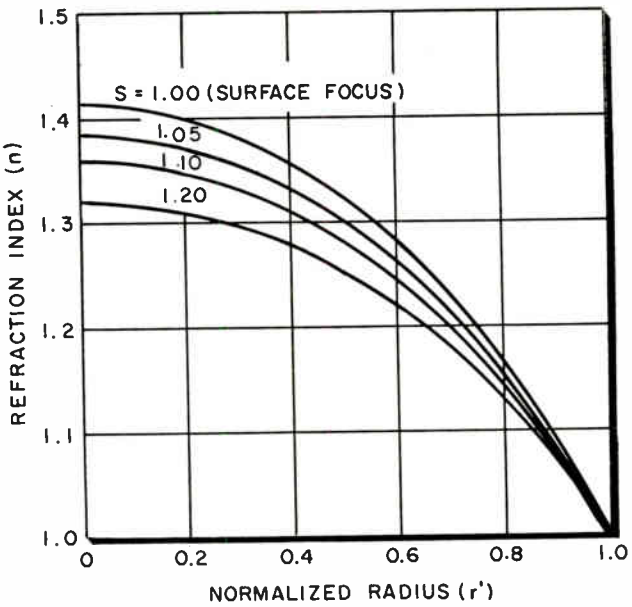


Fig. 2: Graph shows Refraction Index as a Function of the Normalized Radial Variable. Some dielectric loss always occurs and for a given material type is usually a direct function of the index of refraction.

general, an object at some radius R' is exactly imaged on the surface of a lens of smaller radius R as shown in Fig. 1. The limiting case where R' nears infinity is of particular interest. It is a special case of the general theory which predicts a principal focus F on the lens surface and its conjugate F' at a point external to the lens and diametrically opposite from F. When a focus exists an infinite distance from the imaging device, energy radiated from a source at F will be collimated and plane wave propagation will result. Reciprocally, electromagnetic energy in the form of a plane wave impinging upon the device will be concentrated at F; for a cylindrical lens a line focus will result, while for a spherical lens, the focus will exist at a point. For the limiting case, Luneberg has shown that the refraction index n of the lens must vary as a function of the radial variable r according to an equation which reduces to

$$n = \sqrt{2 - \left(\frac{r}{R}\right)^2}. \qquad (1)$$

On the basis of his work, others have shown how the dielectric gradation may be modified to allow adjustment of the foci relative to the lens position and along the line-of-sight through the lens center. Morgan[4] has considered the general solution which includes the case where both foci exist external to the lens. Following Luneberg, who provides a parametric representation for the refraction index and which for the case where one focus exists at infinity is given as $n = \exp[\omega(\rho, s)]$, (2)

(Continued on following page)

World Radio History

Morgan has evaluated and tabulated the function

$$\omega(\rho, s) = \frac{1}{\pi}\int_{\rho}^{1} \frac{\sin^{-1}(k/s)}{\sqrt{k^2 - \rho^2}}\,dk, \quad 0 \le \rho \le 1, \quad s \ge 1 \qquad (3)$$

The variable s is the normalized radial coordinate locating the principal focus, and ρ is the parameter

$$\rho = r' n \qquad (4)$$

where r' is the normalized radial variable. With regard to equation (1),

$$r' = \frac{r}{R}. \qquad (5)$$

Parameter k characterizes the various rays and is constant for any particular ray. Equation evaluations for surface focus ($s = r' = 1$) and external focus at distances of 5% ($s = 1.05$), 10% ($s = 1.10$), and 20% ($s = 1.20$) of the lens radius, are shown in Fig. 2

Lenses having external foci are of particular interest since, in practice, a primary feed or pick-up antenna is most conveniently located external to the lens. This is particularly so when a mechanical scan is contemplated. In addition, as may be seen in Fig. 2, the condition $s > 1$ allows the lens builder some relief since the maximum n needed is less than $\sqrt{2}$ as in the basic surface focus lens. While low-loss materials are available over the range of n needed, some dielectric loss always occurs and for a given material type is usually a direct function of the index of refraction.

Artificial Dielectric Material

A lightweight low-loss medium has found use recently.[5] It is a precision artificial dielectric made of an array of needle-like metallic particles supported by a low density dielectric material. The particles are insulated aluminum slivers and are less than 1/10 wavelength long. The supporting matrix is a low-loss polystyrene foam similar to Armalite®. Composite materials of this type simulate an actual dielectric when immersed in an electromagnetic field. In a dielectric medium, submicroscopic dipoles serve to alter the velocity of propagation of the wave; in an artificial dielectric, this principal effect is achieved macroscopically by conductive particles. Metallic slivers of millimeter lengths, for example, act to delay waves of centimetric or greater length. Artificial dielectrics are not new, and in the past have been devised from several materials and have used arrays of elements of various configurations. However, most mediums described to date have been excessively lossy at microwave frequencies. Randomly-oriented insulated slivers of aluminum appear to provide the optimum particle array from the loss standpoint. Fig. 3 shows the loss tangent variation over the refraction index range of interest for 2 low density polystyrene mediums using different size slivers.

Lens Construction

The history of graded dielectric lenses is essentially a history of construction methods and the development of uniform isotropic mediums. Both dielectric materials and artificial dielectrics have been used in various fabrication schemes in attempts to produce good quality, low cost lenses. Needless to say, some efforts have been more successful than others. Notable among the former are 2 configurations that have been refined to the point where practical embodiments of the Luneberg theory are possible. Both, however, use a stepwise approximation of the needed refraction index gradation, and as a result, dielectric discontinuities necessarily exist. One of them uses a number of different concentric spheri-

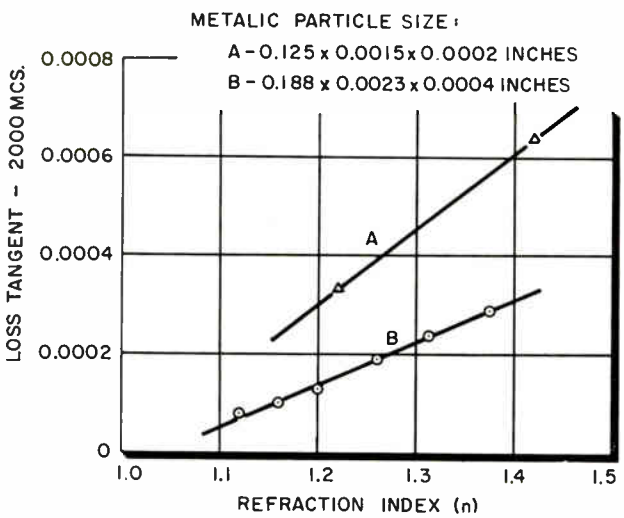
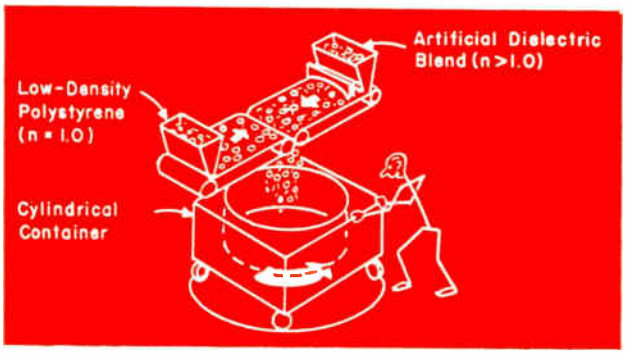


Fig. 3: Graph at left shows loss tangent as a function of refraction index for two low density artificial dielectrics.

Fig. 4: Sketch shows variable-index cylindrical lens preparation.



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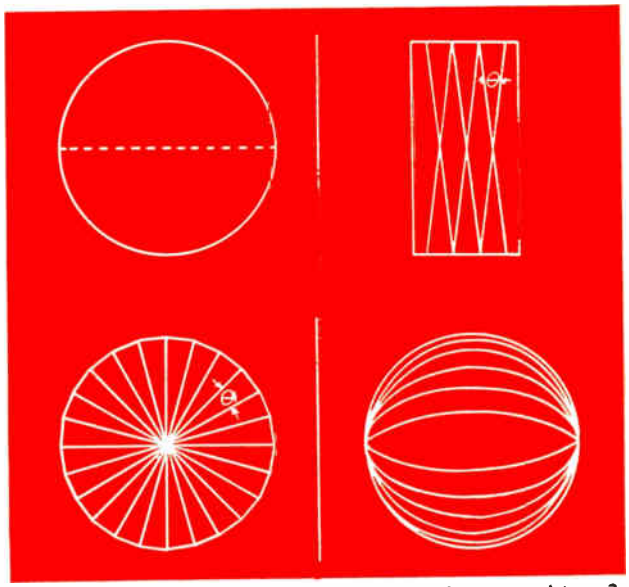

Fig. 5: Figures show how identical wedges may be prepared (top 2 views) and assembled in a spherical configuration (bottom views).

cal shells (each of which is substantially uniform from a properties standpoint) which cumulatively provide a satisfactory approximation to the needed gradation.[6] Another approach has been to use in a single lens thousands of individually uniform cubes of dimensions usually smaller than a wavelength; by careful placement and zoning, the needed dielectric variation is closely approximated. Both approaches are now being used in the manufacture of small diameter (less than 5 ft.) lenses; the cubical module method has been used as well in larger diameter devices.[7]

With the development of high-efficiency artificial dielectric mediums has come the parallel development of new lens building schemes, including a method for achieving symmetric and continuously-variable mediums. A lens having the continuous dielectric gradation prescribed by the theory will have a performance potential exceeding that of the state-of-art stepped lenses mentioned previously, in view of the absence of reflection producing dielectric discontinuities. Previously reported efforts to produce continuous parameter lenses or lens modules, have been confined primarily to the development of variable density (therefore, variable refraction index) materials; in one case the gradation for a spherical lens was achieved by compression of appropriately shaped low-density dielectric pieces into thin spherical wedges.[8] However, modules formed by compression methods are generally significantly anisotropic due to the unidirectional nature of the material alteration. Isotropy is essential and may be achieved in artificial dielectrics. Isotropic blends of granular polystyrene and metallic particles may be contrived. And, by appropriate mixing and diluting means, may be prepared as a fusible mass showing desirable parameter gradations. One such method is shown in Fig. 4. The system uses 2 conveyors with belt width preferably equal to the radius or the diameter of the cylinder being formed. A blend concentrate ($n > 1$) is shown being cross-fed with low index ($n = 1$) plain polystyrene particles identical to those which serve as the vehicle for the metallic elements in the blend. Contoured gates are tailored to provide the prescribed variable index as well as uniform depth of material while being collected in a rotating cylindrical container. The prepared mass is then fused into a solid unit by a steam molding process. The piece is later heat treated for an extended period to effect the removal of all moisture as well as to insure dimensional stability.

Variable-index cylinders may be used directly as lenses, or may serve as base units from which lens modules of other configurations may be built. An example of the latter is the cylindrical wedge, which approaches in geometry a spherical wedge and which may be used in the construction of spherical lenses. Identical wedges may be prepared as shown in Fig. 5a, and assembled in a spherical configuration as shown in 5b. A prototype has been built using twenty-four 15° wedges. The right circular cylinders from which the wedges were cut measured 35.4 in. in diameter (the later diameter of the spherical lens) and were 18 in. in height. The medium is an artificial dielectric made of a variable array of ⅛-in. long aluminum slivers and a low-density polystyrene

Fig. 6: Author R. L. Horst holds spherical lens assembled from cylindrical wedges. This lens was assembled dry; no adhesive was used on the interfaces. Weight of the lens is about 25 lbs.

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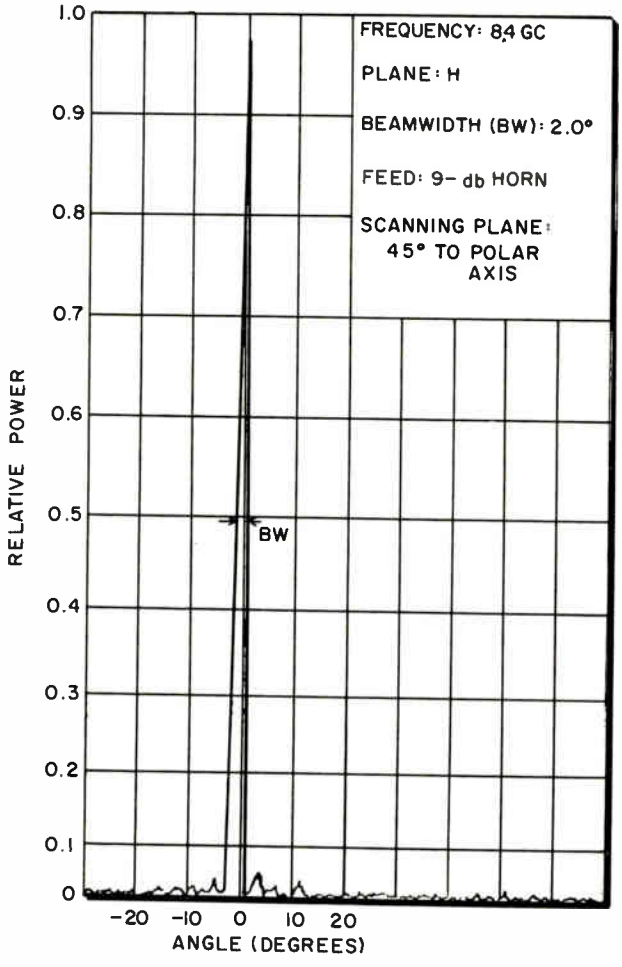


Fig. 7: Typical lens radiation pattern.

LENS ANTENNAS (Continued)

foam matrix (material A in Fig. 3). A smooth radial gradation of refraction index was achieved and varied from a value of 1.385 at the center to value of 1.015 at the cylinder periphery. Such cylinders are operational 2-D Luneberg lenses and are alone unique in that all known previous lenses of this configuration, both stepped as well as others, have been short cylinders (height << diameter) and have thereby imposed a limitation upon the type of feed antenna that could be used. They may be evaluated as lenses as a quality control procedure prior to being processed into wedge modules. Symmetric spherical lenses are therefore virtually assured.

The lens was assembled dry, i.e., no adhesive was used on the interfaces. It is shown in Fig. 6 after great-circle binding with 1-in. fiberglass ribbons, and with a thin glass-reinforced polyester resin shell in place. Weight of the lens as shown is about 25 lbs. Foam lenses such as this may be permanently assembled by use of small quantities of an adhesive such as Armstrong J1170:E18. *(Continued)*

CIRCUIT-WISE

HIGH VOLTAGE RECYCLING

NORMALLY A THERMAL RELAY is used as a time delay to allow time for tubes or equipment to warm up before the high voltage is turned on. This circuit makes use of the time it takes for the relay to release after power is removed.

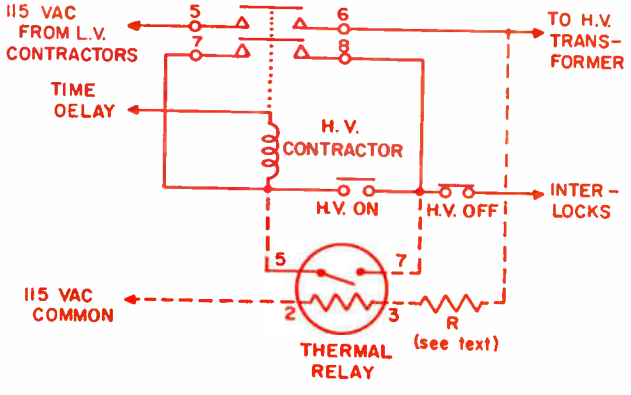
The recycling circuit shown provides re-application of HV power following loss of grid drive or other interlocked functions. Many types of equipment have recycling circuits. These are generally complex circuits that are difficult to install in older equipment.

While the circuit shown here was used in a radio transmitter, other types of equipment can also make use of the idea.

The relay contacts are connected directly across the HV ON button, and the heater circuit between the primary of the HV transformer and the ac common terminal. The circuit will restore HV if the HV contactor is interrupted for less than the "drop out" time of the relay. This drop out time can be a second or more.

A resistor is shown in series with the thermal relay to drop the voltage to 28v. (the relay's voltage). If a higher voltage unit is used, then this resistor can be eliminated. A transformer could have been used in lieu of the resistor.

The OFF button must be held down longer than the drop out time of the relay or HV will be reapplied. Momentarily pressing the button is a good periodic check for system operation.



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The lens was evaluated at 8.4 GC as a composite antenna using a low-gain horn primary feed. The principal focus was found to exist about 1-inch from the surface, and the pencil beam corresponding to a conjugate focus at an infinite distance had a half-power beamwidth of 2°. A typical radiation pattern is shown in Fig. 7.

Acknowledgment

The author is grateful to Dr. R. F. Schwartz of the Moore School of Electrical Engineering, Univ. of Pennsylvania, Dr. G. W. Scott, Jr., and Mr. G. E. Gard, for their guidance during this program.

Dr. W. Rueggeberg provided the dielectric loss data, and his work is gratefully acknowledged. Of the many others who contributed much, Mr. W. L. Buckley and Mr. R. O. Reese are deserving of especial thanks for their assistance during the antenna fabrication and evaluation phases.

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Up to now the Department of Defense has allocated about $300 million dollars for contracts in primary research in microwave technology.

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WJ-281	2–4.5 Gc	35 db	7 db
WJ-271	4–8 Gc	28 db	5.5 db
WJ-276	8–12 Gc	28 db	7.5 db

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A SURVEY OF HIGH POWER MICROWAVE FILTERS

The increasing number of microwave transmitters in use today has caused a serious RFI problem. Filters can be devised to reduce this RFI. They are discussed here and a formula is given which may be used to determine the attenuation needed in the filter.

IN ADDITION TO THOUSANDS of microwave communication transmitters, there are at present about 12,000 radar transmitters in the U. S. In view of these large numbers, which are increasing every year, it is not surprising that a serious problem of radio frequency interference RFI exists.

Many separate actions can be taken to reduce this interference. These include improved operational procedures, pulse repetition frequency gating, better frequency allocation, better siting, use of more highly directional antennas, and increase in the selectivity of receiving equipment. Another step is to use filters which limit the radiation of unwanted signals.

* * *

While harmonic suppression filters are used to avoid radiation of interfering signals, there are other benefits. These result from the fact that harmonics often cause one or more of the following:

(a) Damage to a tube window or other expensive component resulting from voltage breakdown within the waveguide.

(b) Incorrect power measurement associated with abnormally large transmission through sampling devices such as directional couplers.

(c) Reduced life in receiver mixer diodes caused by abnormal transmission through duplexers.

Insertion Loss Needs

All kinds of microwave tubes generate harmonics in addition to the desired output. Moreover, many kinds of transmitting tubes, particularly those suitable for use in pulsed radar, generate spurious signals at frequencies which are unrelated to the nominal one.

The frequency, power level, and detailed characteristics of such signals vary with the type of tube, its age and the conditions under which it is operated. This subject is well covered by the papers of Tomiyasu and others.[1] For present purposes it is enough to note that in unfiltered systems spurious as well as second and third harmonic signals are commonly generated at levels about 30 db below that of the fundamental. Losses in waveguide components and in the antenna make the radiated level of spurious signals about 50 db below the fundamental. Thus, it is appropriate to begin any calculation of insertion loss needed in a given situation by assuming that undesired signals are 50 db weaker than the desired signal. This value should be later replaced by a value based upon actual measurements made on the particular tube and system under operating conditions. In the formula for finding the needed filter attenuation, the effective power in mw radiated at spurious frequencies is designated P_1.

A second parameter affecting the degree of filtering needed to avoid interference is the sensitivity of the receiver in which potential RFI may occur. Use of parametric amplifiers in microwave systems for both radar and communications purposes reduces the noise figure to only 2 or 3 db. This gives sensitivities for pulsed systems of the order −110 dbm. Receiver sensitivity in mw is designated P_2.

Remaining parameters to be specified are the path loss, L, which depends upon the distance between transmitter and receiver and the directivity and gain Gr of the receiver antenna in the direction of the interfering source.

Free-space path loss in db between two nondirec-

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V. G. Price

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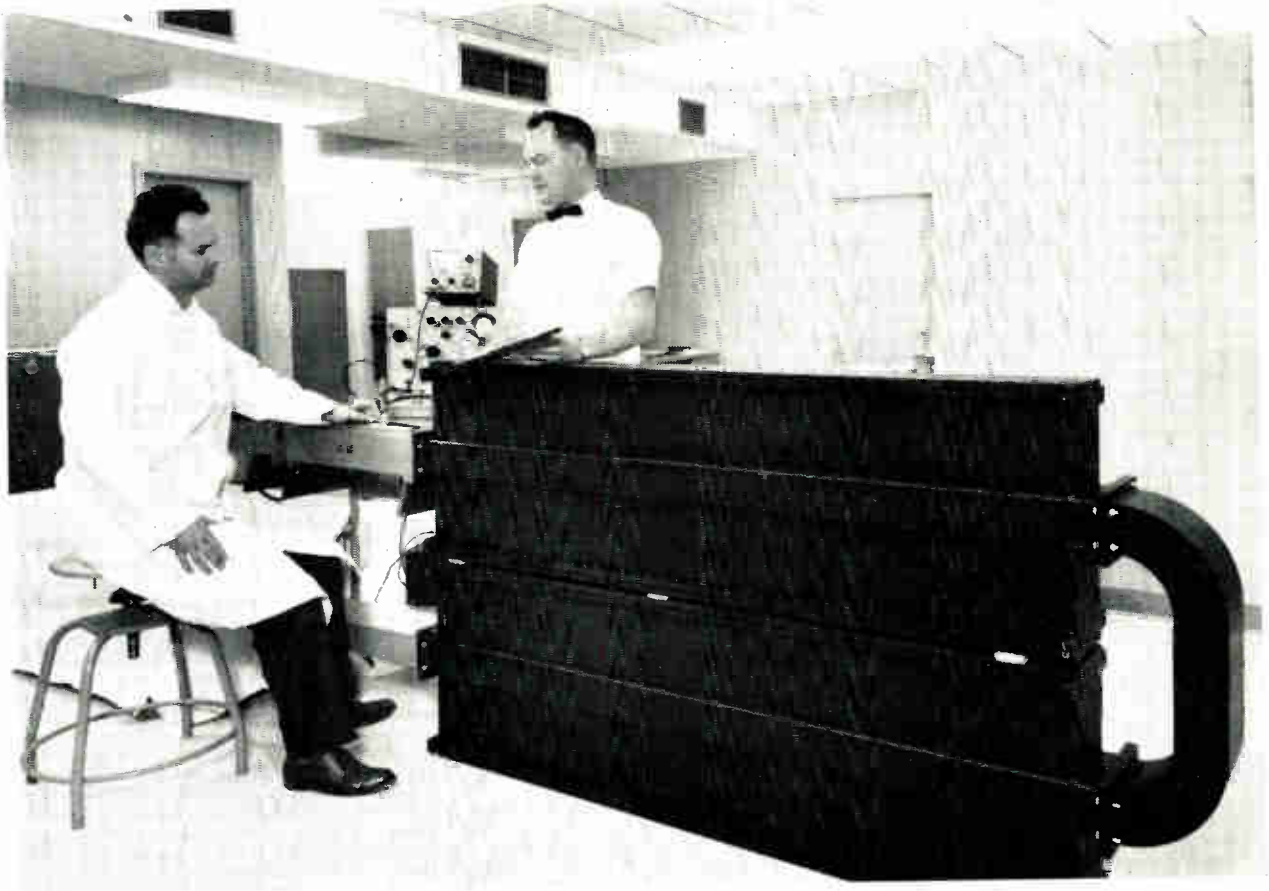
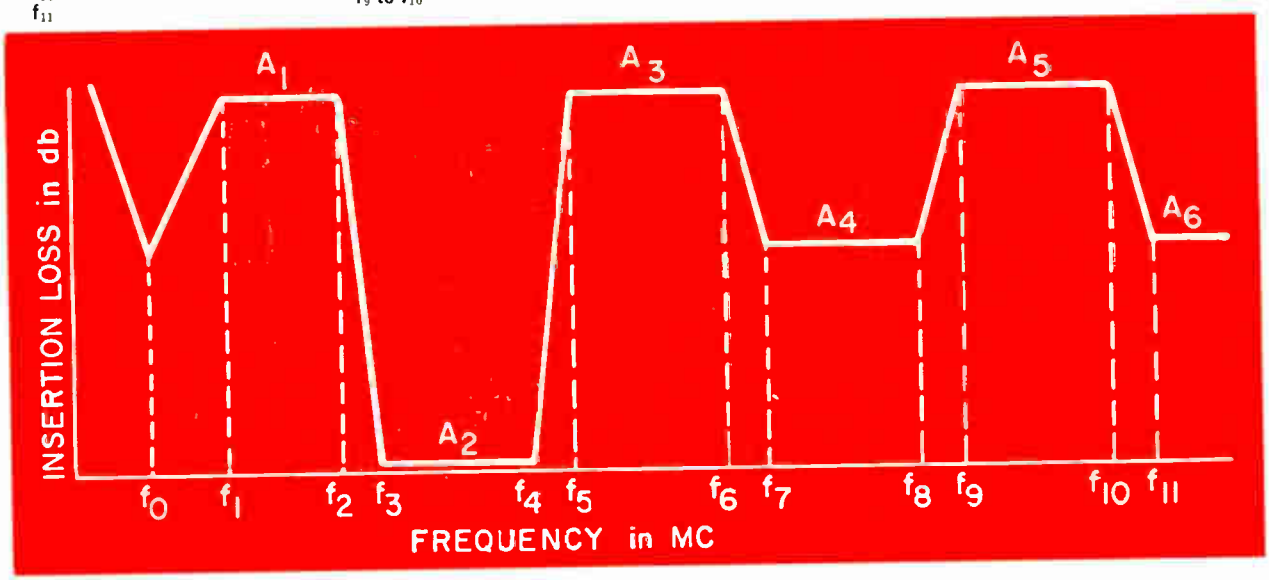


V. G. Price and a co-worker discuss results of tests which were conducted on this absorption type, highpower harmonic filter.

Fig. 1—Filter Electrical Spec.

FREQUENCIES IN MC	ATTENUATION IN DB	POWER CAPACITY
f_0 (waveguide cut-off)	A_1 minimum	Minimum power handling capacity
f_1	A_2 maximum	peak average
f_2	A_3 minimum	f_1 to f_2
f_3	A_4 minimum	f_3 to f_4
f_4	A_5 minimum	f_5 to f_{10}
f_5	A_6 minimum	when pressurized to psig with gas
f_6	VSWR LIMITS	
f_7	f_1 to f_2	Maximum allowable deviation from linear phase in any 10 MC band between f_3 and f_4 is
f_8	f_3 to f_4	
f_9	f_5 to f_6	
f_{10}	f_9 to f_{10}	
f_{11}		



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tional antennas separated a distance D miles is given by the equation

$$L = 36.6 + 20\ log_{10}\ (FD) \qquad (1)$$

where F is the frequency in MC.

A formula for the needed attenuation for an interference suppression filter may not be written as in

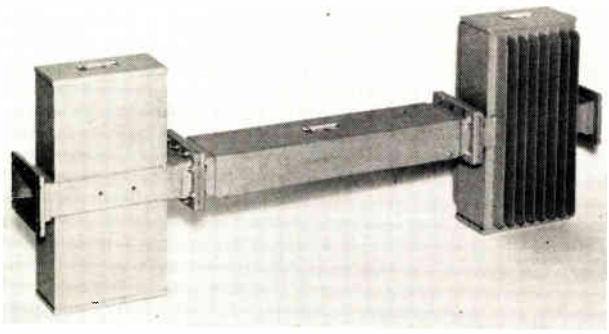
$$A_{db} = 10\ log_{10}\ (P_1/P_2) - L + Gr \qquad (2)$$

As an example, consider a situation in which the second harmonic of a 10 megawatt 1300 MC microwave transmitter causes interference with a receiver 30 miles distant having a sensitivity of −95 dbm. Assuming the second harmonic signal delivered to the antenna is 50 db weaker than the fundamental and that the antenna gain at this frequency is 30 db, the peak effective radiated power at the interferring frequency is + 80 dbm. Free-space path loss L for this situation is 135 db. The receiver antenna is presumed to be fixed and not pointed directly at the offending transmitter. However, the antenna will have some gain in this direction in one of the sidelobes. Assume this gain to be 20 db. Substitution of these figures into formula (2) gives an attenuation value of 60 db needed in a filter to reduce the offending signal to a negligible value.

Types of Filters

High power microwave filters are classified in a number of ways depending upon the specification of insertion loss, impedance, power transmission and absorption capacity and phase as functions of frequency. Filters may also be classified by their mechanical characteristics such as pressurizability, size, weight and tunability. Filters may be divided into two categories, near-band and far-band, based upon the frequency range of the electrical parameters. A near-band filter is one which operates with a range arbitrarily extending from 0.75 f_o to 1.5 f_o, where f_o is a frequency of some functional signal. A far-band filter is one which operates with a range of f_o to six or more times f_o. Differences which exist in these two catgories are based upon the fact that transmission lines conduct far-band signals in many modes while near-band signals are usually propagated in a single mode or not at all.

A waffle-iron filter with leakywall input and output pads.



One finds a variety of filter types within each of these categories. For example, far-band filters may be classified in any of the following types.

a. Dissipative wall
b. Leaky wall
c. Directional coupler
d. Varying impedance

Near-band filters may be divided into:

e. Coupled resonator types
f. Tee-junction types
g. Combinations of the above

Dissipative wall filters

Dissipative wall filters consist of smooth sections of waveguide lined with a material having a frequency-dependent attenuation characteristic. These materials include resonant and dispersive ferrites, dispersive dielectrics and composite materials such as HARP[2]. Filters using these materials can be made to have a low VSWR over a frequency range including both the pass and the stop band. Filters using resonant ferrites can be made to provide high values of stop band loss at resonance while propagating a high power fundamental frequency signal.[3] Magnetized ferrites exhibit large losses around a frequency given by $f = 2.8\ H_i$ where H_i is the internal magnetization field in oersteds and f is in MC. Insertion loss of the material is high over a frequency range (in MC) equal to $2.8\ \Delta H$, where ΔH is the line width of the ferrite.

Dispersive ferrites and dielectrics are most useful for attenuation in the upper end of the far-band, i.e., at frequencies beyond the fourth or fifth harmonic.

Leaky wall filters

Leaky wall filters[4, 5] use a series of apertures along the walls of the transmission line. These withdraw from the main waveguide those signals which can propagate through high-pass filters (usually small waveguides) which are attached to the apertures. The high-pass filters are terminated in absorbers to dispose of the energy coupled out of the main waveguide. Each aperture, which is designed to resonate within the stop band can be made to couple out 1 to 10% of the power within the main waveguide. Associated insertion loss per slot is thus only 0.05 to 0.5 db. Thus hundreds of apertures must be used to get a high insertion loss. This type of filter can be designed to have a low VSWR over both the pass and

World Radio History

stop bands. With proper design, the power capacity can approach that of the unmodified waveguide. Deviation from linear phase shift for signals in the pass band is negligible if a sufficient guard band is used between the pass and stop bands.

Directional coupler filters

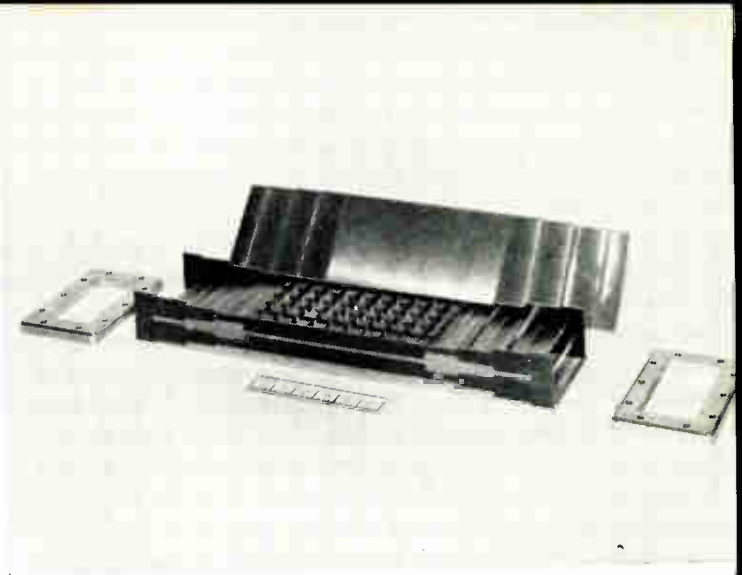
Some filter designs use directional couplers to separate signals of one frequency from those of other frequencies. Directional coupler filters can be made reflectionless over a wide stop band and can be designed to transmit high power signals in 100% power transfer couplers. They do not present high insertion losses compared to typical needs but are used in tandem with reactive filters to attenuate reflected signals. These filters are useful for two reasons; the absorbers are concentrated in two places, and stop band attenuation increases with increasing frequency. References 6 through 10 discuss this type of filter.

Varying impedance types

Varying impedance filters using corrugated walls provide frequency selectivity by reflecting undesired signals. Best example of this filter in waveguide transmission lines is the "waffle-iron" type developed at Stanford Research Inst. This filter has both longitudinal and transverse corrugations and is capable of providing a high insertion loss over a wide stop band. Tandem connected filters provide more than 60 db insertion loss from the second to the tenth harmonic. Since these filters are reactive, VSWR in the stop band is high, and hence they are generally used in tandem with absorptive filters. Internal dimensions of the filter are less than those of a standard waveguide; thus power handling capacity of the filter is reduced to about 3% of the level of the waveguide itself. This reduction of power capability can, of course, be offset by evacuating or pressurizing the filter. An evacuated S-band waffle-iron filter with a stop band loss above 60 db in a range including the second and third harmonics, operated successfully at 3.7 megawatts peak power (0.00072 duty) with a magnetron source. The filter was mounted close to the tube and no adverse effects were observed even though the stop band signals were reflected.

Coupled Resonator filters

Coupled resonator filters make up a large class of near-band filters. They include both the direct-coupled and quarter-wave coupled types. Filters in this class have received intensive development for many years. Thus it is possible to synthesize a desired filter characteristic with high stop band loss, good skirt selectivity and at the same time achieve low pass band losses and VSWR. However, undesired signals are reflected rather than absorbed, so the VSWR in the stop band will be high. Because of resonant field enhancement with the cavities, power handling capacity of the coupled resonator filters is not as great as that of the terminal waveguides. Young[11] has analyzed the peak internal fields in direct coupled resonators. His work shows that conversion of a smooth waveguide into a filter by use of inductive posts or irises reduces power handling capacity by a ratio equal to the fractional bandwidth. Power capacity may be partially or completely restored by evacuation or by pressurization with air or of some special gas.



Waffle-iron filter has both longitudinal and transverse corrugations and is capable of providing a high insertion loss over a wide stop band. It was developed at Stanford Research Inst.

Modern radar transmitters are usually tunable. Therefore any near-band filter also needs to be tunable. Jones[12] has reported a high power tunable direct-coupled resonator filter in L-band waveguide using three TE_{011} resonators. This filter has a theoretical power capacity of one megawatt near the band edges.

Tee-junction filters

Narrow band-reject filters useful in the near-band region, may be made by using a cascade of E-plane Tee-junctions.[13] Reflections in the pass band can be minimized by separating the junctions an odd multiple of $\frac{1}{4}\ \lambda$. Each Tee is then shorted at a $\frac{1}{4}\ \lambda$ distance from the main waveguide to produce a stop band. Filters of this type may be tuned by adjustment of the position of the short circuits in the side arms. With proper design, this type of filter can transmit in band power levels approaching 90% of the terminal waveguide capacity.

Combinations of the above

A combination of the above filter types is often needed to satisfy a particular insertion loss characteristics curve, particularly where both near-band and

World Radio History

far-band filtering action is needed. Typical combinations are a 0-db directional coupler in tandem with a waffle-iron filter, or a leaky wall filter in tandem with a filter using reactive cavities mounted on the transmission line walls. These cavities, similar to those used in reaction wave meters are tuned to appropriate stop band frequencies.

Filter Specifications

Parameters used in specifying a filter for use in a radar system fall into two main categories—electrical and mechanical.

In electrical performance specifications of a filter the insertion loss as a function of frequency, VSWR as a function of frequency, power handling capacity and phase linearity are the main parameters to be considered. A useful plot of the insertion loss curve for specification purposes is given in Fig. 1. By dividing the frequency range into a pass band and various stop bands corresponding to harmonic frequency outputs of a transmitter, one can briefly specify the needs for the filter. The upper stop band is shown with larger attenuation values at harmonic frequency ranges than for the bands between the harmonics. Since there is low spurious power in these bands it is cheaper to make a filter if one does not provide for more insertion loss than is needed.

Specification of the maximum value of VSWR that can be tolerated in the pass and stop bands is important for good system operation. With many components between a tube and the antenna it is important that each component be well matched to avoid voltage breakdown. At the terminals of a filter a VSWR of 1.15:1 is the maximum value usually acceptable in the pass band. Average VSWR should be less than 1.10:1.

In high power transmitters it is important that all signals in the stop band above the dominant mode cut-off frequency be absorbed. Although effects on tube life in the presence of reflected signals have not been defined, some instances of window failure have been attributed to this cause. It is believed that a VSWR of 2:1 or 3:1 should be sufficiently low in the stop band to protect the high power tube source.

Power handling capacity of a filter[14] depends upon dielectric strength of the filter interior, freedom from carbon containing particles and upon the cooling capability. In a given configuration of filter the maximum power capacity will change with the pressurization of gas in the filter and with the type of gas. In specification of the power capacity of a filter it is important, therefore, to include the operating pressure level and type of gas. Sulfur hexafluoride, dry nitrogen, and freon are common gasses used to pressurize waveguide systems.

Phase linearity of a filter in the pass band frequency range is often an important specification for a filter. This is particularly true for filters used in radars using moving target indicators or pulse doppler methods, for example. Deviation from a linear phase characteristic in addition to that due to the natural dispersion in a waveguide occurs at frequencies where the attenuation characteristic changes. Murakami and Covington[15] show the relationship between the change in attenuation of a network and corresponding phase deviations. From this reference one can determine that an important phase nonlinearity will usually occur at the band edges. For example, if the ratio f_5/f_4 in Fig. 1 is 1.03, corresponding to a guard band of 100 MC at 3 GC, there will be a phase deviation of 10°/db near the edge of the pass band.

Mechanical specifications are concerned with type and location of input and output terminals, outline dimensions, maximum weight, location of mounting fixtures, material used in construction, interior and exterior finishes, storage and operating climatic conditions, type of cooling available, maximum operating gauge pressure, vibration, shock environment, etc.

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Modern high repetition rate transmitters require pulses with very steep skirts. The simplest method of speeding up fall time is to place a shunt resistor across the load. This article shows how the fall time of the preloaded circuit can be easily calculated between any two percentage points on the curve.

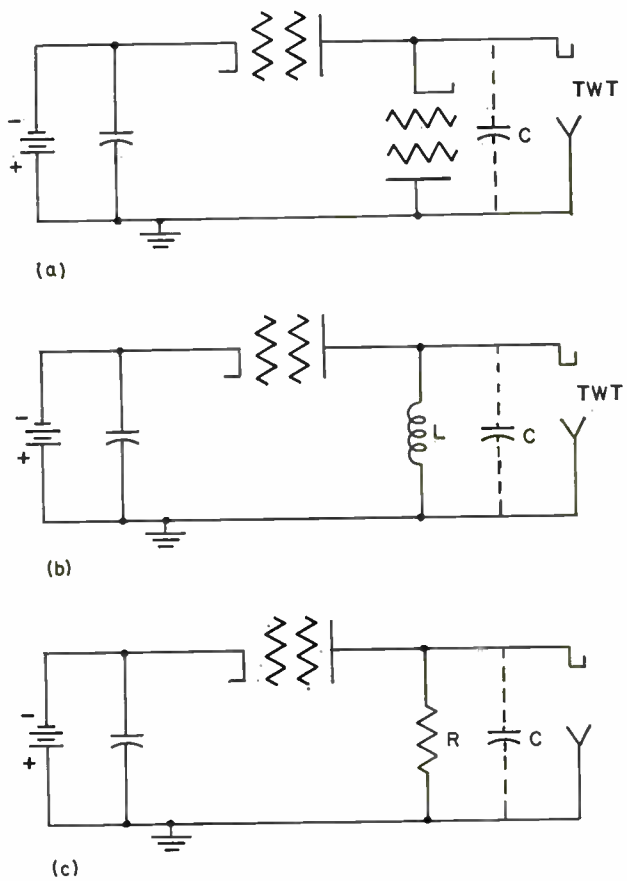
HOW TO . . .

CALCULATE HARD TUBE MODULATOR FALL TIME

As hard tube modulator specs become more stringent, calculation accuracy must follow. A great many hard tube modulators are now used with klystron or TWT loads which are 3/2 exponent types of tubes (i.e.) $I = p V^{3/2}$, where I is tube current, V is beam voltage, p is perveance, typically from 0.5×10^{-6} to 5×10^{-6}.

The present trend toward high duty, high repetition rate transmitters requires pulses with very steep skirts to conserve the power handling ability of the transmitting tube. One method of speeding up full time is the preloaded circuit. It is shown how the fall time of this circuit can be easily calculated.

* * *



There are several means of speeding up fall time (i.e.) actively clamping the r-f tube with a tail clipper tube (Fig. 1a), using inductive tail clipping (Fig. 1b) or placing a shunt resistor across the load (preloading resistor), Fig. 1c.

The tail clipper, 1a, is the most versatile and efficient, but suffers from complexity. The inductive system is simple and effective, but it cannot handle variable pulse widths equally well. It also runs into problems where the duty is high, indicating insufficient time for magnetic recovery with reasonable backswing values. The preloaded circuit, 1c, is the simplest, though somewhat inefficient.

Fall time of the preloaded circuit can be easily calculated between any two percentage points on the curve, such as 10% and 90%. This will lead to the best design.

Result

$$\Delta t = t_2 - t_1 = 2RC \ln \left[\left(\frac{1 + Rp\sqrt{V_0 a_2}}{1 + Rp\sqrt{V_0 a_1}} \right) \sqrt{\frac{a_1}{a_2}} \right]$$

where Δt is fall time in seconds, R is preloading resistance in ohms, C is stray capacitance in farads, p is perveance of load, V_o is the initial voltage on C, a_1 is the fraction of load voltage at which one starts timing fall time, and a_2 is the fraction of load voltage at which one stops timing fall time.

Derivation

$$-i_C = i_R + i_{TWT} \qquad (1)$$

$$-C\frac{dv}{dt} = \frac{v}{R} + p\,v^{3/2} \qquad (2)$$

Fig. 1: Several means of speeding up fall time are shown here (see text).

By G. E. TALLMADGE

Chief Engineer
Solid State Circuits Div.
Energy Systems, Inc.
3180 Hanover St.
Palo Alto, Calif.

World Radio History

TUBE FALL TIME (Concluded)

$$\int_{t_1}^{t_2} \frac{dt}{C} = \int_{v_1}^{v_2} \frac{-dv}{\frac{v}{R} + p\,v^{3/2}} = -\int_{v_1}^{v_2} \frac{dv}{v\left(\frac{1}{R} + p\,v^{1/2}\right)} \quad (3)$$

$$\frac{t}{C}\Bigg]_{t_1}^{t_2} = -2R\,ln\left(\frac{v^{1/2}}{\frac{1}{R} + p\,v^{1/2}}\right)\Bigg]_{v_1}^{v_2}$$

$$= 2R\,ln\left[\frac{v_1^{1/2}\left(\frac{1}{R} + p\,v_2^{1/2}\right)}{v_2^{1/2}\left(\frac{1}{R} + p\,v_1^{1/2}\right)}\right] \quad (4)$$

$$\therefore t_2 - t_1 = 2RC\,ln\left[\frac{v_1^{1/2}\left(\frac{1}{R} + p\,v_2^{1/2}\right)}{v_2^{1/2}\left(\frac{1}{R} + p\,v_1^{1/2}\right)}\right] \quad (5)$$

Let $a_1 = \frac{v_1}{V_0}$ and $a_2 = \frac{v_2}{V_0}$

$$t_2 - t_1 = 2RC\,ln\left[\sqrt{\frac{a_1}{a_2}}\left(\frac{1 + Rp\sqrt{a_2 V_0}}{1 + Rp\sqrt{a_1 V_0}}\right)\right] \quad (6)$$

Example: Let $V_0 = 10$ kv, $p = 10^{-6}$, $a_1 = 0.9$, $a_2 = 0.1$, $R = 10$ k ohm, $C = 10^{-10}$ fd

$$t_2 - t_1 = 2 \times 10^4 \times 10^{-10}\,ln\left[\sqrt{\frac{0.9}{0.1}}\left(\frac{1 + 10^4 \times 10^{-6}\sqrt{0.1 \times 10^4}}{1 + 10^4 \times 10^{-6}\sqrt{0.9 \times 10^4}}\right)\right] = 1.41\ \mu\text{sec.}$$

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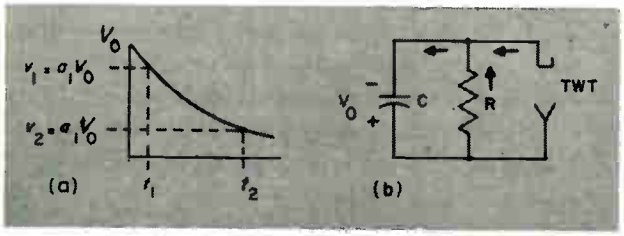


Fig. 2: The above diagrams are to be used with the resultant equation shown on the opening page.

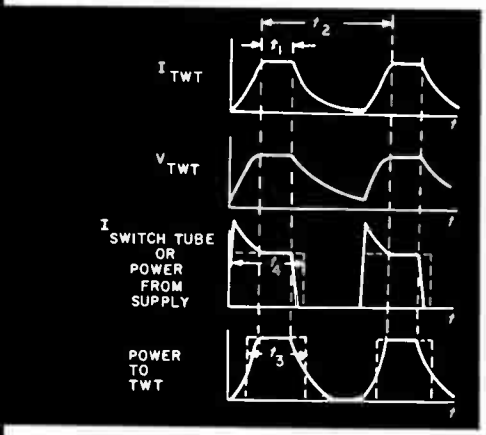


Fig. 3: The diagrams shown at the left illustrate a high duty situation.

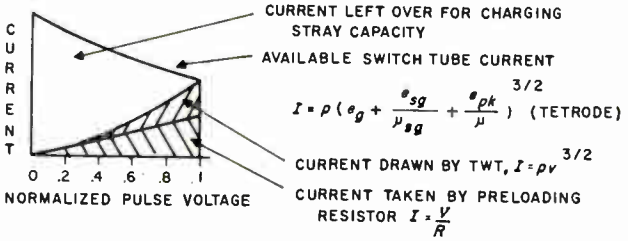
For comparison it may be noted that the 10% to 90% fall time of the R and C alone is 2.3 μsec, and for the C and TWT only it is 4.21 μsec.

General Formula

General formula for the above situation involving only C and a $3/2$ power load may be derived in a similar manner and is:

$$\Delta t = t_2 - t_1 = \frac{2C}{p\sqrt{V_0}}\left(\frac{1}{\sqrt{a_2}} - \frac{1}{\sqrt{a_1}}\right)$$

The problem of accurately calculating rise time is not as easily solved, particularly when the switch tube is not an ideal current source. It can be solved by piecewise integration in the following manner:



One may proceed by tabulating the current left over for charging capacitance, i_C, at each 10% increment of normalized pulse voltage. Making the assumption that the average current is constant during each increment, one may make use of the fact that $\Delta t = \frac{C\Delta V}{i_C}$. Hence, the time needed to traverse each 10% of the pulse rise may be found and a graph of output voltage vs. time may be obtained. Finer segmentation will be necessary in the area near the end of the rise time if this area is involved in the needed calculation.

Where rise time is comparable to pulse width, we may have to know the current passed by the switch tube as a function of time. Then the current which flows in the load, capacitor, and preload resistor may be converted to equal average current needed for the power supply, and to find realistic dissipation ratings for the TWT and preload resistor.

Fig. 3 shows a high duty situation. Theoretical duty, $d_T = \frac{t_1}{t_2}$, is the quantity normally specified by the user, but effective duty for the TWT is $d_{TWT} = \frac{t_3}{t_2}$, and the power supply effective duty is $d_{PS} = \frac{t_4}{t_2}$. d_{PS} includes the power to repetitively charge the stray capacitance, $P_c = 1/2\ CV^2f$, where f is pulse repetition rate, and the power delivered to the TWT and preload resistor. The pertinent fact is that the ratio of the actual to the theoretical duty, $\frac{d_{PS}}{d_T}$ may in practical cases be as high as 1½.

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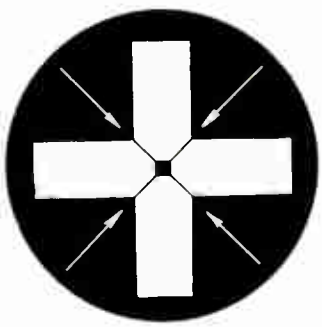

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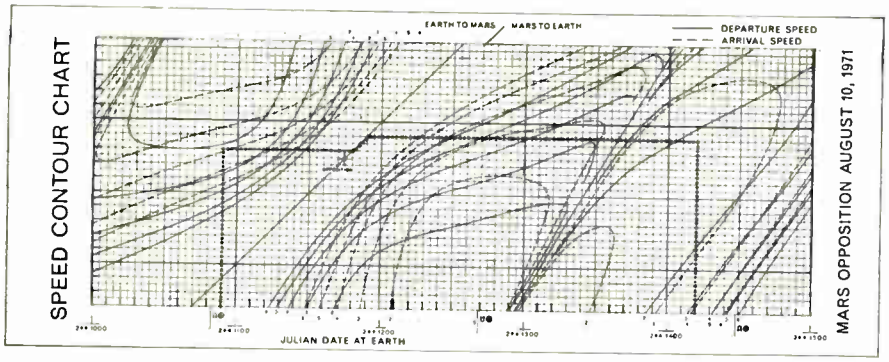

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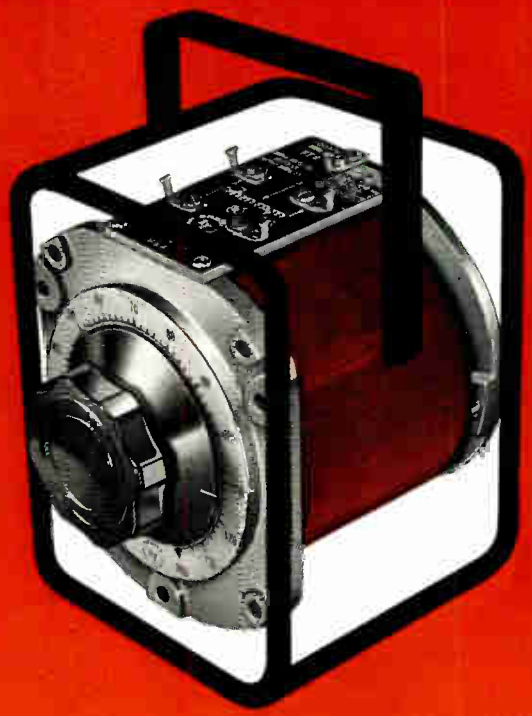

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120	10.0	0-120	w/volt. & ammtr., gnd. conn.	VT8NFCVA
120	10.0	0-120	w/volt. & wattmtr., gnd. conn.	VT8NFCVW
120	16.0	0-120/140	w/voltmeter, gnd. conn.	VT20GCV
120	16.0	0-120/140	w/volt. & ammtr., gnd. conn.	VT20GCVA
120	16.0	0-120/140	w/volt. & wattmtr., gnd. conn.	VT20GCVW
120	25.0	0-120	w/voltmeter, gnd. conn.	VT20NFCV
120	25.0	0-120	w/volt. & ammtr., gnd. conn.	VT20NFCVA
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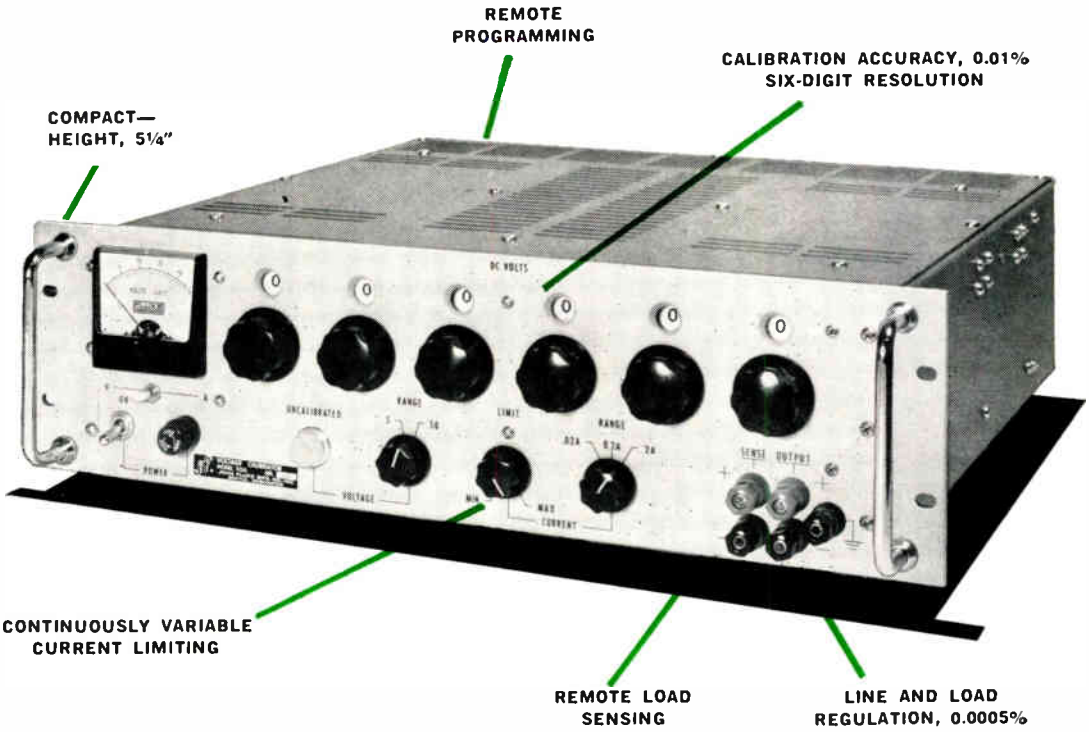

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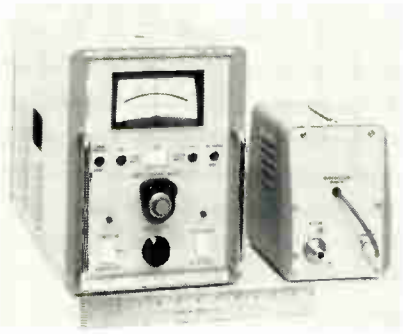

The Model 430A has an RMS probable error of 2% of reading from 50-1500w. A precision wattmeter measures calibration power with a 0.05% accuracy. Unit has a digital readout. Specs: direct reading, 10 to 1500w.; substitution, 10 to 500w. Freq. range, termination loads, dc to 12.4GC. Sierra Electronic Div., 3885 Bohannon Dr., Menlo Park, Calif.

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70 synthesized standard freqs. from 8.2 to 12.4GC; output to 0.5w.

The DY-2042A X-Band freq. standard provides synthesized freqs. spaced at 60MC intervals through all or part of X-band (depending on the klystron selected). It is also a versatile source of secondary reference signals for the standards laboratory. The high output level provides ample power for calibration purposes and for local oscillator and exciter uses. Features: Short term stability better than 2 parts in 10^{11}; spectral width less than 1CPS; spurious signals and noise more than 70db down; output freqs. adjustable over 2MC range. Dymec, div. of Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

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3kv unit with 30nsec. rise and fall times. Outputs 0.2kv-3kv.

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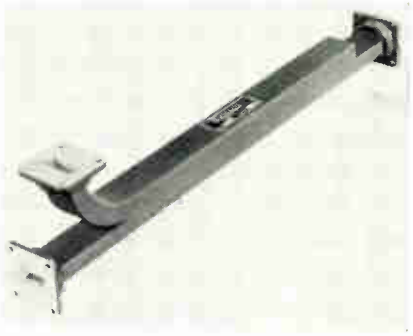

These precision couplers are suited to precision measurement work at any power level where high directivity and min. freq. sensitivity are desired. Specs: average coupling, ±0.3db; coupling sensitivity, ±0.5db max.; min. directivity, 40db; main line VSWR, 1.10 max.; and secondary line VSWR, 1.20 max. Waveline Inc., Caldwell, N. J.

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Available in 6 different models ranging from 500MC to 18GC.

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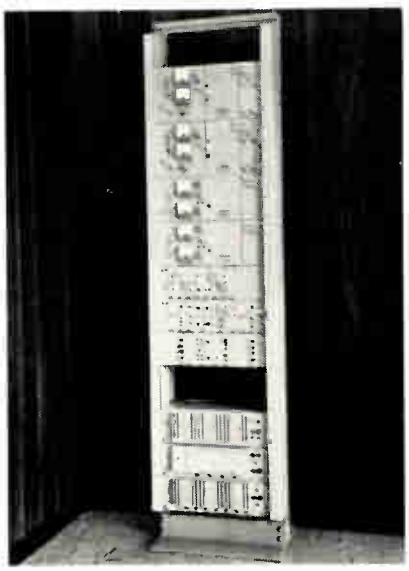

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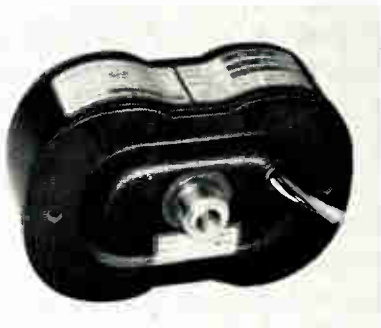
MAGNETRONS

Voltage tunable units have an output power range of 10mw to 100w.



These tubes offer various power levels over a broad tuning range. The noise level has been greatly reduced. Specs. include: typical overall efficiency, 30-50%; electronic bandwidth, 3 to 1; weight 1 to 3 lbs; tuning method, linear electronic Available in many useful frequency ranges. Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif.

Circle 173 on Inquiry Card

TRANSMITTER CONVERTERS

Unity gain with up to 6 watts into 50 ohms @ 500vdc.

Type 1090 provides outputs of up to 15w. in the 2200-2300MC band when driven by the output of a standard 215 to 260MC telemetry band transmitter. Other features include circuit protection in the event of loss of drive by using cathode self-biasing; full bandwidth of 1.25MC; pressurized case for protection against the effects of altitude, humidity, salt spray, sand, and dust; and high-efficiency heat sink. Tele-Dynamics Div., American Bosch Arma Corp., 5000 Parkside Ave., Philadelphia, Pa.

Circle 176 on Inquiry Card

World Radio History

NEW PRODUCTS

PARAMETRIC AMPLIFIER

Operates at UHF freq. Gain is 25db or greater; recovery time is 30nsec.

The Model NDL-1 electron-beam parametric amplifier consists of a quadrupole amplifier mounted in a solenoid, an r-f pump, and a power supply. When operating in the non-degenerate mode, it is pumped at 5 times the signal freq. Specs: pump power, 10 to 100mw; input VSWR, 1.3 or less; phase stability, better than 2°. Zenith Radio Corp., 6501 W. Grand Ave., Chicago 35, Ill.

Circle 177 on Inquiry Card

R-F EQUIPMENT

Operates in the 7125-8400MC band. AC or dc powered—48vdc or 115vac.

The MW-508 Transistorized Mircowave Radio Equipment is one of a series of intermediate-range communication systems for telephone and data applications. It uses a lw. temp. stabilized, transmitting klystron. Aperiodically tuned 15 or 25 MC receiver bandwidths are furnished. SSB-SC service channels and baseband gain regulators are available. Collins Radio, Dallas Div., Dallas, Tex.

Circle 178 on Inquiry Card

SERIAL MEMORY

Less than 45 cu. in. of space is required for a 1010 bit memory.

The SEMS-2S memory reads or writes at 200KC and operates over a temp. range of −55°C to +100°C. A wide range of bit sizes is available from 5005 bits up to 150,150 in 5005 bit increments. Electronic Memories, Inc., 12621 Chadron Ave., Hawthorne, Calif.

Circle 179 on Inquiry Card

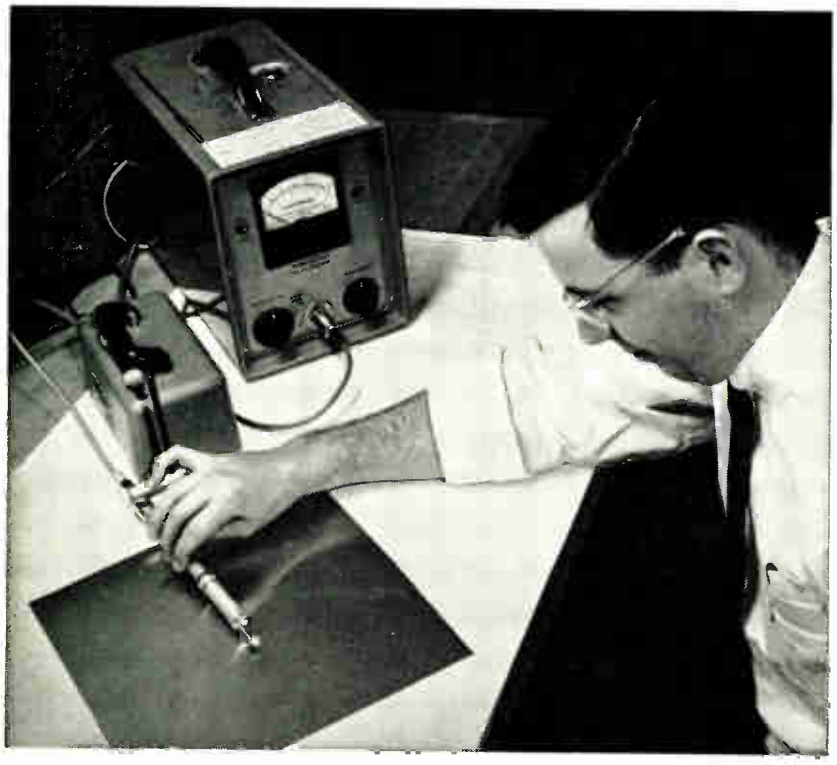
VARACTOR TRIPLER

Can handle input power to 40w; efficiency is approx. 65%.

This UHF varactor tripler incorporates lumped parameter techniques. The circuitry is designed to maximize the efficiency and power-handling capabilities of a single varactor diode. A shunt-type varactor circuit is used for better diode heat dissipation. Specs: Input freq., 125MC; output freq., 375MC; output power, 12.8w. Aircraft Armaments, Inc., Cockeysville, Md.

Circle 180 on Inquiry Card

How Taylor copper-clad quality control



One of the many instruments used by Taylor to check product quality is the Profilometer. Here a quality-control specialist is inspecting surface finish on a composite sheet.

You get clean copper-clad material. The copper-clad laminated plastic, used in making etched printed circuits, is prepared for pressing in Taylor's dustfree "white rooms."

World Radio History

NEW PRODUCTS

COMPARATOR-RECEIVER

Provides continuous comparison of local standard to VLF signals.

Receiver is sensitive to min. input signal of 0.05μv at the 50Ω antenna terminal. Meter indications include r-f signal, VCO correction and linear phase comparator output. Front panel selector for any of 4 freqs. from 10KC to 60KC. Input signals from local standard are 1MC or 100KC, 1v. RMS into 1KΩ. Output signals are audio. 1KC at high impedance. Full scale of 1ma represents accumulated phase difference of 100μsec. Pre-detection bandwidth is 250 CPS. Post-detection bandwidth is adjustable from 4 to 32 parts in 10^9 of received freq. Montronics Inc., P. O. Box 345, Bozeman, Mont.

Circle 181 on Inquiry Card

WAVEFORM MONITOR

Any of 4 input signals may be chosen for display. Sensitivity, 0.2v/in. max.

The V-9 displays waveforms of TV-type signals with time base of 7875CPS (showing 2H. lines), or 30CPS (showing 2v fields) chosen by a switch. Sweeps may be locked to either drive signals, sync or video. A built-in voltage calibrator provides means for level-checking. Diamond Electronics, Diamond Power Specialty Corp., P.O. Box 415, Lancaster, Ohio.

Circle 182 on Inquiry Card

KLYSTRON OSCILLATOR

Tuning range, 60MC min; beam voltage, 400v.; beam current, 55ma max.

SRK-291 is a reflex klystron oscillator operating in the freq. range of 23.6 to 24.4GC. It produces a min. output power of 70mw from 23.75 to 24.0GC at a beam voltage of 400v. Designed for immersed operation in FC-75 coolant as a rugged stable parametric pump tube. Sperry Rand Corp., Electronic Tube Div., Gainesville, Fla.

Circle 183 on Inquiry Card

STORAGE TUBE

Resolution exceeds 1200 TV lines/dia. Used with FAA systems.

The CK1383 dual-gun scan-converting storage tube has electronic input and output for use in equipments requiring simultaneous reading and writing. It was developed for use in all transistorized "bright display" systems of the FAA. It erases gradually previously-recorded information; thus efficiently scan converts circularly-scanned radar data into horizontally-scanned TV form. Automatic and gradual erasure of information is adjustable and provides a means of generating target trails indicating course and speed. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass.

Circle 184 on Inquiry Card

provides high reliability in etched circuits

Every precaution is taken to protect the surface. Before leaving the "white rooms" for the laminating presses, copper-clad loads are covered with plastic film to prevent dust or other foreign matter from contaminating the surfaces of the material.

Taylor copper-clad laminates are custom-engineered to provide assured performance by combining thermosetting resins, reinforcing materials, and copper foil in carefully formulated combinations.

Composite sheets are made in atmosphere-controlled layup rooms under strict quality control (MIL-Q-9858 qualified). All have low moisture absorption, excellent chemical resistance, and high mechanical strength, combined with good dielectric strength, high surface resistivity and insulation resistance.

The standard glass epoxy grades shown in the table meet most of the critical requirements of today. If you are working on requirements for tomorrow, let Taylor assist you by developing a copper-clad material engineered to your planned application. Bulletin 8-1B gives technical information about our standard grades. Write for your copy today.

TAYLOR COPPER-CLAD GLASS EPOXY LAMINATES

TAYLOR GRADE	NEMA GRADE	MILITARY SPECIFICATIONS	PRINCIPAL CHARACTERISTICS
Fireban 1011-E	G-10, G-11, FR-4, FR-5	MIL-P-13949 Types GE, GB, GF, GH	Combines all desirable properties of G-10 (GEE) and G-11 (GEB), plus flame retardance in one grade.
Fireban 600-E	G-10, FR-4	MIL-P-13949 Types GE, GF	Self-extinguishing. Excellent electrical properties under high humidity conditions. Extremely high flexural, impact and bond strength.
GEC-500-E	G-10	MIL-P-13949 Type GE	Extremely high flexural, impact and bond strength. Low moisture absorption. High insulation resistance.

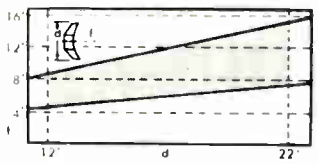
Taylor corporation
ENGINEERED PLASTICS

FORMERLY TAYLOR FIBRE CO.
VALLEY FORGE 53, PA.
WEST COAST PLANT: LA VERNE, CALIF.

Circle 59 on Inquiry Card

World Radio History

ANY F/D
IS STANDARD
WHEN YOU SPECIFY **RF!**



This source for solid or mesh surfaced parabolic antennas allows the unique advantage of specifying any focal length without extra design and production costs!

RF Systems will manufacture, to your specs, antennas from 12' to 22' (and larger sizes too) and with F/D's from .35 to .7. These precision surface antennas can be ordered as complete units (including support structure and wave guide system) or as component parts, as you prefer.

For more details, and for information on new developments as they occur, send your name for placement on our mailing list.

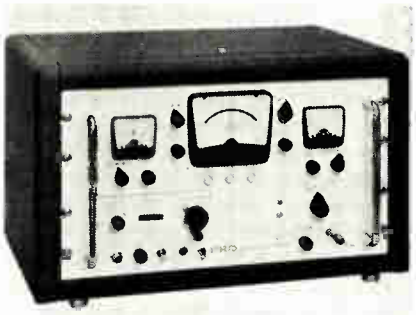
RF SYSTEMS
WHITMAN, MASS.

Circle 60 on Inquiry Card

NEW PRODUCTS

RECEIVER

Power measurements at levels to —120dbm can be made.

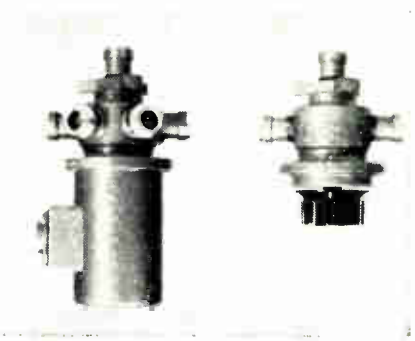


The PRD 215 is used for measurement over the freq. range from 10MC to above 40GC, with appropriate local oscillator and mixer. The unit can be used for the attenuation calibration of signal generators, antenna pattern measurements, and as a sensitive detector for r-f and microwave. PRD Electronic Inc., 202 Tillary St., Brooklyn 1, N. Y.

Circle 185 on Inquiry Card

MICROWAVE SWITCHES

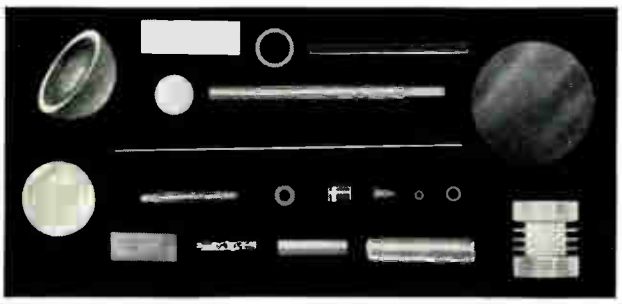
VSWR of 1.5 and max. insertion loss of 0.5db, from dc-12GC.



This series of coaxial rotary switches have an r-f power of 400w. or better, and min. voltage rating of 1500v. RMS. Isolation is greater than 50 db over the range. Operating temp. range is —60°C to +100°C, and life exceeds 100,000 operations. Sage Laboratories, Inc., 3 Huron Dr., Natick, Mass.

Circle 186 on Inquiry Card

PRECISION GRINDING • OF HARD MATERIALS



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Circle 61 on Inquiry Card

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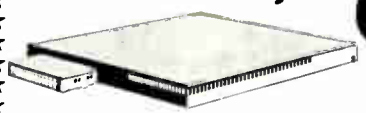
BRAND NEW ONE STORY PLANT built for you $5.60 Sq. Ft.



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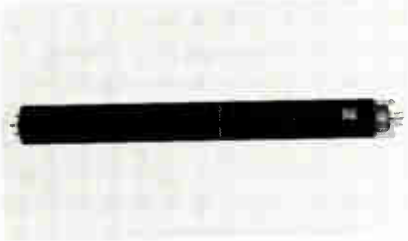
Circle 62 on Inquiry Card

World Radio History

NEW PRODUCTS

TWT AMPLIFIER

The liquid cooled unit weighs 65 lbs. and can be mounted in any position.

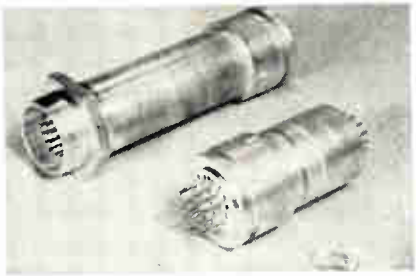


The L-3844 TWT amplifier is tailored to a min. saturated power output of 4.5kw. over the freq. range of 400 to 450MC. With the internal r-f structure of a single filar helix, the usable freq. band is much wider. Center freq. can easily be changed with simple modification. This all metal-ceramic tube utilizes electromagnetic focusing. Its hollow electron beam operates with relatively low voltages while maintaining a short overall length. Litton Industries, Electron Tube Div., 960 Industrial Rd., San Carlos, Calif.

Circle 249 on Inquiry Card

HERMETIC CONNECTORS

Provide multiple-conductor feed-through for high-vacuum uses.



These connector receptacles are for penetration through chamber bulkheads of extreme thickness. The high-compression glass inserts withstand pressure above 1000psi. All internal conductors are isolated by dielectric oil. Air leakage at either interface is guaranteed to less than 0.2 micron cu. ft./hr. at 30psi differential. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 250 on Inquiry Card

• SCAN CONVERSION
• FLICKERLESS DISPLAY STORE
• VIDEO STORAGE

RECORDING STORAGE TUBE SYSTEMS
Single-gun, dual-gun, multi-tube systems to convert scan for radar, sonar, television, and to perform analog processing, data analysis, contract or expand time scale, auto correlation.

• SLOWED TELEVISION TRANSMISSION
by telephone line or other narrow-band systems.

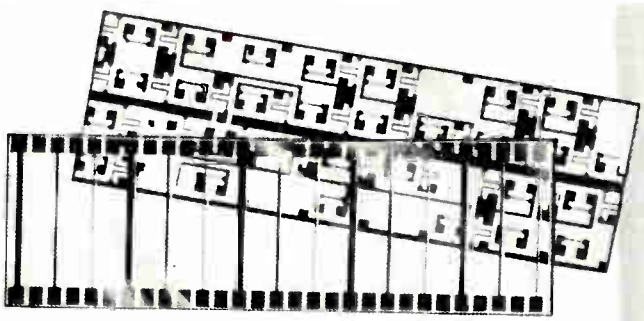
• IMAGE ENGINEERING
OPTICAL CHART READERS, FLYING SPOT SCANNERS, LOW-LIGHT-LEVEL CAMERAS, and IMAGE RECTIFICATION. Automatic inspection and recognition of size, shape, color, and texture.

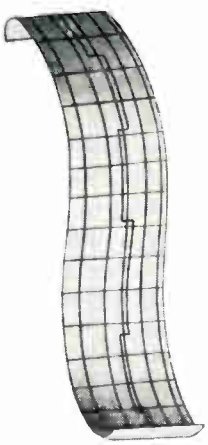
IMAGE
Write or call for complete information:

INSTRUMENTS, Inc.
2300 Washington Street
Newton 62, Massachusetts
617 WOodward 9-8440

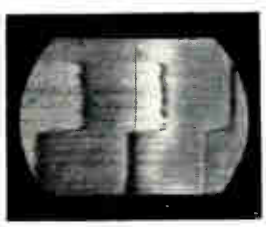
Circle 64 on Inquiry Card

THIN FILM





thickness measurement
surface evaluation



By Stylus with the Talysurf Model 3

By Optics with the N-130 Interferometer

Engis instrumentation now provides precision methods to determine thickness of films, evaporated or sputtered, single or multi-layer; and the characteristics of substrates or micro-etched surfaces . . . from 0 to 5000 Angstroms normally, and up to .002" for depth or height, when necessary.

For description and specifications of this precision instrumentation, ask for folder ES-113

Engis precision instrumentation includes:

Optical, Electronic, Mechanical Tools, Gages and Instruments.

Universal Optical Tooling, Surface Measuring and Photo-Electric Equipment.

Special Optical Systems and Components.

Instrumentation for Research and Industry in the visible, ultra-violet and infra-red regions.

X-ray Equipment, Special Products.

A condensed catalog or specific details will be furnished upon request.

ENGIS EQUIPMENT COMPANY
431 SO. DEARBORN ST., CHICAGO 5, ILL. PHONE: HARRISON 7-3223

Circle 63 on Inquiry Card

World Radio History

NEED A HIGH VOLTAGE RELAY?

Jennings type RB4, 4PDT vacuum relay has a peak rf test voltage rating of 15 kv. Continuous 60 cycle current rating is 20 amps.

WITH MAXIMUM RELIABILITY

Jennings type RB1, SPDT relays are available in some models with a rated life of 10 million operations and switching speeds to 3 milliseconds maximum. RF operating voltage is 10 kv peak.

CAN CARRY LOTS OF RF CURRENT

Jennings type RS8, SPST relay has a continuous current rating of 22 amps rms at 16 mc. Peak test voltage rating (60 cycle) is 30 kv.

INTERRUPTS HIGH POWER

Jennings type RE6B, SPDT relay will interrupt 25 kw dc power (not to exceed 5 amps or operating voltages of 10 kv). Peak rf test voltage is 15 kv.

RESISTS SHOCK AND VIBRATION

Jennings type RA vacuum relays will withstand vibration of 20G at 10 to 2000 cps. Rated operating voltage is 2 kv peak (60 cycle). Heavy duty versions of this relay will interrupt 20 amps for minimum 50,000 operations.

NEVER CHANGES CONTACT RESISTANCE

Jennings type RB7 2PDT vacuum relays have a rated rf operating voltage of 4 kv peak yet they are only 1-11/16 inches long. Contact resistance never exceeds 10 milliohms for the life of the relay.

Jennings Radio has specialized for years in the design and construction of vacuum transfer relays to solve high voltage switching problems where space and weight are critical and reliability a must. In addition to the relays illustrated Jennings offers many more models to solve a wide variety of applications.

A brief inspection of the complete ratings and advantages of these relays will suggest many circuit design possibilities formerly deemed impossible. Send for detailed catalog literature today.

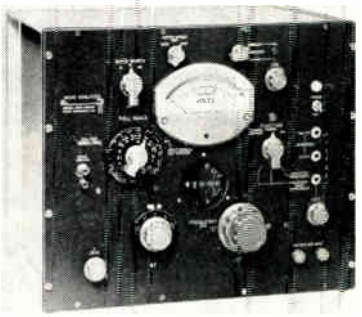
RELIABILITY MEANS VACUUM / *VACUUM MEANS* Jennings®

JENNINGS RADIO MFG. CORP., 970 McLAUGHLIN AVE., SAN JOSE 8, CALIF., PHONE CYpress 2-4025

Circle 65 on Inquiry Card

WAVE ANALYZER

Full-scale voltage range is 30μv to 300v, with 1 megohm input impedance.

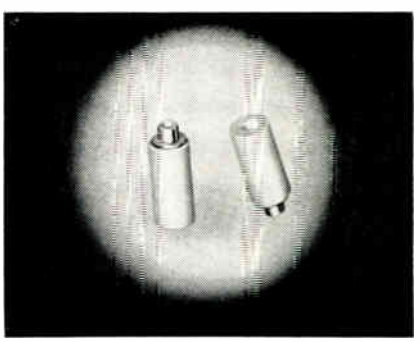


Switch-selection of 3, 10, or 50CPS bandwidth is one feature of Type 1900-A wave analyzer. The heterodyne voltmeter covers the freq. range from 20CPS to 50KC. Several outputs are provided: 100KC and 1made outputs for recording; a restored-signal output at the freq. of the input signal; and a tracking-analyzer sinewave output at the indicated center freq. These outputs make it a complete system for response measurements on a wide variety of networks and devices. The analyzer has a voltage-calibrating system, a precise, linear freq. scale, and AFC. General Radio Co., West Concord, Mass.

Circle 251 on Inquiry Card

TEST-POINT JACK

Designed to be staked or swaged into a printed-circuit board.



The SKT-112PC is a new Teflon® test-point jack which features a beryllium copper contact and a Teflon bushing. It accepts an 0.080 in. (±0.001) x 0.382 in. long dia. probe. Fits into a chassis having a 0.062 in. max. thickness. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y.

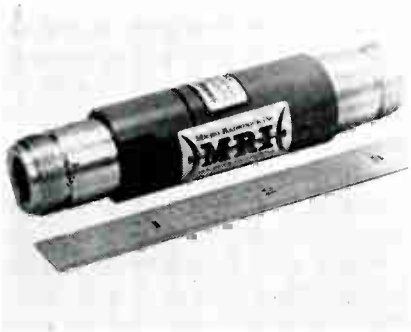
Circle 252 on Inquiry Card

World Radio History

NEW PRODUCTS

COAXIAL ISOLATOR

Isolation, 20.0db min; insertion, 1.0db max.; VSWR, 1.20 max.



Model C-F-IS-S-000-3437 is a miniature S-band coaxial internal magnet isolator suited to low-power uses. Unit operates over 2.7 to 2.9GC. Power, 10w. CW and 10kw peak; size, 3 7/16 in. long x ¾ in. dia.; weight, 3 oz. Micro-Radionics, Inc., 14844 Oxnard St., Van Nuys, Calif.

Circle 253 on Inquiry Card

TUNNEL-DIODE AMPLIFIER

Amplifier has a 100MC passband centered at 2250MC; min. gain 15db.

This fully enclosed 2250MC tunnel-diode amplifier is for telemetry uses. Gain stability ±1db from −30 to +60°C. The noise figure is 4.5db max. Coax input and output connectors are supplied on the front of the amplifier. Microwave Associates, Inc., Burlington, Mass.

Circle 254 on Inquiry Card

POWER SUPPLIES

Output voltages range from 6 to 3000-vdc or ac, adjustable +5% and −10%.

Series SMU high-temp., adjustable-output inverters and converters have a 3w. capability and operating life is 1000 hrs. Circuits use silicon semiconductors for stable operations. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 255 on Inquiry Card

CARBON FILM

MOLDED STYLE: The Electra DCM Series offers the extra protection of a durable molded jacket of thermo-setting alkyd resin and capped lead construction. Stocked in sizes from 1/10 to 2 watts and resistances from 10-ohms to 10 meg. CONFORMAL COATED: Both CF and DC series coated with high impact Impervium "N". Available in sizes from 1/10 to 2 watts and values from 10 ohms to 10 meg. Copper leads are standard. Dumet, Grade A nickel, and gold-plated leads are available on all styles of Electra resistors.

HERMETICALLY SEALED STYLE: Available in ⅛ to 2 watt sizes, the HC Series is indicated for extreme moisture resistance. Meets or exceeds MIL-R-10509 D.

METAL FILM

MOLDED STYLE: Standard of the industry in sophisticated applications. Weldable leads; Dumet, nickel & gold-plated. Thermosetting alkyd resin jacket. 1/10 to 2 watts, 25-ohms to 10 Meg. Electra Series MF.

CONFORMAL COATED: High performance in small light package. Coated light blue in Impervium "X" identifies Electra Series MFC. Cap terminals—complete selection of leads. ⅛ to 2 watts, 25 ohms to 10 meg.

HIGH RELIABILITY

SERIES HRM: Designed and produced to meet the most exacting reliability requirements. HRM ⅛ is designed toward a failure rate of .0004 ER*, meets the dimensional requirements of RNR57 as specified in MIL-R-55182. 30.1 ohms to 301 K.

SERIES CHM: Companion to HRM 1/8, the CHM 1/8 is highly miniaturized. Eminently suitable for use in cordwood packaging or other high density applications.

20 Ohms to 301 K.

Now from Electra—get all three

ONE SOURCE

for all precision film resistors

Built into every Electra Resistor is a reliability unmatched throughout the industry. This is a large claim, but we back it up with proof. Type for type, resistor for resistor, Electra can and does prove their reliability in *continuing* power-temperature testing.

Since the start of the test, undergoing 2½-times their rated wattage load, sufficient data has been accumulated to establish a reliability figure of better than .000139 ER* on standard Electra Carbon Film resistors—that is Electra Reliability!

*ER=per cent per one thousand hours.

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Circle 66 on Inquiry Card

World Radio History

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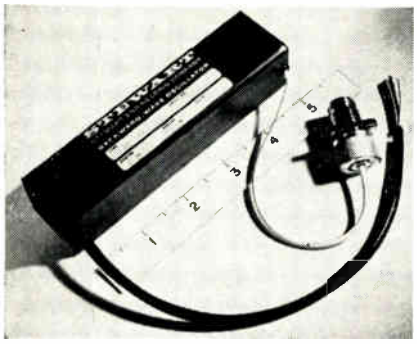
diodes and capacitors
5 watt miniature Zener Diodes, high voltage temperature compensated Reference Elements, non-polar solid and hermetically sealed wet Tantalum Capacitors, 400MW Glass Zeners Mil Types USN 1N 962BM –USN 1N 984BM
call your local Avnet Headquarters
AVNET
The Avnet System, coast to coast
Circle 68 on Inquiry Card

NEW PRODUCTS

MINIATURE BWO

Tunable over the full X-band, it has a min. power output of 20mw.



Type SE 303 is a PM-focused BWO of radically reduced size and weight. It is designed for airborne and space applications in rugged environmental conditions. Weight is 1.5 lbs. Stewart Engineering Co., Santa Cruz, Calif.

Circle 256 on Inquiry Card

FAST-SWITCH RECTIFIERS

Recover in less than 200-nsec.; current range is 1 - 30a.

Recovery times of these units are 200-nsec. or less with the average being 120-nsec. An 80nsec. device is also available. They are available in DO-4, DO-5, DO-10 and DO-11 packages. Hughes Semiconductors, Box H, Newport Beach, Calif.

Circle 257 on Inquiry Card

THERE'S AN ALPHA FLUX FOR EVERY SOLDERING PROBLEM

LIQUID ROSIN FLUX — Non-activated, mildly activated and activated liquid rosin flux for printed circuit and and other electronic applications.

WATER SOLUBLE FLUX — Highly active flux, aqueous and non-aqueous compositions for soldering hermetically sealed components.

SPECIAL FLUXES — For stainless steel, Nichrome and similar alloys; aluminum and aluminum alloys; hot-tinning and other high temperature applications.

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• SOLDER RESISTS • COPPER BRIGHTENERS.

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Los Angeles, Calif. • Alphaloy Corp. (Div). Chicago, Ill.
• Alpha Metals, Inc. (U. K.) Ltd., London, England
J-2606
Circle 69 on Inquiry Card

★ ★

Are You Designing or Building Under Any of These Specs?

MIL-E-5400F
airborne electronic equipment

MIL-E-8189B
guided missile electronic equipment

MIL-E-16400D
shipboard electronic equipment

MIL-P-11268D
communication equipment

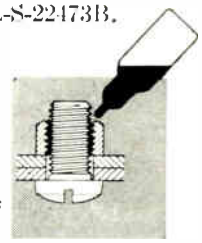
MIL-T-21200D
electronic and fire-control systems test equipment

If so, these specifications now authorize the use of Loctite® Sealant (*MIL-S-22473B—Sealing Compounds, Retaining, Single-Component, Anaerobic*) for staking screws and sealing threads. Insulating varnishes are not acceptable for these functions.

Loctite Sealant prevents loosening from vibration and reduces weight by eliminating locknuts and lockwashers.

Write now for catalog and copy of MIL-S-22473B.

LOCTITE
CORPORATION
Self-Hardening Resins for Assembling Metal Parts
187 N. Mountain Rd. Newington, Conn. 06111



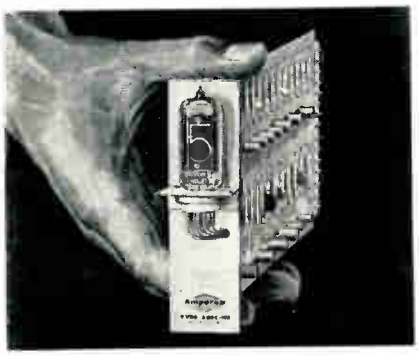
Circle 70 on Inquiry Card

World Radio History

NEW PRODUCTS

DECADE COUNTER

Module features built-in error detection capability. No decoding matrix.

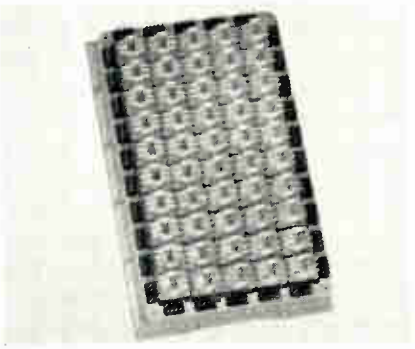


Model BQDC-100 consists of a 100kc counter circuit, tube-driver circuit, Bi-Qui numerical indicator tube, and connector. The Bi-Qui tube makes decoding matrix unnecessary. Applications include timing controls, marine depth sounding, machine tool control, etc. Amperex Electronic Corp., Hicksville, L. I., N. Y.

Circle 258 on Inquiry Card

SWITCHING MATRIX

Magnetic reed capsules are rated at 1a. (switching) and 5a. (carry).



The crosspoint correed matrix can interconnect any one of 5 circuits with any one of 10 other circuits in less than 3msec. Each circuit has 5 leads plus 1 holding lead. Multiple matrices may be interconnected. The device operates faster than a crossbar switch. Freq. switching to 100kc. Automatic Electric Co., 400 N. Wolf Rd., Northlake, Ill.

Circle 259 on Inquiry Card

specify the new Microdot Products contact Avnet for best service

AVNET

on-time delivery of Microdot Connectors and cable

Multipin connectors with up to 61 power or 19 coaxial contacts in 1⅛" o.d. plug; microminiature coax connectors in 50, 70, 90 ohm types; coax, twinax, triaxial cables (RG types approved to MIL-C-17C).

many other Microdot Products are available immediately from Avnet

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Salt Lake City; Bellevue, Wash.; San Diego, L. A., Sunnyvale, Cal.

Circle 73 on Inquiry Card

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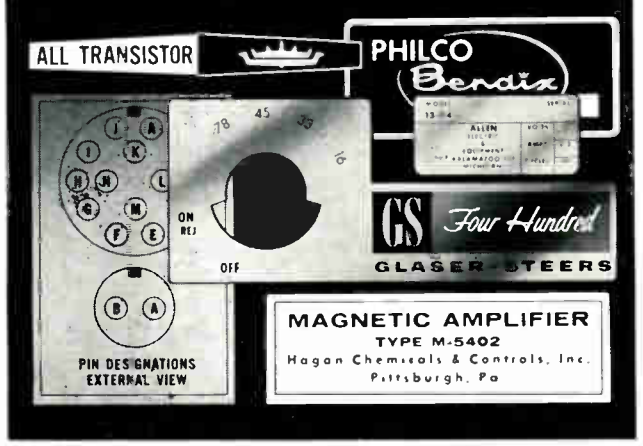

Here are permanent, abrasion-resistant nameplates you can apply *exactly where they're needed.* No moistening, screws or rivets required. Self-bonding Poly-Plates adhere tightly to any clean, dry surface. Made of miracle sub-surface printed Mylar*. Non-conductive . . . safe on or near energized equipment. Any wording, shape, size or color, including rich gold or silver. Low cost.

Write for bulletin and samples. 143

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EST. 1914

Manufacturers of Quality Pressure-Sensitive Industrial Tape Products, Self-Bonding Nameplates, Automatic Machines for Dispensing Labels, Nameplates, Masks and Tape

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PRECISION Molded Bobbins

Precision molded bobbins can be furnished at low unit cost in any size or shape. This economy is achieved by a specially designed, fully automatic, single-cavity mold process that holds down costs on both relatively small production runs as well as in larger quantities. This process also permits increased flexibility in production and fast delivery.

Bobbins can be molded from a variety of materials including nylon, polystyrene, polycarbonate, and other thermoplastics to provide the highest electrical, mechanical, and corrosion-resistant properties.

Send or phone specs. for quote.
Request bulletin and arbor list.

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Telephone: (Area Code 312) 537-4250
OTHER PLANTS IN HARTFORD, CONN., AND CLEVELAND, OHIO

Circle 72 on Inquiry Card

World Radio History

specify the new circuit breakers by Mechanical Products, Inc.

AVNET

contact The Avnet System for best service & on-time delivery

the line includes breakers with both standard commercial and Mil Spec part nos. Mechanical Products' circuit breakers meet requirements of MIL C-5809 and MIL C-7079.

for MP circuit breakers

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LOCAL

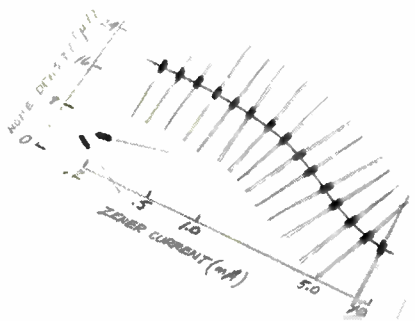
Salt Lake City; Bellevue, Wash.; San Diego, L. A., Sunnyvale, Cal.

Circle 74 on Inquiry Card

NEW PRODUCTS

ZENER DIODES

Voltage and impedance ratings char. at 250μa max. Noise limit specified.



Types 1N4099-1N4135 are 250mw low-level oxide-passivated zener diodes rated at 6.8-100v. Max. noise density is 40μv/sq. root cycle. They are said to have 80% lower knee impedance, 2 orders of magnitude lower leakage current, 33% lower forward voltage drop, and a wider temp. range (−65° to +200°) than conventional 250-400mw devices. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 260 on Inquiry Card

PLUG-IN CAPACITOR

For printed circuits. Values of 0.001-8.0μf; voltages from 100-600vdc.

These radial lead plug-in capacitors, designated styles M2E, W2E and D2E, are constructed with metallized paper. Operating temp. range is −55°C to +125°C. Applications include ac and dc printed circuits, blocking coupling, by-pass, filtering, power factor correction, etc. Electron Products Div., Marshall Industries, 1960 Walker Ave., Monrovia, Calif.

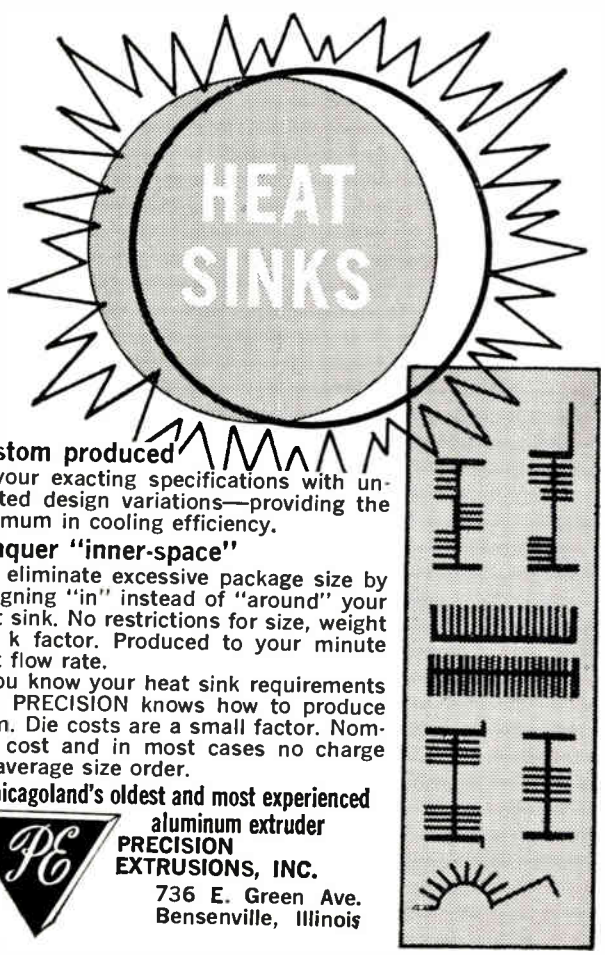
Circle 261 on Inquiry Card

DC SOURCES

Stability, 0.005%/hr. and 0.01%/day; voltages to 6000; current to 20ma.

Model 3K20 has a range of 0 to 3Kv; model 6K20, 0 to 6Kv. Output voltages are available continuously from 0v. through the max. range, while output current is 0 to 20ma. The units can be mounted in standard relay racks or, equipped with removable rubber feet, used as bench instruments. Honeywell, Denver Div., 4800 E. Dry Creek Rd., Denver 10, Colo.

Circle 262 on Inquiry Card



Custom produced to your exacting specifications with unlimited design variations—providing the optimum in cooling efficiency.

Conquer "inner-space" and eliminate excessive package size by designing "in" instead of "around" your heat sink. No restrictions for size, weight and k factor. Produced to your minute heat flow rate.

If you know your heat sink requirements . . . PRECISION knows how to produce them. Die costs are a small factor. Nominal cost and in most cases no charge for average size order.

Chicagoland's oldest and most experienced aluminum extruder

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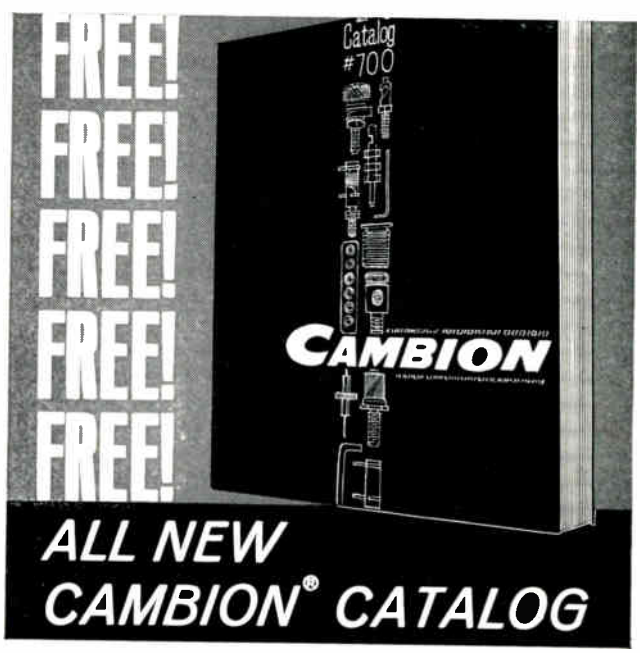
Bensenville, Illinois

Circle 75 on Inquiry Card



Full-line design catalog contains over 130 pages, lists over 15,000 *guaranteed* CAMBION electronic parts — coils, coil forms, chokes, connectors, capacitors, panel and chassis hardware, kits, tools, etc. All easy to locate in clearly organized sections, easy to specify with the aid of comprehensive diagrams and tables, helpful engineering hints. Send *now* for this new single-source buying guide to best quality electronic parts!

Cambridge Thermionic Corporation, 330 Concord Ave., Cambridge 38, Mass.

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Standardize on CAMBION...The Guaranteed Electronic Components

Circle 82 on Inquiry Card

World Radio History

NEW PRODUCTS

GLASS CAPACITORS

Glass trimmer for r-f use; the Q is above 500 at 1MC-20MC.

No. 1869 has a capacitance range from 0.85 to 7.0pf and is free from reversals. Max. mounted height is 5/8 in. at min. capacity. Eyelet type terminals afford rugged, easy-to-solder connections. The Permatorq tensioning device is shock and vibration resistant, yet permits ease of tuning at temps. as low as —55°C. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Circle 263 on Inquiry Card

TEMPERATURE CHAMBER

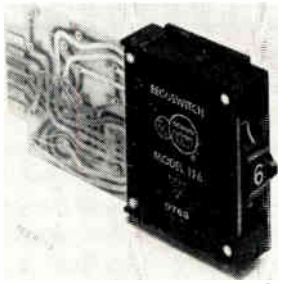
Programmable temp. control will hold to ±¼°F from —100°F to +600°F.

The 1064 Temp. Chamber has a solid-state temp. controller which offers advantages over mechanical temp. controllers. An auxiliary failsafe device prevents temp. from exceeding any preset failsafe value. A disk thermometer checks internal temp. at any time. Volumes range from 0.14 to 5.4 cu. ft. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 264 on Inquiry Card

VOLTAGE-DIVIDER SWITCH

Thumbwheel switch functions as a digital voltage divider.



Ten thumbwheel positions, 0-9, allow selection of the desired decimal fraction of an applied reference voltage. Printed-circuit card extending from the back of the switch provides mounting for voltage-divider resistors. Provision is also made for an additional scale-factor resistor. Accidental hang-up between switch positions is eliminated. Model number is 116. Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif.

Circle 265 on Inquiry Card

specify the new
Widney Dorlec Enclosure System
AVNET
custom electronic enclosures
at modular prices

Widney Dorlec custom consoles, desks, racks save costs, save time, give flexibility. Precision die cast heavy aluminum extrusions. Complete enclosures or produce your own.

For 1 or many electronic enclosures
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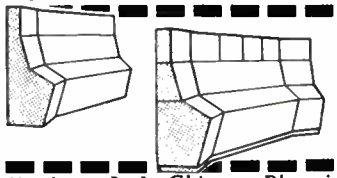

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Circle 79 on Inquiry Card

NEW
VIBROTEST®
Megohmmeter
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Measures resistance
to 10,000,000 megohms

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fob Chicago

versatile·accurate·reliable

dual test voltage...500 vdc and 50 vdc

24" total scale length...1 to 10,000,000 megohms in 6 decades

measures resistance on printed circuits, transistor and miniaturized circuit components, cables, motors, etc.

measures leakage resistance of capacitors

measures grounded and ungrounded sections of three-terminal resistors

advanced features

- constant test voltage over full range
- no overload damage
- positive line voltage control
- maximum guarding flexibility
- latest tube-miniaturization techniques

Get all facts...
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2-35.7

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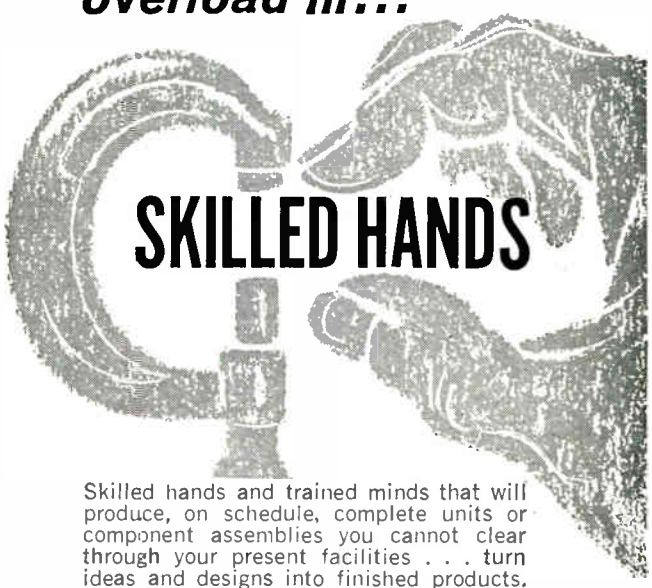

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Q-MAX impregnating and coating composition penetrates deeply, seals out moisture, provides a surface finish. Q-MAX imparts rigidity and promotes stability of the electrical constants of high frequency circuits. Effect on the "Q" of RF windings is negligible.

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MARLBORO, NEW JERSEY

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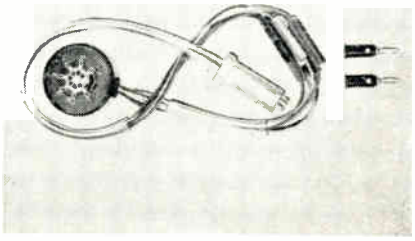
Circle 80 on Inquiry Card

NEW PRODUCTS

TESTING ADAPTER

Eliminates unsoldering and resoldering. Connections color coded.



The Universal harness testing adapter makes quick, reliable testing of current, voltage, resistance and video possible by extending all test points 24 in. from chassis. Phone tip/banana plug adapters permit use with all meters. Three models are available for 7, 8, and 9 pin sockets: models 1737-39 respectively. Pomona Electronics Co., Inc., 1500 E. 9th St., Pomona, Calif.

Circle 266 on Inquiry Card

OSCILLATOR

Temp. characteristics are 1% of DBW freq. shift/100°F from −65 to +200°F.

Model VCO-103 voltage-controlled subcarrier oscillator uses a temp. compensation technique to provide accurate performance in extreme temp. environments. All standard IRIG channels are available. Input impedance is 500K for channels 1-18, and 250K for channels A-E. Output distortion is less than 0.5% at center freq. The Scionics Corp., 8900 Winnetka Ave., Northridge, Calif.

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It's all here! Everything you need to know about selecting a case for your particular military or commercial packaging requirement. Contains 28 pages of valuable reference data that can help you save your company hundreds, if not thousands of dollars.

Easy to read, easy to understand. Illustrates TA's broad line of cases including the various hardware components obtainable. All TA cases are designed to surpass Mil-Spec requirements . . . completely dust and water proof. Can be painted or finished to enhance the appearance of any instrument or product. Huge warehouse stock insures you delivery within three weeks at the lowest prices imaginable. No tooling charges. Free vellum service and panel templates. Write, wire, or phone today for a quotation and let us put our staff of case engineers to work for you.

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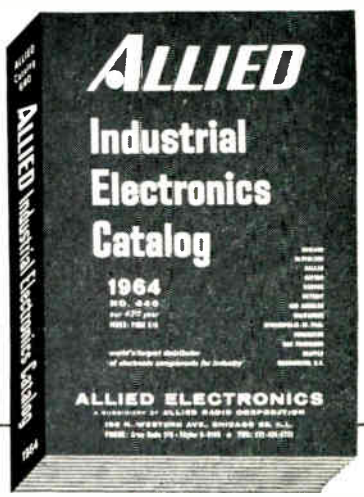

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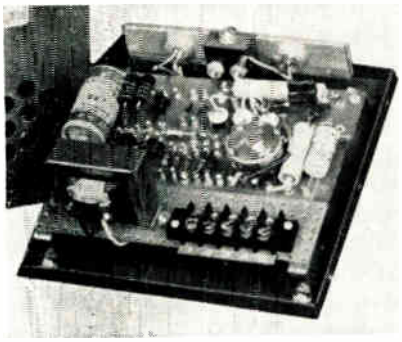
Circle 76 on Inquiry Card

World Radio History

VOLTAGE REGULATOR

Response is approx. 0.1 sec. for line, load, and freq. changes.



The Solatron 1kva has a regulation of ±0.25% for ±10% variations in line and load when operated at its rated output setting. When adjusted to other than rated output, ±1% regulation is held. The all solid-state unit has an efficiency of 93% at full load; rated output is 120v. nominal. Load range is 0-8.4a. Sola Electric Co., div. of Basic Products Corp., 1717 Busse Rd., Elk Grove Village, Ill.

Circle 268 on Inquiry Card

MICROWAVE PHOTOTUBE

Can handle several hundred TV channels simultaneously.

The A1283 Lasecon microwave phototube is a head-on detector for light which is amplitude modulated at freqs. in the range 0-4000Mc. The tube resembles a conventional TWT except the thermionic cathode is replaced by a transmission-type photo-cathode. The tube operates as an optical video detector, an optical video detector with r-f heterodyne, and an optical heterodyne detector. Radio Corp. of America, Electron Tube Div., Harrison, N. J.

Circle 269 on Inquiry Card

CRYSTAL CAN RELAY

Low-level to 2a switching; for printed-circuit and high environments.

The GO series half-size crystal can relay meets Mil-R-5757D. Standard specs. include: contact arrangement 2PDT, bifurcated, dc resistive, life (at rated load) 100,000 cycles. Coil data 6 to 25°C are 85Kc-in. radial and 80Kc-in. 26.5vdc nominal, continuous duty. Typical operate time 0.0004 sec. max.; typical release time 0.0002 sec. max. Guardian Electric Mfg. Co. of Calif., Inc., 5755 Camille Ave., Culver City, Calif.

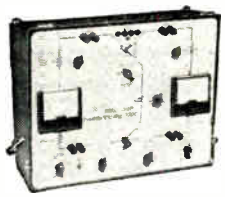
Circle 270 on Inquiry Card

HICKOK Dynamic Beta®

TRANSISTOR TESTER

MODEL 870

Tests transistors as recommended by manufacturers at specified I_c, V_{ce} and I_b • checks Collector Saturation Voltage ($V_{ce\text{-}SAT}$) • provides low voltage, high current tests—excellent for switching transistors • controls provide maximum set-up flexibility combined with speed-engineered layout for volume testing of transistors • *Complete with roll chart giving test data for over 1,150 transistors.*



HICKOK MODEL 850P TRANSISTOR ANALYZER

Tests under actual circuit conditions and is ideal for use as a "breadboard" in transistor research and experimentation.

The new Hickok Model 870 portable transistor tester—*two* transistor testers in *one*—measures large signal DC Beta on power transistors as well as small signal AC Beta on low and medium power transistors. It features variable collector current and collector voltage. (Beta tests are meaningless unless tests are made at specified current and voltage values.) Collector test current is variable up to 2 amperes, permitting Beta measurement on power transistors rated at 5 amperes or more.

Write for complete details and specifications on Hickok Transistor Testers. Ask for Form TT-607.

THE HICKOK ELECTRICAL INSTRUMENT CO.

World Radio History

NEW PRODUCTS

DC to AC or

- Frequencies from 400 cps to 5 KC
- Output voltages from 5-500 VAC
- 50, 100, 200 VA Standard

Designed to change low voltage DC power to sine or square power, these small-size, transistorized inverters can be supplied in a wide range of output voltages and frequencies. Units feature regulation to ½% for input 24 to 30 VDC, short circuit protection, and meet the environmental requirements of MIL-E-5272C. Prices range from $185. to $595. Delivery of most units from stock.

Send for complete 20-page catalog or see E.E.M. pgs. 1255-1259.

abbott transistor
LABORATORIES, INCORPORATED
3055 Buckingham Rd. • Los Angeles 16
Direct Dial 213 • REpublic 1-9331
Circle 84 on Inquiry Card

SYNCHROS AND RESOLVERS

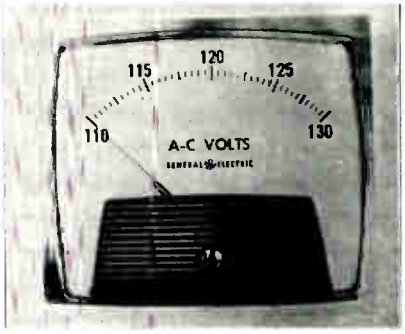
400 cycle units are available in a wide range of input voltages.

The R900 series consist of 22 basic size 11 high-accuracy units including transmitters, transformers, differential transmitters, and receivers. Available in hundreds of electrical and mechanical modifications and in accuracies ranging from 3 min. to 10 min. max. error from electrical zero. Equipped with either leads or terminals, they have stainless-steel housings, bearings, and shafts. Kearfott Div., General Precision Aerospace, 1150 McBride Ave., Little Falls, N. J.

Circle 271 on Inquiry Card

VOLTMETERS

Incorporating zener diode references. Max. sensitivity, 100Ω/v.

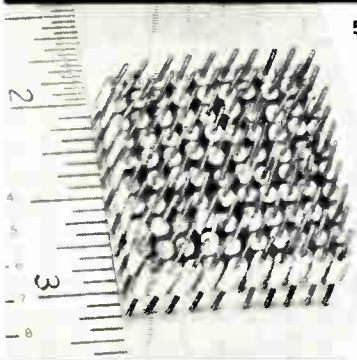


The Big Look voltmeters provide accuracy of ±0.5% and good narrow-range readability. Expanded-scale meters are available in 3½ in. and 4½ in. completely self-contained ac or dc models. Min. span is 16% of mid-span rating, which can range from 12 to 270v. self-contained. Standard ac ratings are 110-130 and 115-125v. Standard dc ratings are 24-30, 110-130, and 220-260v. Current drain is 10ma. General Electric Co., Schenectady 5, N. Y.

Circle 272 on Inquiry Card

THE DECI-CAP

New Subminiature **Ceramic Capacitor**—*0.100" Diameter by 0.250" Molded Envelope*—**to 10,000 pf**



0 PER LINEAR INCH,
100 PER SQUARE INCH

5 pf to 10,000 pf in 34 values
200 WVDC to 470 pf
100 WVDC to 10,000 pf

Epoxy molded. Capacitance change is less than 7½% from 5 pf to 470 pf and less than 15% from 560 pf to 10,000 pf at —55°C to +125°C

FEATURES:

Standardized size for high density cordwood packaging

Designed to meet all the requirements of MIL-C-11015

The DECI-CAP is the latest addition to Nytronics' DECI Series—a series that does consist of inductors, capacitors and resistors in a uniform envelope to facilitate point-to-point assembly in cordwood, printed circuit and other high density module assemblies.

For complete engineering data, write Dept. WL-25, or phone 201-464-9300.

NYTRONICS, INC.
550 Springfield Ave., Berkeley Heights, N.J.

Design Leaders STANDARD components to meet CUSTOM requirements

Circle 85 on Inquiry Card

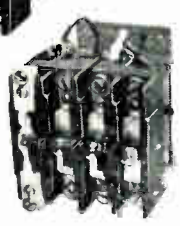
A ROWAN CHOICE FOR *any application*

A complete line of versatile, multiple-pole relays and contactors with extreme reliability.

featuring:

Industrial (Nema sizes 0 to 5)
Special (10 to 75 amp)
AC or DC, air-break or oil-immersed

(Also a full line of overload relays & starters.)



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ROWAN

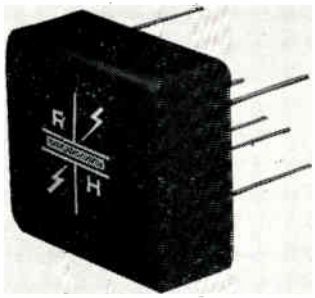
THE ROWAN CONTROLLER CO.
30 Bridge Ave., Red Bank, New Jersey
(201) SH 7-5094

Circle 86 on Inquiry Card

World Radio History

TEMPERATURE CONTROLLER

Ideal for printed-circuit uses in original or updated designs.



Model V1523 proportional temp. controller is used in connection with amplifying power transistors. The control provides up to 0.02a to drive an external power transistor. In this manner any heater load from a fraction of a watt to hundred of watts can be precisely controlled. Temp. stability is 0.01°C vs a fixed amb. and 0.001°C vs ±10% supply. Operation is at 20 to 30vdc. Reeves-Hoffman Div., Dynamics Corp. of America, Cherry & North Sts., Carlisle, Pa.

Circle 273 on Inquiry Card

CROSSBAR SCANNER

Offers unlimited capacity. It will take any number of poles or contacts.

Model R-1100 is a transistorized, multiple-position, variable-pole, solid-state scanner. It provides complete program flexibility, random access and ideal switching with over 100 million operations/circuit. Plug-in modular construction allows the data capacity to be expanded as the requirements change. The capacity can be quickly expanded to 600 channels. Digital Pacific Electronics Corp., 5258 Anna St., San Diego, Calif.

Circle 274 on Inquiry Card

STRAIN GAUGE

Available with 347 stainless steel for use in corrosive fluids.

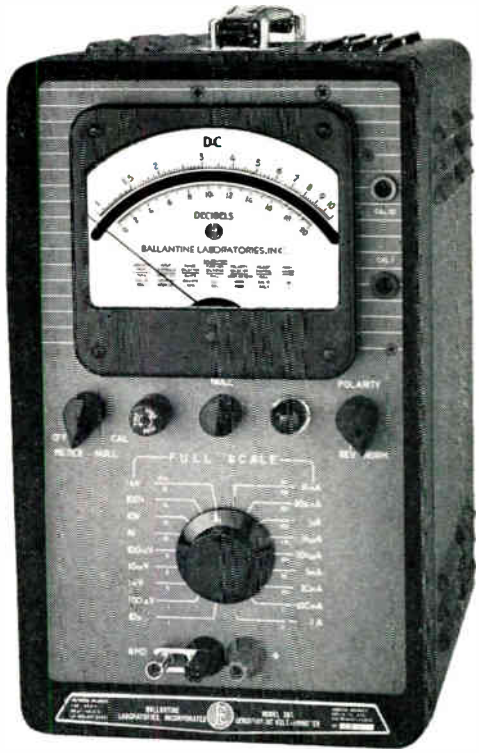
The 2521 unbonded strain-gauge pressure transducer can be used with either male or female pressure connectors. Available with a single or multi-point calibration which is accomplished by adding external resistors across the strain-gage bridge. Specs: pressure range, 0-5000psia; output, 4mv/v; zero balance, ±1% of full-scale output; and thermal zero shift, ±0.005%/°F. Bourns, Inc., 1200 Columbia Ave., Riverside, Calif.

Circle 275 on Inquiry Card

NEW! BALLANTINE SENSITIVE DC VOLT/AMMETER

MODEL 365

Measures
1 μV to 1,000 V dc
0.001 μA to 1 A dc



EXTREMELY WIDE VOLTAGE AND CURRENT RANGE

UNMATCHED ACCURACY FOR ALL INDICATIONS

BUILT-IN CALIBRATION STANDARD

Price $650

DC voltages with the extremely wide voltage range of 1 μV to 1 kV and currents from 1 nA to 1 A can now be displayed on an analog indicator and measured with unmatched accuracy. The Ballantine Model 365 Sensitive DC Volt/Ammeter, with a single logarithmic scale and range selector, will measure voltages above 1 mV with a constant accuracy of 1% of indication. Currents above 0.1 μA are measured with an accuracy of 2% of indication.

The accuracy of the Model 365 is supported by a high order of stability gained by both ac and dc feedback techniques and conservative operation of all components. For further assurance of accuracy, a simple and reliable internal standard is available to check calibration accuracy and panel controls can correct the calibration, if necessary, in seconds.

Signal-ground isolation allows floating measurements to 500 volts above panel ground, and ac rejection is provided to reduce the effects of common-mode signals.

The new 365 is available in both portable and rack versions.

PARTIAL SPECIFICATIONS

Voltage ..... 1 μV – 1 kV	**Current** ..... 1 nA – 1 A
Accuracy .... 1% of indication above 1 mV	**Accuracy** ..... 2% of indication above 0.1 μA
Impedance ..... 1 MΩ above 1 μV; 5 MΩ above 0.1 mV; 10 MΩ above 0.1 V	**Impedance** ..... < 10 kΩ above 1 nA; < 100 Ω above 10 μA; < 1 Ω above 10 mA

Impedance Between Signal and Panel Grounds: R > 100 MΩ, C = 0.1 μF, 500 V Peak Max
Usable as DC Amplifier: 100 db max gain, 0.1 to 1 V output for each decade input range

Write for brochures giving many more details

– Since 1932 –

BALLANTINE LABORATORIES INC.
Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC/DC LINEAR CONVERTERS, CALIBRATORS, WIDE BAND AMPLIFIERS, DIRECT-READING CAPACITANCE METERS, AND A LINE OF LABORATORY VOLTAGE STANDARDS 0 TO 1,000 MC.

Circle 87 on Inquiry Card

World Radio History

How to come out ahead on contact bases for semiconductor devices!

MATERIAL	COMPOSITION % by weight	DENSITY gm/cc	SPECIFIC RESISTANCE μ ohm-cm	THERMAL CONDUCTIVITY Watts/cm°K	THERMAL COEFFICIENT OF EXPANSION x 10^{-6}/°C	YOUNGS MODULUS x 108 gm/cm²
STACKPOLE GRADES (in bold face type)						
CW298	**100W**	18.0	6.70	1.56	4.5	19.5
CW307	**10Ag-90W**	17.32	4.83	2.05	6.2	16.5
CW267	**15Ag-85W**	16.70	4.45	2.17	6.5	16.6
CW315	**20Ag-80W**	16.13	3.71	2.53	8.7	12.3
CW316	**25Ag-75W**	15.40	3.56	2.57	10.7	10.7
CW317	**30Ag-70W**	14.75	3.40	2.62	11.5	9.6
RW34	**15Cu-85W**	16.0	4.57	2.07	7.0	
RW35	**10Cu-90W**	16.9	4.95	1.99	5.8	
Mo		10.2	5.78	1.34	5.1	
W		19.3	5.5	1.65	4.4	
Si		2.33	(a)	1.13	2.3 2.7	
Ag		10.5	1.59	4.17	19.4	
Cu		8.96	1.67	3.93	16.5	

(a) A function of impurity level.

STACKPOLE has the grades, combinations of properties, the sizes prices and service to make selection a cinch . . . savings sure

Now Stackpole has a still broader line of sintered powder metal materials to choose from for supports or contact bases for power devices.

This, in turn, increases the possible combinations of properties available in contact bases, assuring a still better chance of your getting the best combination. Specify what you want in properties that are superior to or comparable to stamped molybdenum or tungsten, and Stackpole can meet your requirements virtually on the button!

In addition . . . the wide range of sizes of Stackpole contact bases and their ready-to-use feature assure long-range savings.

Consider, for example, what you save because Stackpole base materials are lapped and ready to use as received. Their rigidly controlled quality assures a high production yield of good assemblies. Compared with molybdenum and tungsten, their higher thermal and electrical conductivities and strain-free features can raise power handling capacities and increase safety margins without increasing size. In short, one order to Stackpole by-passes many time-taking and costly headaches . . . and your purchase price tells you your total cost going into the assembly!

Note the comparative properties of Stackpole grades shown above. Then contact us direct for information on any of these or other Stackpole sintered metal contact developments. Our technical men are at your service. Address: Carbon Division, Stackpole Carbon Company, St. Marys, Pa.

STACKPOLE

CARBON COMPANY

Carbon Division

St. Marys, Pennsylvania

NEW PRODUCTS

TEST UNIT

Combination freq. meter, deviation meter, and signal generator.

FM-9 features direct digital reading of all allocated channels in the 150-162MC band. It uses the 3rd harmonic to measure and generate channels in 450-486MC band with a 0.0002% accuracy. Outputs can be attenuated to less than 0.5μv for receiver sensitivity checks. Outputs of 400-500KC are also available for i-f alignment. As a deviation meter, instrument measures peak FM deviations in 2 full-scale ranges, 5 and 15KC. Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Circle 276 on Inquiry Card

INDICATOR

Combines transistor-controlled lamp and 2 million cycle switch.

TIB Series TEC-LITE indicator is a 9/16 dia. x 2 in. long (backpanel) device. It combines a replaceable incandescent lamp indicator and an isolated momentary action pushbutton switch. The lamp is controlled by signals as small as 0.3ma. Signal input impedance is 1KΩ nominal. Supply voltages range from ±6.3 to ±28v. Current rating for the SPST switch is 100ma at 120vac, non-inductive. Transistor Electronics Corp., Box 6191, Minneapolis, Minn.

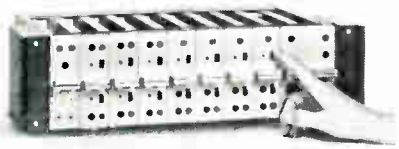
Circle 277 on Inquiry Card

World Radio History

NEW PRODUCTS

TONE CARRIER

Provides 18 additional channels for each of 600 voice freq.



With this solid-state tone carrier, up to 24 narrow-band tone channels can be added to any existing standard telephone-type circuit in the voice freq. range. Designated Type 18 (freq. shift) and Type 19 (amplitude modulation) tone, it is used as a low-cost method of multiplying channel capability of microwave, wire-line or other communication circuits. The equipment provides up to 100 words/min. teletype and telegraph, and 40CPS telemetering. General Electric, Communication Products Dept., Lynchburg, Va.

Circle 278 on Inquiry Card

VSWR TEST SET

Freq. range: 0.2MC to 1GC; VSWR scale: 1.0:1 to 3.0:1 expanded.

The Model 2590 test set contains directional couplers, meter circuit, indicator, and power supply. The set is inserted in the r-f circuit at any point where a VSWR measurement is desired. The VSWR value may be read directly, thus eliminating any formulas or calculations. Microwave Devices Inc., sub. of Bendix Corp., Farmington Industrial Park, Farmington, Conn.

Circle 279 on Inquiry Card

FREQUENCY METER

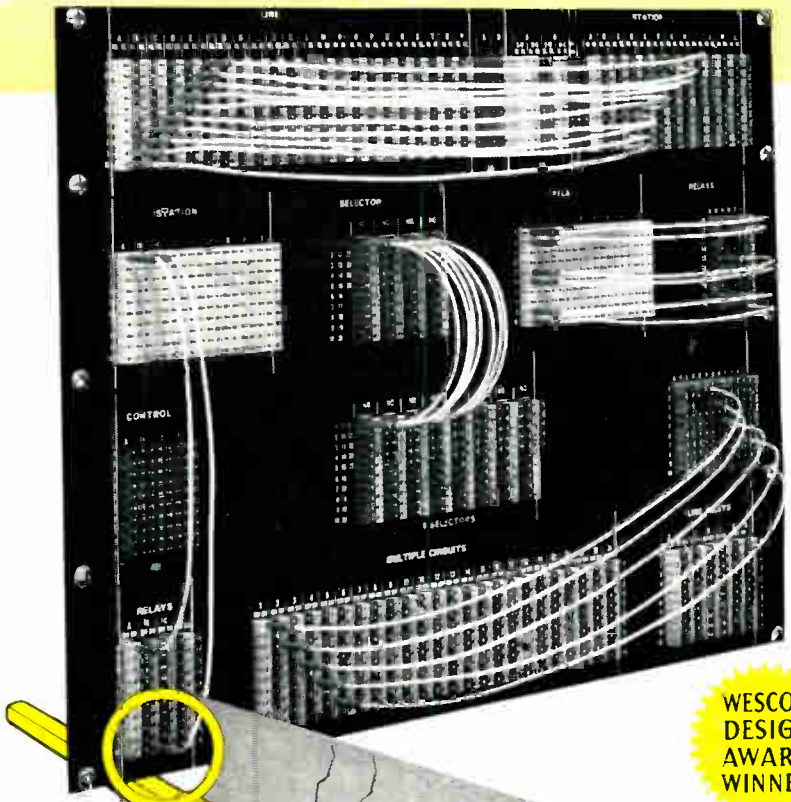
Freq. is read directly on a counter in 1GC increments.

This digital, direct-reading freq. meter operates from 60-90GC. The unit wheel resolution is to 100MC. The cavity plunger travel has been expanded by a linearizing mechanism to yield this resolution. The multiplication is so increased that a 0.0001 in. movement of the cavity plunger produces an 80MC change in the region around 90GC. Microwave Components and Systems Corp., 1001 S. Mountain Ave., Monrovia, Calif.

Circle 280 on Inquiry Cord

Package Engineering Ideas by Malco

PATCH PATCH BOARDS and CORD TERMINALS



WESCON DESIGN AWARD WINNER

FEATURES

. . . One piece patchboard construction—up to 24″ square

. . . Positive plug-in connection

. . . Reverse side of panel for wire wrapping

. . . Color coded receptacle points

. . . Inserting or removal tools not required

For more information— Request Bulletin 631

MALCO MANUFACTURING COMPANY

4037 West Lake Street, Chicago 24, Illinois

WASP

Circle 89 on Inquiry Card

World Radio History

Costly Originals...

but transistor heat dissipators like these, from volume production, cost as little as ordinary "fuse-clip" retainers.

Our **Therma-link** retainers give you a choice of screw, rivet or solder mounting. **Fan-top** radiators provide easy slip-on installation. They effectively retain and cool TO-18, TO-5 and TO-8 cases on printed circuit boards, heat sinks or chassis. You can save assembly time because the beryllium copper fingers adapt to varying case diameters. Gold, nickel, black cadmium and our insulating finish, **Insulube,** are available for space and all other environments.

Research makes the difference in our complete line of advanced design heat dissipators. Request technical data and ask our field engineers about the most economical devices for semiconductor thermal control.

Patented and Patent Pending.

IERC DIVISION

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION

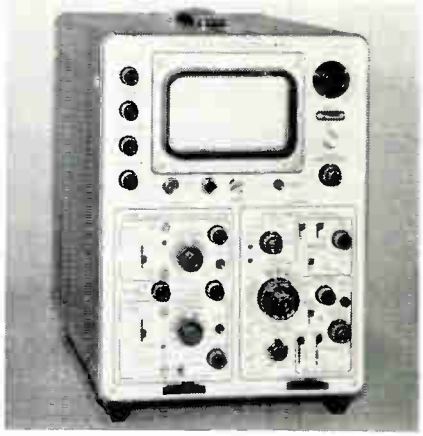
a subsidiary of Dynamics Corporation of America

135 WEST MAGNOLIA BOULEVARD • BURBANK, CALIFORNIA

NEW PRODUCTS

SOLID-STATE OSCILLOSCOPE

Features dc to 50MC passband with solid-state amplifier.



The Type 647 solid-state scope consists of Type 10A2 passband with solid-state amplifier and Type 11B2 time-base plug-in units. A trace finder attenuates both horizontal and vertical voltages. A 1KC calibrator affords 18 squarewave voltages from 0.2mv to 100v. in 1-2-5 sequence: squarewave symmetry and freq. is accurate with ±0.1%; risetime and fall-time are approx. 2μsec. The amplifier's risetime is less than 7nsec. Its sensitivity from 10mv/cm to 20v/cm is in 11 calibrated steps. In chopped position, electronic switching occurs at a 1MC rate to show successive 500nsec. samples of each trace. The timebase and sweep range is from 0.1μsec./cm to 5sec./cm in 24 calibrated steps. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 281 on Inquiry Card

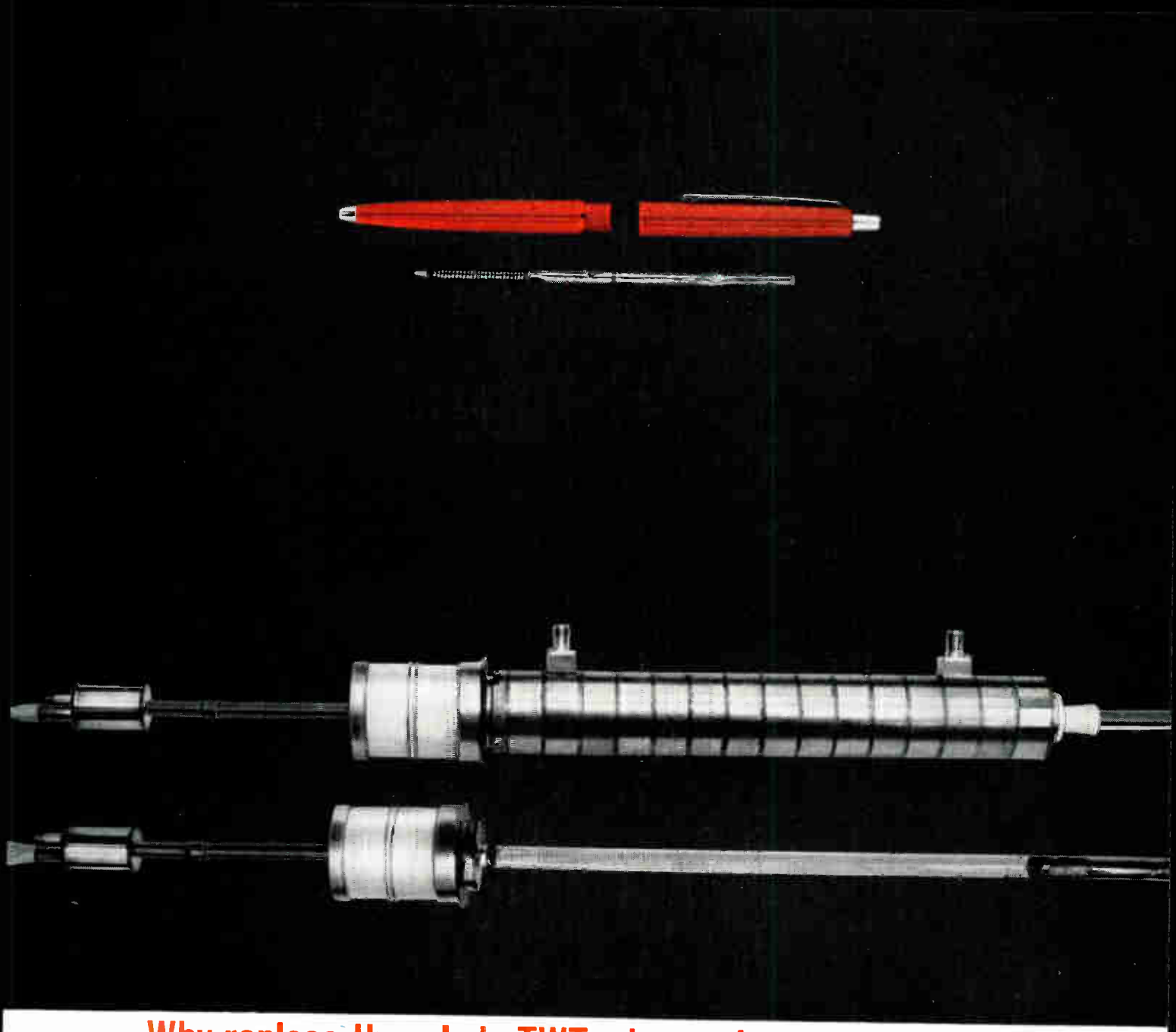
LADDER FILTERS

Provides 80db stop-band rejection in a 0.1 cu. in. package.

These 5 filters are standard models at 455KC center freq. with the following 6db bandwidths: 2, 4, 6, 8, and 10KC. They have a 60db/6db shape factor of between 1.6:1 to 2.5:1. The piezoelectric filters have a peak-to-valley ripple of 1 to 3db max depending on bandwidth, and exhibit a 1db increase from −40°C to +85°C. The units meet Mil. STD 202 B. Piezoelectric Div., Clevite Corp., 232 Forbes Rd., Bedford, Ohio.

Circle 282 on Inquiry Card

World Radio History



Why replace the whole TWT, when only part wears out?

Putting traveling-wave tubes into phased-array transmitters creates special problems. Replacement is expensive —some transmitters may have as many as 10,000 individual tubes, each costing several thousand dollars. Further, all tubes must maintain phase within 6° of the total 10,000° under a variety of operating conditions. Tight manufacturing controls help to do this, but they don't prevent the inevitable variation in performance due to aging.

A new and unique Sylvania approach answers both problems and adds a reliability dividend as well. For phase reproducibility, the new design includes a controller (much like the familiar audio amplifier feedback circuit) which adjusts phase instantly to the desired value. It's small, inexpensive, and even more reliable than the tube itself.

Our new "bottled beam" design is what slashes replacement costs. All of the expensive parts, including the interaction helix, are permanent and are outside the vacuum envelope. Gun and electron beam, however, are enclosed in a glass envelope, and you can replace this "bottled beam" separately. Result: a perfectly good renewed tube for a fraction of a new unit's cost. Tubes last longer, too, because the glass bottle isolates the gun from harmful gases emitted by the microwave structure.

Here is another example of the way Sylvania engineers come up with unconventional approaches when conventional designs don't meet a need. For more information see your Sylvania sales engineer or write to Microwave Device Division, Sylvania Electric Products Inc., Mountain View, California.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

Circle 91 on Inquiry Card

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

World Radio History

CUT BACK-PANEL SPACE REQUIREMENTS UP TO 20%

WITH NEW, RECTANGULAR MINISIG® TRANSISTORIZED INDICATORS

Here's the new shape of indicator miniaturization. In these tiny MINISIG models, the typical 2" extension behind the panel shrinks to about ¾"; at the same time, overall volume is reduced by as much as one-fifth.

Performance, however, is king-size. These are high-gain devices with built-in transistor driver-amplifiers and low-voltage incandescent lamps. They operate directly and brightly from low-voltage signals, yet are a light load on the signal source. Lamp currents stay inside the indicator housing, out of your sensitive logic circuits.

If your needs are highly specialized, chances are EECo's design staff can find a fast, economical answer —an answer backed by the MINISIG record of reliability in hundreds of major systems.

THREE MODELS AVAILABLE

Model R-382: —11V, off; —3V, on.

Model R-481: 0V, off; —6V, on. Features keep-alive current to extend bulb life.

Model R-381: 0V. off; +6V, on.

Back-panel dimensions: ¾" x ¾" x ½"

Lens colors available: red, green, amber, white.

EECo offers you a full line of MINISIG indicators. Choose from neon, filament and thyratron types. Many have adjustable operating characteristics, and will accommodate a broad range of input signal conditions.

Competitive prices, fast delivery. Write today for technical data.

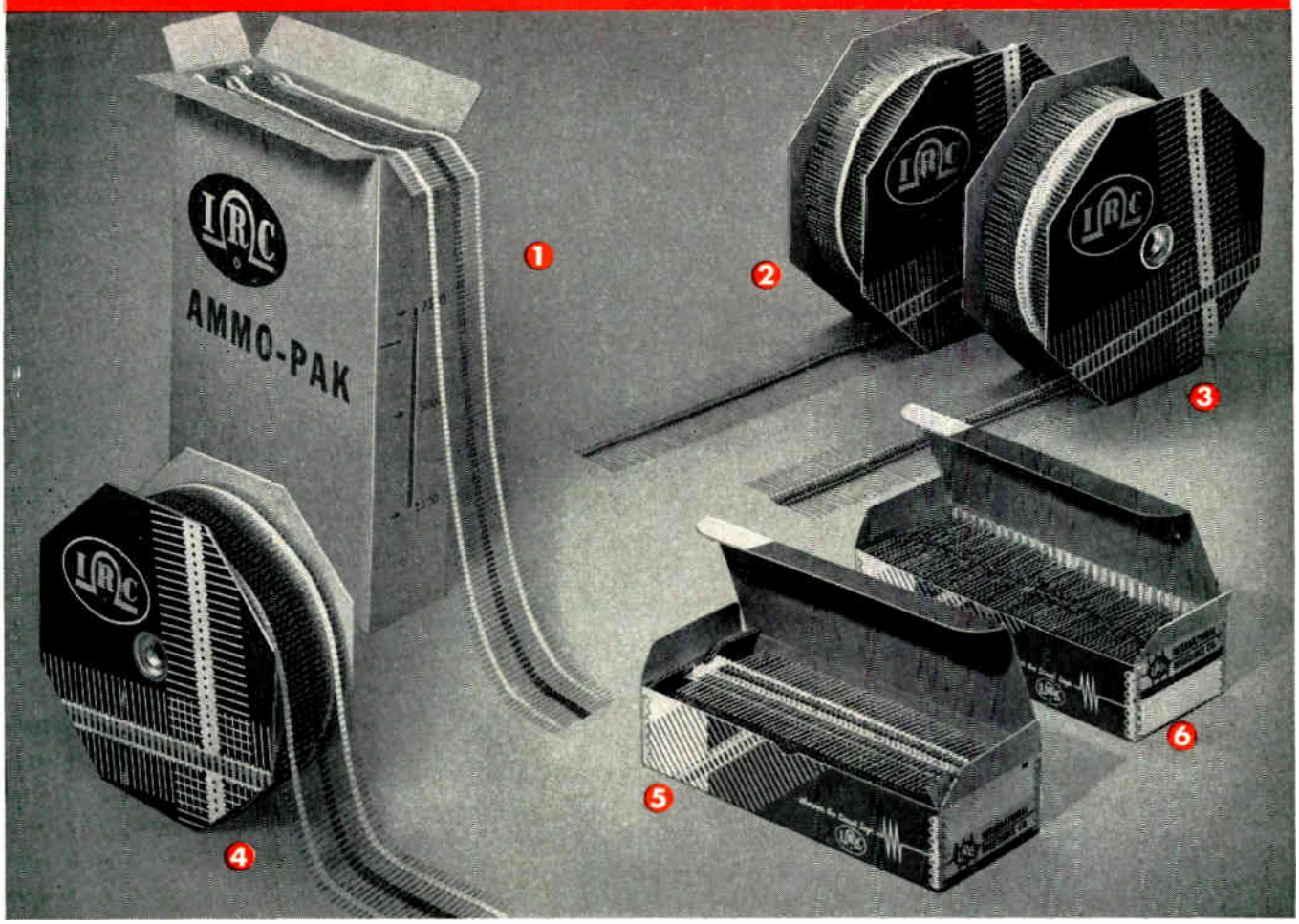
ENGINEERED ELECTRONICS Company

1441 East Chestnut Avenue, Santa Ana, California

Telephone: 547-5651 Cable Address: ENGELEX

World Radio History

In FIXED COMPOSITION RESISTORS : if it's news, expect it first from IRC



Only IRC Fixed Composition Resistors offer

6 WAYS TO CUT ASSEMBLY COSTS

HERE'S WHY . . . IRC MIL-R-11 resistors are available in 6 forms of packaging. Whether you use high speed inserting machines or solder resistors individually, there is a packaging form to simplify your production procedure.

1. AMMO PAK. 10,000 resistors on continuous lead tape.
2. BODY TAPE REEL. Bodies held by pressure sensitive tape.
3. GRIP REEL. IRC exclusive; no adhesive, indexed for automation.
4. LEAD TAPE REEL. Leads held by pressure sensitive tape.
5. GRIP STRIP®. IRC exclusive; no adhesive, spill-proof, easy release.
6. ORIENTED BULK. Neatly oriented resistors with straight leads.

IRC Fixed Composition Resistors offer significant savings in counting, handling, stocking and assembling. Write for Packaging Bulletin. International Resistance Co., Philadelphia 8, Pa.

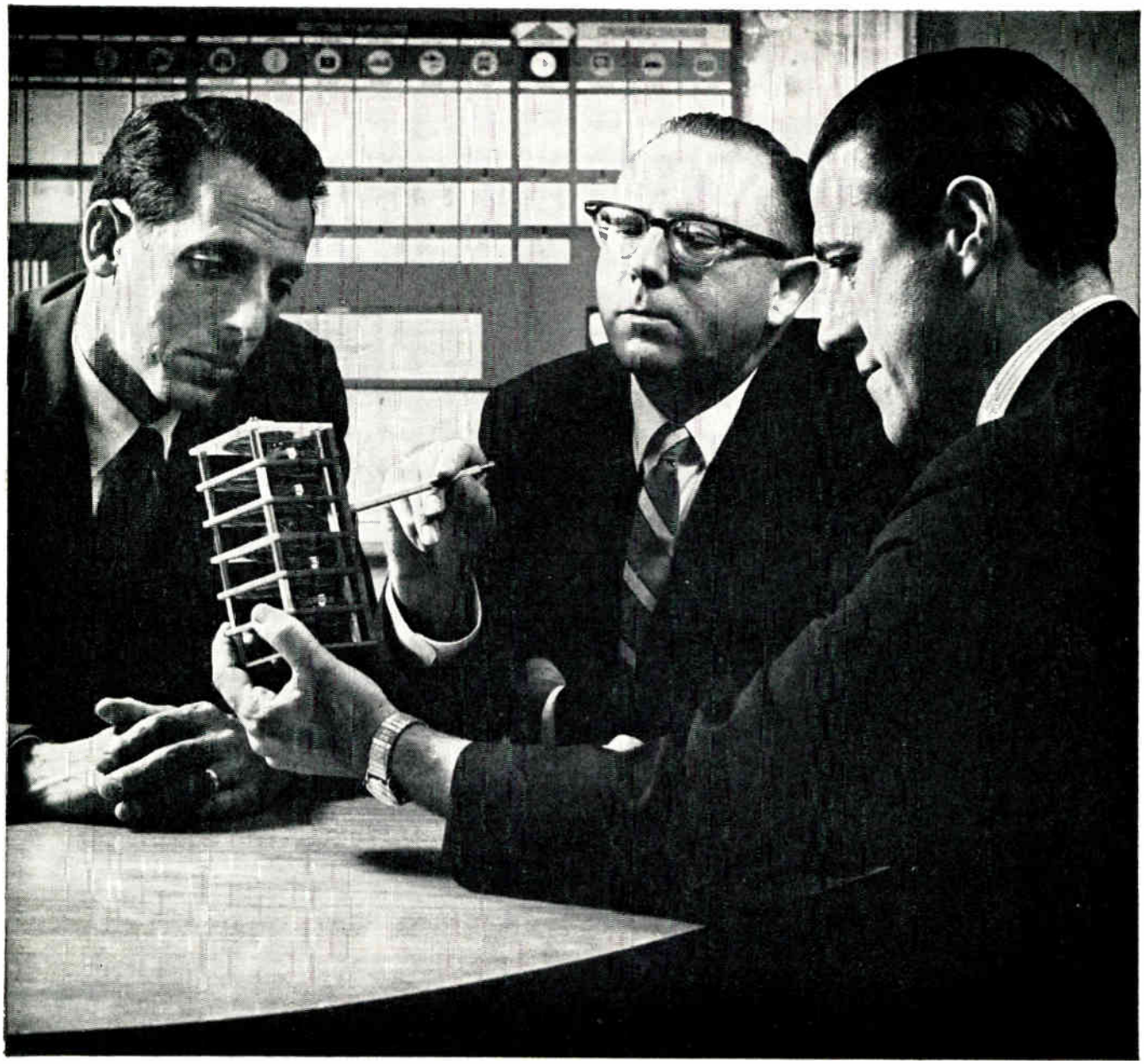
PERFORMANCE ADVANTAGES

IRC Type GBT's also provide

- Ranges to 100,000 megohms
- Superior high frequency characteristics
- Outstanding load life
- Better resistance-temperature characteristics
- Greater moisture protection
- Stronger termination
- Weldable leads

IRC

World Radio History



The 3 most stubborn men in the switch field

Just try lowering a switch standard on Daven's Quality Control Supervisors.

That's when they lower the boom. On the subject of quality control this trio is doggedly stubborn, often downright unreasonable... but oh, so right.

They know darn well that no instrument is more reliable than the switch that controls it. And if that switch bears the name Daven, they are determined to make sure it **never** lets the instrument down.

They have precedent, too. For over 30 years, Daven switches have proven their reliability. No breakdowns. No spec shifts in operation. The reasons: solid silver alloy contacts and wiper arms; patented enclosed "knee-action" silver alloy multi-leaf rotor blades; high-grade, accurately machined dielectric; accurate contact positioning; and switch stops that are independent of switch blades.

There is a Daven precision rotary step-type circuit switch for every instrument, every application.... many available off-the-shelf from your local distributor, others on direct order from the factory.

Write today for your Daven Switch catalog!

DAVEN

LIVINGSTON, NEW JERSEY
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TWX 201 992-7356
Cable: Daven Livingston, N.J.

World Radio History

Saddled Like Sinbad?

Shuck Off High Costs with New Benelex 100A

Sinbad the Sailor kindly gave the Old Man of the Sea a lift—then found himself locked in an unshakable grip. Some electrical laminates are like that—saddling users with a burden of high costs. But not Benelex 100A! This hard, dense electrical laminate provides important cost reductions...reduces production waste and problems. Stands up under years of use. Send for Benelex 100A technical brochure today.

BENELEX 100A

the electrical laminate
a product of
MASONITE CORPORATION

Masonite and Benelex are registered trademarks of Masonite Corporation

What's better about Benelex 100A?

- Self-extinguishing with superior arc resistance compared to phenolic laminates
- Physical and electrical properties are constant and dependable
- Benelex 100A is eligible for use up to 105° C as sole support of current carrying electrical parts where the suitability of the application is determined by Underwriters' Laboratories, Inc.
- Costs much less than phenolic laminates
- Weighs less than competitive, higher priced materials
- Absolutely grainless, without defects, uniform in hardness
- Machines with ordinary woodworking equipment

Masonite Fabricator Service delivers Benelex 100A components made to order in any size, shape or quantity.

Masonite Corporation, Dept. EI-11, BOX 777, Chicago 90, Ill.

Please send me brochure on Benelex 100A

Name_____

Firm_____

Address_____

City_____ State_____

World Radio History

NEW TECH DATA

for Engineers.

Test Equipment

This product handbook describes spectrum analyzers, oscilloscopes, pulse generators, freq. meters, counters, freq. standards, ovens, etc. Each item is accompanied by a photo, description features, and applications. Lavoie Laboratories, Inc., Morganville, N. J.

Circle 187 on Inquiry Card

Microwave Diode

Data sheet CS4B describes this low-level diode which is used where only video amplification is needed. It develops the modulating freq. across a suitable output load. It is self screening to stray r-f energy. Associated Electrical Industries Ltd., Carholme Rd., Lincoln, England.

Circle 188 on Inquiry Card

Magnetron Applications

This 21-page booklet is divided in 7 sections. Chapters include test specs., essential tube information, measurement of system and tubes as a unit, and application notes for testing. The brochure is entitled, "Sylvania Magnetron Application Notes." Sylvania Electric Products, Inc., 1100 Main Street, Buffalo, N. Y.

Circle 189 on Inquiry Card

Capacitor Catalog

This 20-page, full line catalog describes "VY" solid-state porcelain capacitors, "VK" microminiature ceramic capacitors, "V-LAM" and new laminated higher capacitance "VK" capacitors, and labstock kits. Included are complete electrical and environmental specs., typical curves, dimensional drawings and complete parts listing. Vitramon, Inc., P. O. Box 544, Bridgeport, Conn.

Circle 190 on Inquiry Card

Capacitor Bulletin

Bulletin 2423, 24 pages, describes a comprehensive line of paper-dielectric capacitors. Types 40 through 71 and their Mil-C-62 equivalents are included. Detailed engineering and ordering information is given with liberal use of graphs and charts to facilitate use of important data. Sangamo Electric Co., Springfield, Ill.

Circle 191 on Inquiry Card

Ignitron Selection Chart

This chart shows the demand current vs. percent duty rating of all welder ignitrons, size A to E, including the new National Hi-Power Ignitrons. Rating charts are given for 3 voltages: 250, 500, and 600v. The 500v chart occupies the entire front of the sheet, making it easy to read. The 250v and 600v charts are listed on the back of the sheet. Copies of this chart, SB-21, are available from National Electronics, Inc., Geneva, Ill.

Circle 192 on Inquiry Card

Tube Catalog

This 1964 short-form catalog describes a broad line of traveling-wave tubes and backward-wave oscillators from L through Ku band. The tubes are low, medium, and high power, gridded and ungridded. Hughes Microwave Tube Div., 11105 S. La Cienega Blvd., Los Angeles 45, Calif.

Circle 193 on Inquiry Card

Circulator and Isolator

Catalog Sheet 4 describes this 3-port coaxial ferrite circulator which is mechanically tunable from 750MC to 1GC. A calibrated dial permits tuning within seconds. Micromega Corp., 4134 Del Rey Ave., Venice, Calif.

Circle 194 on Inquiry Card

Test Equipment Catalog

Short-form catalog 63 lists high-voltage test equipment such as dielectric testers, corona test equipment, cable fault locators, automated test sets, etc. Also listed are power packs, high-voltage kits and components. Catalog is illustrated. Peschel Instruments Inc., Route 216, Towners, Patterson, N. Y.

Circle 195 on Inquiry Card

Conductor Material

Bulletin 100 gives complete specs. on a new line of conductors containing Alloy HFL, a highly improved material combining the desirable properties of high flex life and tensile strength, while eliminating the undesirable characteristics of variability, temp. effect and partial failure. Unlike stainless-steel reinforced conductors which gradually lose their copper strands during flexing, Alloy HFL conductors allow complete conductivity throughout the life of the wire. Tensolite Insulated Wire Co., Inc., W. Main St., Tarrytown, N. Y.

Circle 196 on Inquiry Card

Voltmeter

Model 8001 and 8002 voltmeters are built to Mil-T-21200. The standard configurations operate from 115v.-400CPS power. The high-impedance unit has a 3% accuracy. Information available from American Avionics, Inc., div of Astro-Science Corp., 2028-2832 Stoner Ave., Los Angeles 25, Calif.

Circle 197 on Inquiry Card

Heat Treating Furnace

This bulletin describes and illustrates the gas-fired wide-range furnace. It can be used for batch annealing, pack carburizing, hardening, normalizing, preheating, stress relieving and tempering from 300 to 2400°F. Specs. are given for 3 pre-engineered standard sizes. Sunbeam Equipment Corp., Meadville, Pa.

Circle 198 on Inquiry Card

Chart and Catalog

Catalog 5801 contains photos, specs., and descriptions on a line of waveguide seals. In addition, a waveguide conversion wall chart is included. Parker Seal Co., Culver City, Calif.

Circle 199 on Inquiry Card

Tube Catalog

This 20-page catalog contains photos and descriptions on a complete line of tubing. Included is the new Coaxitube, a semi-rigid metal shielded wire and coaxial cable. Request on company letterhead to Precision Tube Co., Church Rd. & Wissahickon Ave., North Wales, Pa.

Variable Attenuator

Model 757 series of solid-state voltage variable attenuators solves the problem of remote control r-f level over broad freq. bands. The constant impedance device provides attenuation to 10db/stage. Control voltage range as low as 0 to 0.75v. Additional data available from Primier Microwave Corp., 33 New Broad St., Port Chester, N. Y.

Circle 201 on Inquiry Card

Frequency Meter

The Model 738A is a solid-state digital freq. meter designed for direct measurement and display of freqs. from 10CPS to 100MC. With the addition of the Model 735A plug-in heterodyne converter, the range is extended to 500MC. Readout (in-line): 7 digits in KC. Automatic decimal point accuracy ±1 count, ± oscillator accuracy. Additional information available from Computer Measurements Co., 12970 Bradley Ave., San Fernando, Calif.

Circle 202 on Inquiry Card

Conductive Coating

A silicone conductive coating, E-Kote 3027, is intended for electromagnetic shielding and soldering uses which require continuous operating temps. of 600°F. It fills the temp. gap between epoxy-base conductives and fired-on coatings. After curing, it will withstand operating temps. of 600°F and cycling up to 1000°F. Additional data from Epoxy Products Inc., 133 Coit St., Irvington, N. J.

Circle 203 on Inquiry Card

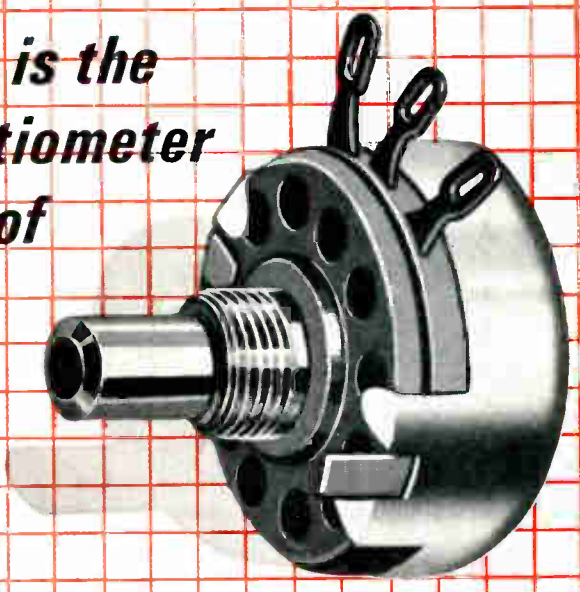
Wave Absorbers

This line of electromagnetic wave absorbers are for use at freq. as high as 35GC down to 50, 600, 940, 2400, and 2500MC. Complete electrical characteristics are included in this catalog, along with a description of antenna test chambers. Electronic Components Div., McMillan Industrial Corp., Brownville Ave., Ipswich, Mass.

Circle 204 on Inquiry Card

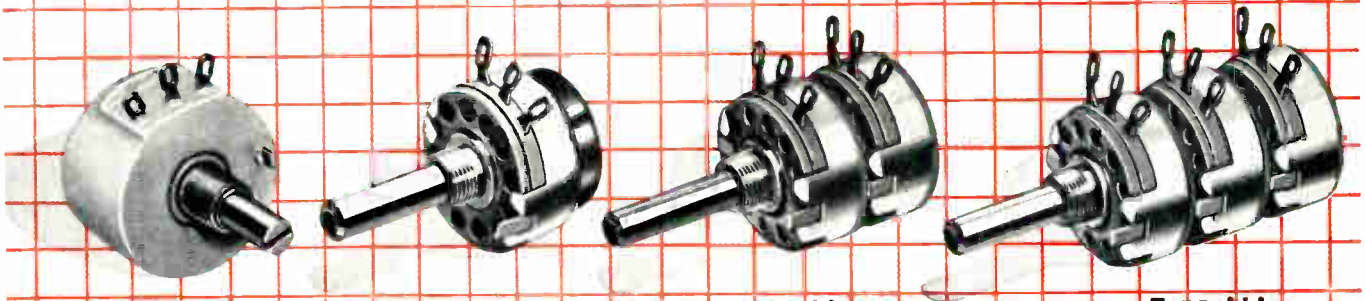
World Radio History

Allen-Bradley's Type J is the only hot molded Potentiometer with a 25-year record of unfailing service



(Shown twice actual size)

Type J controls are rated 2.25 watts at 70°C and are available in special as well as standard tapers ... and in standard total resistance values up to 5 megohms. Higher resistance values and various mechanical variations can also be furnished to fit your special requirements.



Type J (encapsulated) | Type JS | Type JJ | Type JJJ

■ Over "25 years" much can go wrong—but no A-B hot molded potentiometer has failed in service to date. And, the A-B potentiometers of today are superior to those built 25 years ago, because continuing improvements have been made over the years to make sure the Type J has no equal for performance.

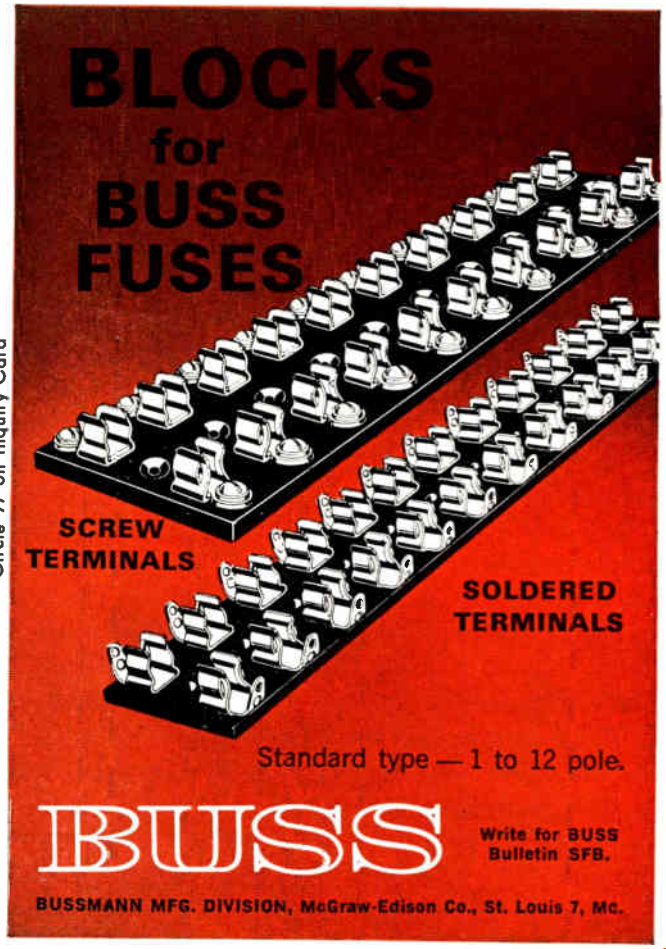
Today, the Type J hot molded potentiometers can claim: Longest life, yet high wattage rating in a compact structure; stability under the most demanding conditions; extremely low noise level; smooth, stepless control.

And here are the reasons: Type J solid resistance element made by A-B's exclusive hot molding process; and A-B's production control of resistance-rotation characteristics. These reasons account for the fact that the Type J potentiometer provides consistently uniform characteristics . . . that the Type J assures complete freedom from catastrophic failures . . . that the Type J eliminates the incremental steps of wire-wound units, and provides the freedom from inductance which insures excellent high frequency response.

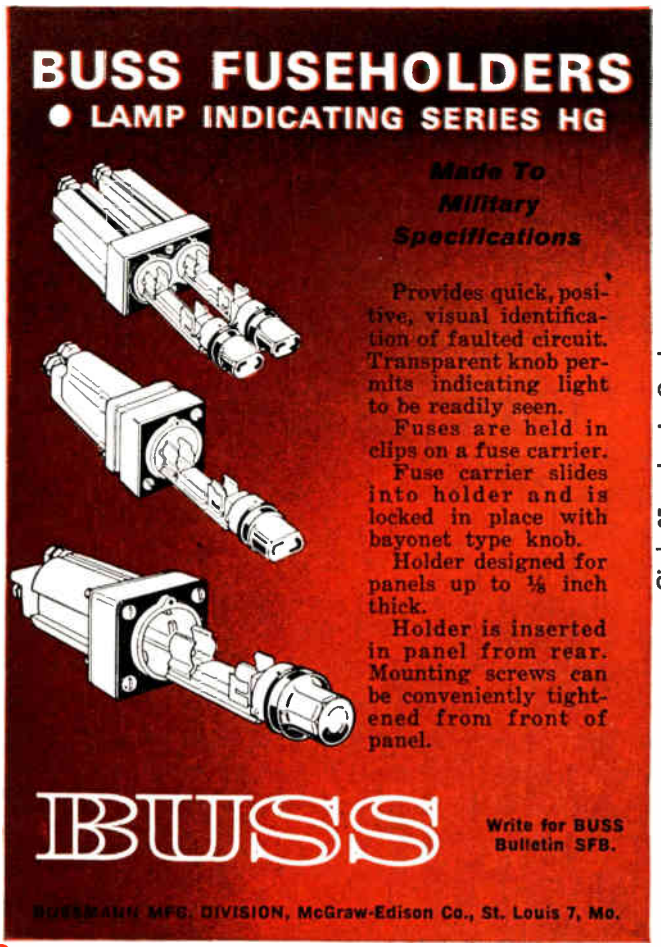
For full details on Type J potentiometers, write for Publication 5200, please: Allen-Bradley Co., 102 West Greenfield Ave., Milwaukee 4, Wisconsin. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

QUALITY ELECTRONIC COMPONENTS | **ALLEN-BRADLEY**

World Radio History



Circle 97 on Inquiry Card



Circle 97 on Inquiry Card

BUSS : the complete line of fuses .

NEW TECH DATA

Reliability Factors

"Reliability Factors Affecting the Selection of Mylar-Paper Dipped, Paper Dipped, or Mylar Dipped Capacitors," 40 pages, should be invaluable to design engineers. Graphs and equations are included. The Electro Motive Mfg. Co., Inc., Willimantic, Conn.

Circle 213 on Inquiry Card

Switches

Catalog D, 28 pages, lists complete catalog data and specs. on a variety of switches. Included are aircraft, electronic, and military types. Carling Electric Co., Inc., 505 New Park Ave., W. Hartford, Conn.

Circle 214 on Inquiry Card

Components and Instruments

This 31-page catalog describes a line of microwave components and instruments. Some of the components described are: TWTs, sweep oscillators, portable TWT amplifiers, solenoid power supplies, nsec. pulse generators, Uniline load isolators, and ferrite circulators. Photos and specs. accompany the description. Huggins Laboratories, Inc., 999 E. Arques Ave., Sunnyvale, Calif.

Circle 215 on Inquiry Card

Portable D-C Bridges

Data Sheet E53(14) fully describes both compact and precision designs—4288 and 4287 D-C Kelvin Bridges: 4283 and 4289 D-C Wheatstone Bridges: and 8017 and 8064 D-C Resistance Thermometer Bridges. These 6 bridges cover a wide range of resistance values. Fully illustrated, the data sheet contains complete descriptions, uses, and design features. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44, Pa.

Circle 216 on Inquiry Card

Plastics Fabrication

"Laminated Plastics Parts . . . Make or Buy?" is the subject of a brochure issued by Synthane Corp., Oaks, Pa. Designed to answer questions by users of laminated plastics parts on whether to buy or make them, the brochure points out several factors which must be considered in determining fabricating operations.

Circle 217 on Inquiry Card

Gas Lasers

A brochure from Spectra-Physics, 1255 Terra Bella Ave., Mountain View 10, Calif. describes a line of helium-neon gas lasers. Data includes photos, specs. and descriptions.

Circle 218 on Inquiry Card

Coated Glass Tubing

An epoxy-coated glass tubing rated for continuous use at Class-F (155°C) is described in this brochure. Uses for the electrical tubing range from Class-F motor, transformer and epoxy-encapsulated units to use in aerospace equipment. Called "Irvington" brand epoxy-coated glass tubing No. 450, it has the electrical, physical and thermal capabilities for continuous operation between Class-B (130° C) and Class-H (180°C) temps. Thermal life expectancy is more than 40,000 hrs. at 155°C. Electric Strength at 155°C is 4000v. (min. individual). Irvington Div., 3M Co., Dept. W3-478, 2501 Hudson Rd., St. Paul 19, Minn.

Circle 219 on Inquiry Card

Coaxial Circulators

Data is available on broadband circulators that cover as much as 35% bandwidths in the UHF region between 250 and 1000MC. Three models are described: Model U120LYC covers the freq. range of 375 to 550MC with isolation of 20db min., insertion loss of 0.5db max., and a VSWR of 1.25 max. The other 2 models cover the 500 to 650MC range and the 700 to 1000MC range. Insertion loss for both is 0.5db. E & M Laboratories, 15145 Califa St., Van Nuys, Calif.

Circle 220 on Inquiry Card

World Radio History

NEW TECH DATA

Cooling Panel Brochure

Brochure RF-300 covers the design parameters to be considered in the dual problem of RFI shielding with forced air-cooling, including both electrical and mechanical aspects. A variety of mounting methods, product specs., RFI control rating, forms available, material specs., and ordering instructions are included. Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J.

Circle 205 on Inquiry Card

Printing Converter

Bulletin 2144 describes the Datascribe™ Model 4400, an analog-to-digital converter with printed readout. The unit takes any slowly-changing millivolt signal, converts it to a binary decimal code, and prints the desired terms. Research Specialties Co., 200 S. Garrard Blvd., Richmond, Calif.

Circle 206 on Inquiry Card

Plugs, Jacks, Panels

This colorful catalog presents photos, specs. and descriptions for a line of telephone plugs, jacks, and panels. Tables list military type, description, cable size, engineering data, dielectric material. Ken-Tron Corp., 395 Lynnway, Lynn, Mass.

Circle 207 on Inquiry Card

Breadboarding Brochure

Catalog 3023 details Facilogic® concept of digital logic modules (250KC and 5MC) for breadboarding, proposal preparation, systems design and checkout, and final production. Data includes comprehensive specs., and photos of the K-6000 Starter Kit and K-6001 Laboratory Kit. A complete list of flip-flops, clock multivibrators, quadruple complementary emitter followers, dual Schmidt triggers, Nixie indicator assembly, and dual-pulse gates is also included with diagrams, specs., and prices. Data Systems Div., Harman-Kardon, Inc., 55 Ames Court, Plainview, L. I., N. Y.

Circle 208 on Inquiry Card

UHF Capacitors

These UHF capacitors are offered in 5 standoff styles and 2 ribbon lead styles. Each of these styles is available in 13 different ceramic bodies. Style S-1 is a sq.-base standoff and Style S-4 is hexagonal base standoff. The standoff capacitors are epoxy coated and are obtained in any specific value up to a max. capacitance of 17,000pf. Ribbon lead units are available in sizes and specs. similar to Mucon's "thinline" series. Mucon Corp., Dept. M-5, 9 St. Francis St., Newark, N. J.

Circle 209 on Inquiry Card

Thermocouple Gage

This portable vacuum gage operates by measuring the heat conductivity of any gas remaining in evacuating system. This portable gage is dc operated. It can be used in conjunction with a vacuum pump operating on either 110 or 220v. Micron range is from 1000-0. Robinair Mfg. Corp., 1224 So. East Ave., Montpelier, Ohio.

Circle 210 on Inquiry Card

Power Amplifier

This brochure describes Type 621A, 600-kw peak envelope power high-freq. electronic amplifier. Used in the World Spanner transmitter and other SSB and pulse output modes. Continental Electronics, P. O. Box 5024, Dallas 22, Tex.

Circle 211 on Inquiry Card

Digital Voltmeter

A bulletin describing the model 2660 digital voltmeter with 1μv/digit sensitivity and 5-digit readout is available from Houston Instrument Corp., 4950 Terminal Ave., Bellaire 101, Tex. The 2660 is an automatic precision DVM for the measurement of dc voltages from 1μv to 1000v, in 6 ranges.

Circle 212 on Inquiry Card

..... of unquestioned high quality

BUSS FUSEHOLDERS

- LAMP INDICATING
- SIGNAL ACTIVATING
- SERIES HKA

For ¼ x 1¼ inch BUSS GLD Fuses, ¼ to 5 amps.

Where a visible or audible signal or both is desired to indicate trouble on a circuit, the BUSS HKA fuseholder with BUSS GLD fuses presents a practical answer.

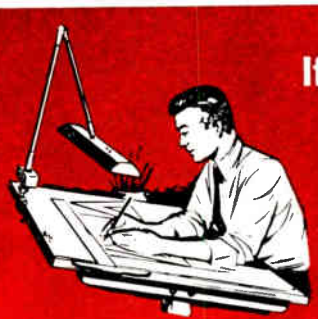
When fuse opens, an indicating pin completes a circuit that lights knob indicating lamp and makes electrical contact on external signal circuit. The external signal can be an audible alarm, or another lamp mounted at a distance, or it can operate a relay.

BUSS

Write for BUSS Bulletin SFB.

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 97 on Inquiry Card



If you should have a special problem in electrical protection...

. . . we welcome your request either to quote or to help in selecting the type of fuse or fuse mounting best suited to your particular conditions.

Submit description or sketch, showing type of fuse to be used, number of circuits, type of terminal, etc. If your protection problem is still in the engineering state, tell us current, voltage, load characteristics, etc. Be sure to get the latest information BEFORE final design is crystallized.

At any time our staff of fuse engineers is at your service to help solve your problems in electrical protection and save you engineering time.

BUSS

Just call or write:

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis 7, Mo.

Circle 97 on Inquiry Card

World Radio History

Reeves

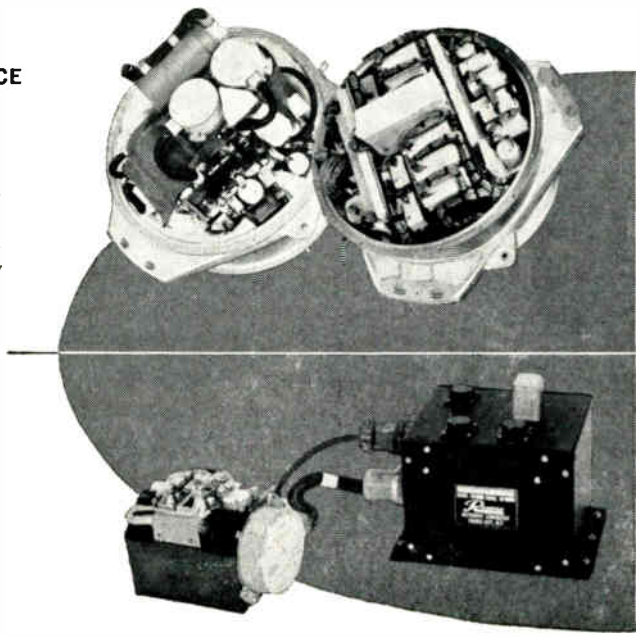
modular strap-down gyro packages

FOR GUIDANCE . . . STABILIZATION . . . CONTROL

Operational . . . producible . . . with reliabilities and performance fully demonstrated in current satellite and aircraft programs. The following four representative types indicate the scope and experience of design, engineering, and production capabilities immediately available to aid in your advanced projects. Write for Data File 311.

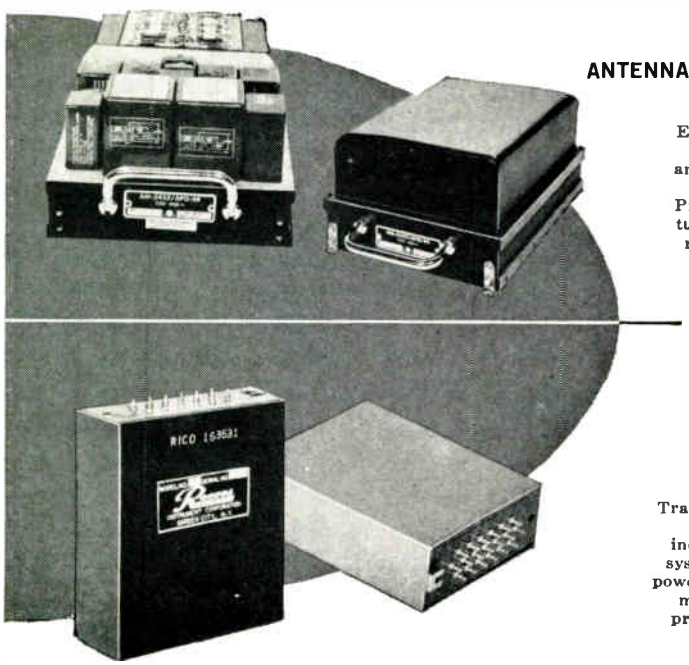
THREE AXIS SATELLITE INERTIAL REFERENCE PACKAGE:

Three single-axis floated gyros and two accelerometers, with loops employing seven voltage and five power amplifiers. Current regulator and heater relay amplifiers. Amplifiers fully transistorized, individually encapsulated.



SINGLE CHANNEL SATELLITE STABILIZATION SYSTEM:

Utilizes Reeves D30S gyro, with trimmed drift rate of 0.1°/ hr. Gyro loop incorporates voltage amplifier, demodulator, and d.c. power amplifier for gyro d.c. torque motor. Proportional temperature control amplifier regulates temperature.



TWO CHANNEL ANTENNA STABILIZATION SYSTEM:

Each loop comprises a Reeves HIG-4 gyro and a voltage amplifier and power amplifier. Proportional temperature control amplifiers regulate temperature to ±0.5 degrees for each gyro.

MODULAR AMPLIFIER COMPONENTS:

Transistorized, encapsulated units, readily incorporated into any system for voltage and power amplification: demodulation, and high precision temperature control.

REEVES INSTRUMENT COMPANY

Division of Dynamics Corporation of America, Roosevelt Field, Garden City, N.Y.

NEW TECH DATA

Components

Electrical and physical specs. for a wide range of coaxial components and semiconductor devices are given in this 12-page catalog. Over 200 items are listed. Included among the standard products are terminations, attenuators, phase shifters, tuners and semiconductor switches. Engelmann Microwave Co., 1259 U. S. Highway 46, Parsippany, N. J.

Circle 221 on Inquiry Card

Tubes and Components

This completely illustrated brochure pictures and describes pump tubes for parametric amplifiers, TWTs for general and pulse amplifier use, klystrons for communication, CW, and pulse doppler radar, crossed-field tubes, solid-state products, and other microwave devices. Features and characteristics are given. Varian Assoc., Palo Alto, Calif.

Circle 222 on Inquiry Card

Instruments and Accessories

This brochure contains descriptions and specs. for wideband amplifiers, voltmeters, probes, adapters and filters. The Model 104 Wideband Amplifier has selectable gains of 1, 10 and 100 into 50Ω. Response from 25CPS to 150MC. The Model 120R peak-reading voltmeter is accurate to ±2% from 20CPS to 50MC. It has 12 full-scale voltage ranges from 1mv to 300v. Two new r-f probes are given: Model 1202 10:1 probe with input impedance of 10 megohms, 8pf; and Model 1203 10:1 with input capacitance of 5pf. Keithley Instruments, 12415 Euclid Ave., Cleveland 6, Ohio.

Circle 223 on Inquiry Card

Matrix Design Data

This high-density matrix provides random access interconnection and is particularly suited for missile checkout and data-logging equipment. The matrix consists of a laminated sandwich of circuits and provides pair connections between any input or output by inserting a single connector pin. Connections are made in pairs, thus making the unit suitable for use in communications, telemetering, and control applications. Additional data contained in a bulletin from Sylvania Electric Products, Inc., Waltham, Mass.

Circle 224 on Inquiry Card

Logic Cards Catalog

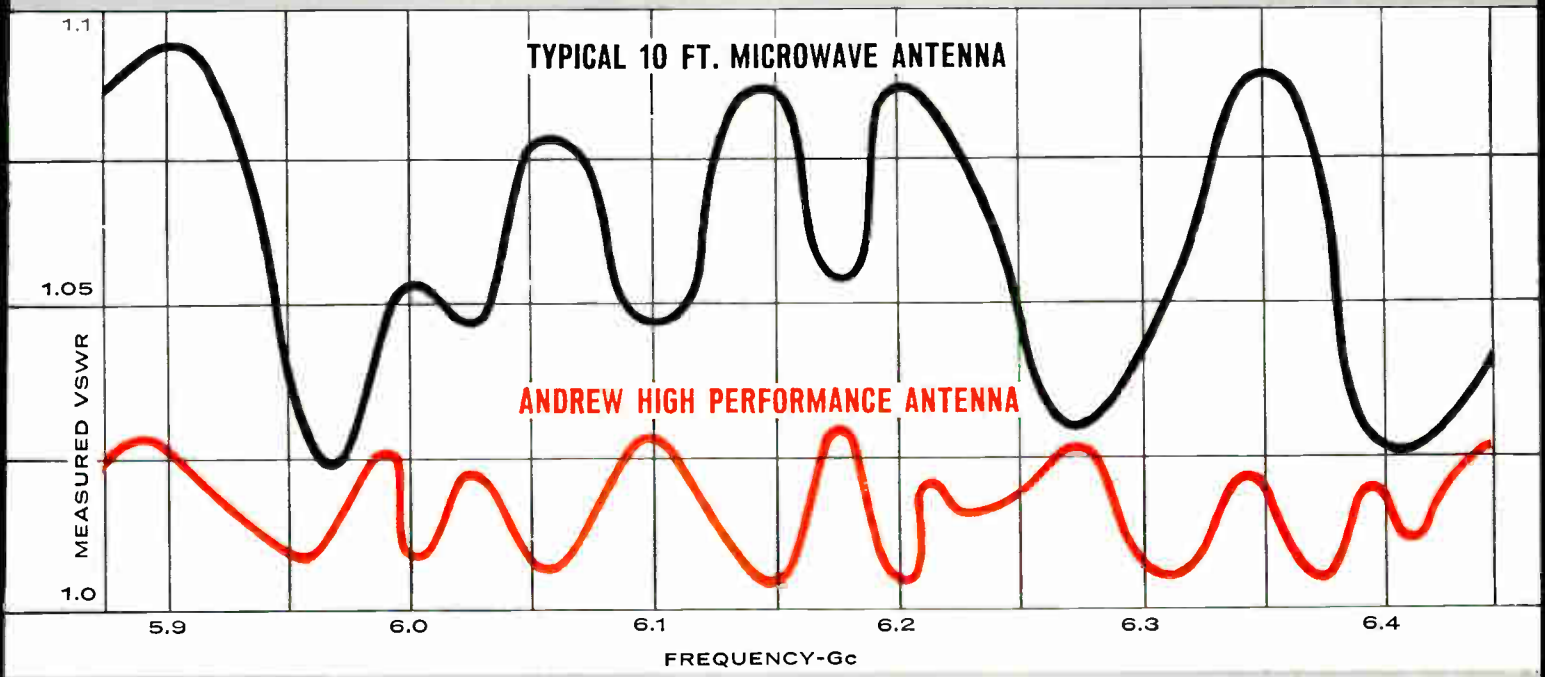
A comprehensive line of NAND logic cards, operating at clock rates of 3MC and 10MC, are described in this 28-page catalog. Included are specs., application and price data on logic elements for use in high-density, rack-mounted trays and rack-mounted chassis. Intercontinental Instruments Inc., 123 Gazza Blvd., Farmingdale, L. I., N. Y.

Circle 225 on Inquiry Card

World Radio History

ANTENNA PERFORMANCE

IN A CLASS BY ITSELF



COMPOSITE E & H PLANE PATTERN

NEW high performance Microwave Antenna

5925-8250 Mc

The certification of each individual antenna in this line is your assurance of high performance with low VSWR. Specially designed for signal congested areas, the Andrew High Performance Microwave Antenna is shielded to reduce the wide angle lobes and to increase the front to back ratio. A reinforced back frame provides an extremely stable system and keeps the antenna pointed on the path after installation. New radomes, engineered specifically for high performance characteristics, maintain gain efficiency of basic antenna. Write or call your Andrew sales engineer for complete information.

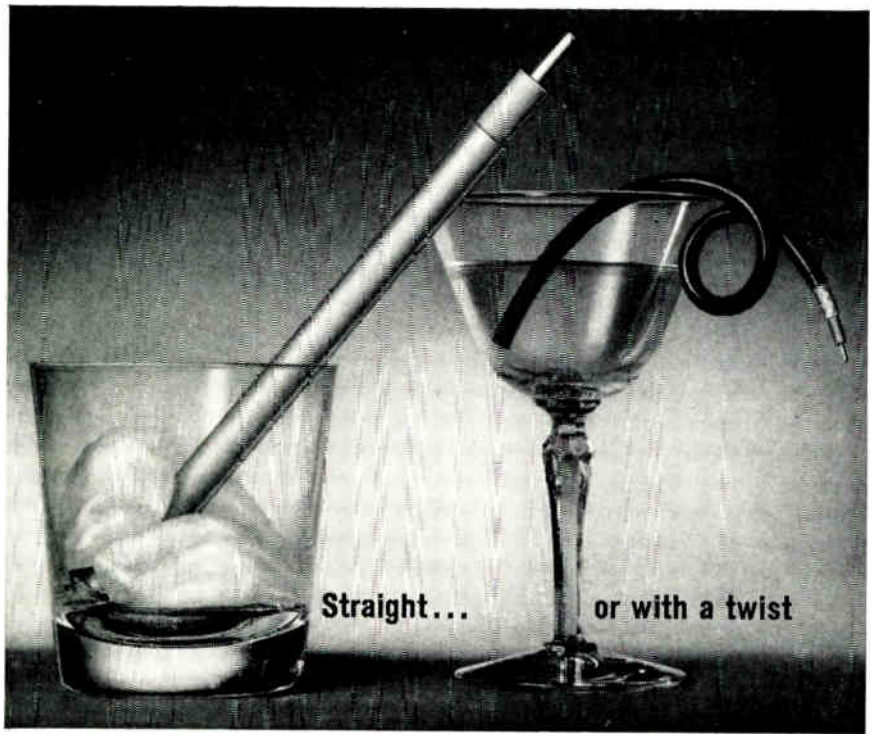
Andrew

P.O. BOX 807, CHICAGO 42, ILLINOIS

BOSTON
NEW YORK
WASHINGTON, D. C.
LOS ANGELES
TORONTO

Circle 101 on Inquiry Card

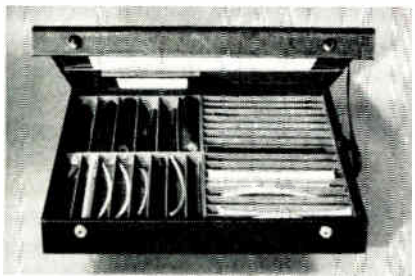
World Radio History



(We can serve you with both!)

Because we engineer and manufacture the most complete line of high frequency cable available in this country, we are in the unique position of being able to offer highly competitive prices and delivery on all your semi-flexible (aluminum and copper tube sheath) coaxial cable, your flexible coaxial cable and triaxial cable requirements. One source for all cable. Let us prove it. Put Times on your bidders list.

Times specializes in transmission system analysis, and offers comprehensive experience in impedance (VSWR) attenuation, electrical and crosstalk problems. And, as always, Times will manufacture cable and assemblies to your precise electrical requirements, including cutting to precise electrical length.



HAVE YOU SEEN THE NEW CABLE-KIT?

Since we have produced virtually every type of standard coaxial cable (over 300) plus thousands of special coaxial and multi-conductor cables, Times has put together this one-of-a-kind kit, which enables you to see, at a glance, samples of the types of cables we design and produce. It's probable that you may find in it a cable already produced that will meet your exact needs, or be able to select composite construction for a new requirement.

For transmission with critical requirements of attenuation, or attenuation and impedance uniformity, crosstalk or electrical length (phase), we suggest one of the following semi-flexible cable constructions:

● ALUMIFOAM-low loss, 30% better than RG solid dielectric coaxial cable. Aluminum sheath. foamed polyethylene dielectric (50 & 75 ohm).

● ALUMIFIL-low loss, 40% better than RG solid dielectric. Helical filament dielectric (50 & 75 ohm) coaxial cable.

● ALUMISPLINE-lowest loss and best electrical characteristics, 45% better than RG solid dielectric. Splined dielectric (50 & 70 ohm) coaxial cable.

● ALUMISOL-excellent electrical length vs. temperature and uniformity characteristics — better than RG solid dielectric coaxial cable (50 & 75 ohm).

TIMES WIRE AND CABLE
Division of The International Silver Company
Wallingford, Connecticut

Dept. EI-311

I am interested in receiving technical data on:
☐ Semi-flexible coaxial cable
☐ Flexible coaxial cable
☐ I am interested in seeing the Cable-Kit demonstration—have salesmen call:

telephone _____

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

TRANSMISSION SYSTEM DESIGN AND ENGINEERING • STANDARD & SPECIAL PURPOSE COAXIAL CABLE • MULTICONDUCTOR CABLE • COMPLETE CABLE ASSEMBLIES • TEFLON® HOOK-UP WIRE
® A DuPont Trademark

NEW TECH DATA

Planar Report

A brochure describing the state-of-the-art of the planar process is available from Fairchild Semiconductor, div. of Fairchild Camera & Instrument Corp., Syosset, N. Y. The brochure, titled, "Fairchild Planar Progress Report," discusses the evolution of silicon planar transistors and technology from 1960 to present, including the development of integrated silicon planar microelectronic circuits.

Circle 226 on Inquiry Card

Navigation System

This brochure describes the N16M miniature inertial navigation system which meets the navigational requirements for surface ships and submarines. The system offers advantages of light weight, compact size, high reliability, ruggedness, and simplified maintenance and operator requirements. Its modular construction assures adaptability. Autonetics, div. of North American Aviation, Inc., Anaheim, Calif.

Circle 227 on Inquiry Card

Signal Source

This microwave instrument offers the spectral purity of a precision crystal oscillator and sufficient output power to be used as a local oscillator or signal source from 2 to 12Gc. The freq. stability specs. are 1 part in 10^9/msec., 4 parts in 10^{10}/100msec., and 1 part in 10^8/day. The instrument is coarse-tuned by a single knob to the desired freq. Curry, McLaughlin & Len, Inc., Packard Bldg., E. Mallory Rd., Syracuse, N. Y.

Circle 228 on Inquiry Card

Resistor Catalog

This catalog shows a complete line of precision wirewound resistors and resistor networks. Design engineers will be particularly interested in the miniaturized, printed-circuit resistors for high-density packaging, and the series RT, a new line of fast-rise time resistors—ideal for computer, data processing, process control and related systems. Comparable military part numbers are also a part of the catalog. Kelvin Sales Co., 5919 Noble Ave., Van Nuys, Calif.

Circle 229 on Inquiry Card

Delay Module

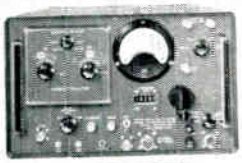
Data sheet DT-5 describes this unity gain, digital-delay module. A digital write-read amplifier is combined with a magnetostrictive delay line, resulting in a complete input-output module for delays to 2000μsec. The write amplifier drives the delay line; the read amplifier amplifies the delay-line output and restores the input-pulse waveform to the input power level, resulting in unity gain. The addition of a feedback loop makes possible a complete recirculating system for data storage. Deltime Inc., 608 Fayette Ave., Mamaroneck, N. Y.

Circle 230 on Inquiry Card

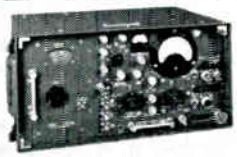
World Radio History

MICROWAVE INSTRUMENTATION

RFI METERS • 20 CPS to 15,000 MC



NF-315



NF-105

Interference measurements to government and commercial specifications over this entire frequency range with only three basic instruments.

Model NF-315: 20 CPS to 15 KC
Models NF-105 and NF 205: 14 KC to 1000 MC
Model NF-112: 1000 MC to 15,000 MC

Model NF-105/M-126: For increased sensitivity to —126 DBM
Model NF-157: For broadband power density measurements, 200 to 10,000 MC

NF-112

MICROWAVE SIGNAL GENERATORS • 900 to 11,000 MC

SG-12

Four models of uniform design: digital frequency display; ruggedized construction; optimum flexibility.

Model SG-11: 900-2200 MC
Model SG-12: 1800-4400 MC
Model SG-13: 3800-7600 MC
Model SG-14: 7000-11,000 MC

OTHER INSTRUMENTS

IG-118B

Impulse Generators—produce broadband RF spectrum, 14 KC to 10,000 MC.

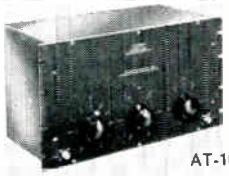
Model IG-115: 14 KC to 1000 MC
Model IG-102: 100 KC to 1000 MC
Model IG-118A & B: 1000 MC to 10,000 MC

AM Modulation Meter Model, MM-120: 15 KC to 1000 MC

Indicates modulation percentage of carrier levels as low as 10 millivolts.

Variable Frequency Power Supplies—47 to 6000 CPS. Low distortion, excellent regulation, quick recovery.
Model VP-410: 400 VA
Model VP-1000: 1000 VA

COAXIAL ATTENUATORS • DC to 10,000 MC



AT-106

A wide variety of configurations consisting of coaxial resistive attenuators in values from zero to 60 DB; individual pads; six and twelve position step attenuators; attenuator panels for even higher resolution; remotely operated attenuators. Average power from 1 to 50 watts. Standard impedance: 50 ohms. Special impedance values.

CRYSTAL MIXERS

BCM-321

Three basic types of broadband crystal mixers; Single-ended Mixers for achieving good noise figure in general applications over the frequency range of 225 to 8200 MC; Balanced Crystal Mixers of the hybrid junction type for frequencies from 250 to 8000 MC, where space is a consideration; Balanced Crystal Mixers of the hybrid ring type for frequencies from 1000 to 5600 MC, for applications where the optimum in local oscillator rejection and noise cancellation is desired.

DIRECTIONAL COUPLERS

DC-10-C

Octave ranges and high directivity from 200 to 8000 MC

Coupling values: 3, 6, 10, 20, and 30 DB

Coupling values: 3, 6, 10, 20, and 30 DB

Frequency ranges: 200— 400 MC, 250— 500 MC, 500—1000 MC, 1000—2000 MC, 2000—4000 MC, 4000—8000 MC

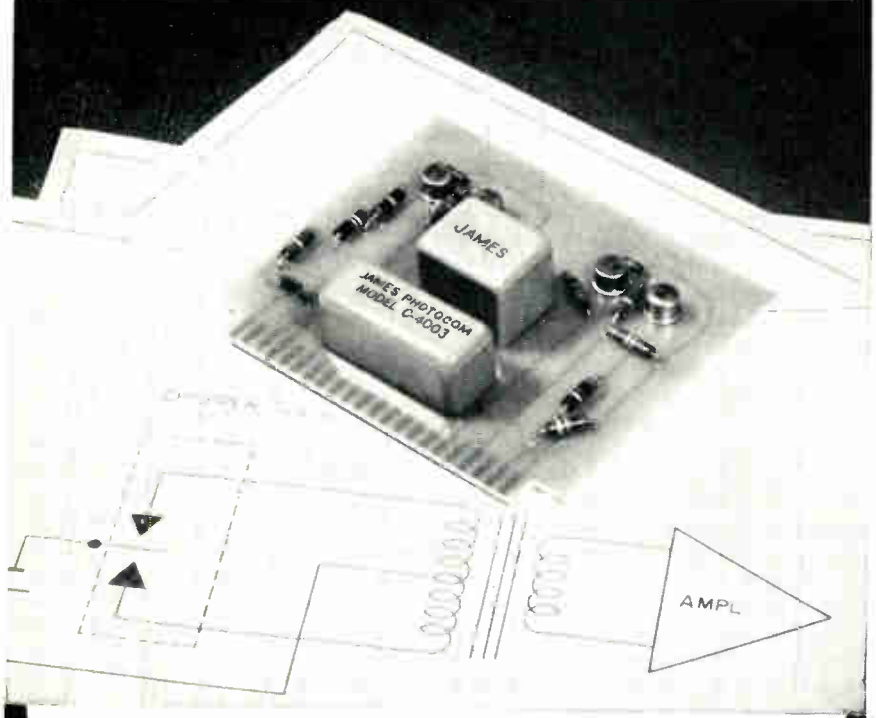
Let us send you our Catalog No. 634

ed EMPIRE DEVICES *Manufactured by*
THE SINGER COMPANY • METRICS DIVISION
915 PEMBROKE ST., BRIDGEPORT, CONN., PHONE (203) 366-3201

World Radio History

JAMES ANNOUNCES State-of-the-Art

BREAKTHROUGH



"Photocom"

SOLID STATE CHOPPER

with less than: 1μv DRIFT (24 HOURS)
3μv NOISE (INTO 1 MEGOHM)

- JAMES ELECTRONICS has achieved a state-of-the art breakthrough with a new solid state chopper incorporating a photosensitive, light actuated element.
- The PHOTOCOM chopper is designed for printed circuit board and 7 pin plug-in mounting. It has wide application in null-seeking servo systems, low-level DC amplifiers, and other industrial and military ground control equipment.
- Three models are available in both lay-down and up-right packages for high, medium, and low impedance applications at frequencies from 1 to 2000 cps.
- Write for the new JAMES PHOTOCOM catalog (F-5186) for complete technical details, specifications, and application data.

MECHANICAL-PHOTO CHOPPERS • MULTIPLEX RELAYS • INSTRUMENT TRANSFORMERS

JAMES®
ELECTRONICS, INC.
4050 North Rockwell • Chicago 18, Illinois • 463-6500

NEW TECH DATA

Power Supply Handbook

A new 40-page reference handbook on regulated power supplies for systems use is available from Kepco, Inc., Flushing, N. Y. Purpose of the publication is to aid the design engineer in making full use of the versatility in many of today's power supplies. Information ranges from basics of how to select a power supply, power supply classifications and glossary of power supply terms, to detailed theoretical discussions on uses of a voltage correcting system.

Circle 231 on Inquiry Card

Display Selector Guide

A handy "Readout Display Selector Guide" contains cut-away diagrams of various modules, showing principles of operation, complete specs. and prices. A complete lamp selection and spec. chart is included. Industrial Electronic Engineers, Inc., 5528 Vineland Ave., N. Hollywood, Calif.

Circle 232 on Inquiry Card

Electrolytic Capacitors

Complete specs. on Type CRE ultra-miniature aluminum cased electrolytic capacitors are contained in Bulletin NPJ-124. Operating temp. range, dc leakage current, working voltage, and surge voltage data, microfarad ratings and sizes are given. Ideal for bypass, filter and coupling applications in low-voltage, compact, and miniaturized equipments. Aerovox Corp., Distribution Div., New Bedford, Mass.

Circle 233 on Inquiry Card

Modules Catalog

Bulletin TC-118 is a 32-page catalog on Tri-Plate® Strip Transmission Line Modules. The catalog lists over 600 modules for use in breadboarding and testing circuit ideas. In addition, it contains freq. ranges, dimension diagrams, and electrical data and prices covering 150 mounts for advanced semiconductors. Sanders Associates, Inc., 95 Canal St., Nashua, N. H.

Circle 234 on Inquiry Card

Semiconductor Dopant

Tech. data describes P_2O_5 (phosphorous pentoxide) dopant for semiconductor processing. Special packaging keeps material inert until needed and reduces hazards of using. Packaging, handling and technical information are included. Nitine, Inc., 45 S. Jefferson Rd., Whippany, N. J.

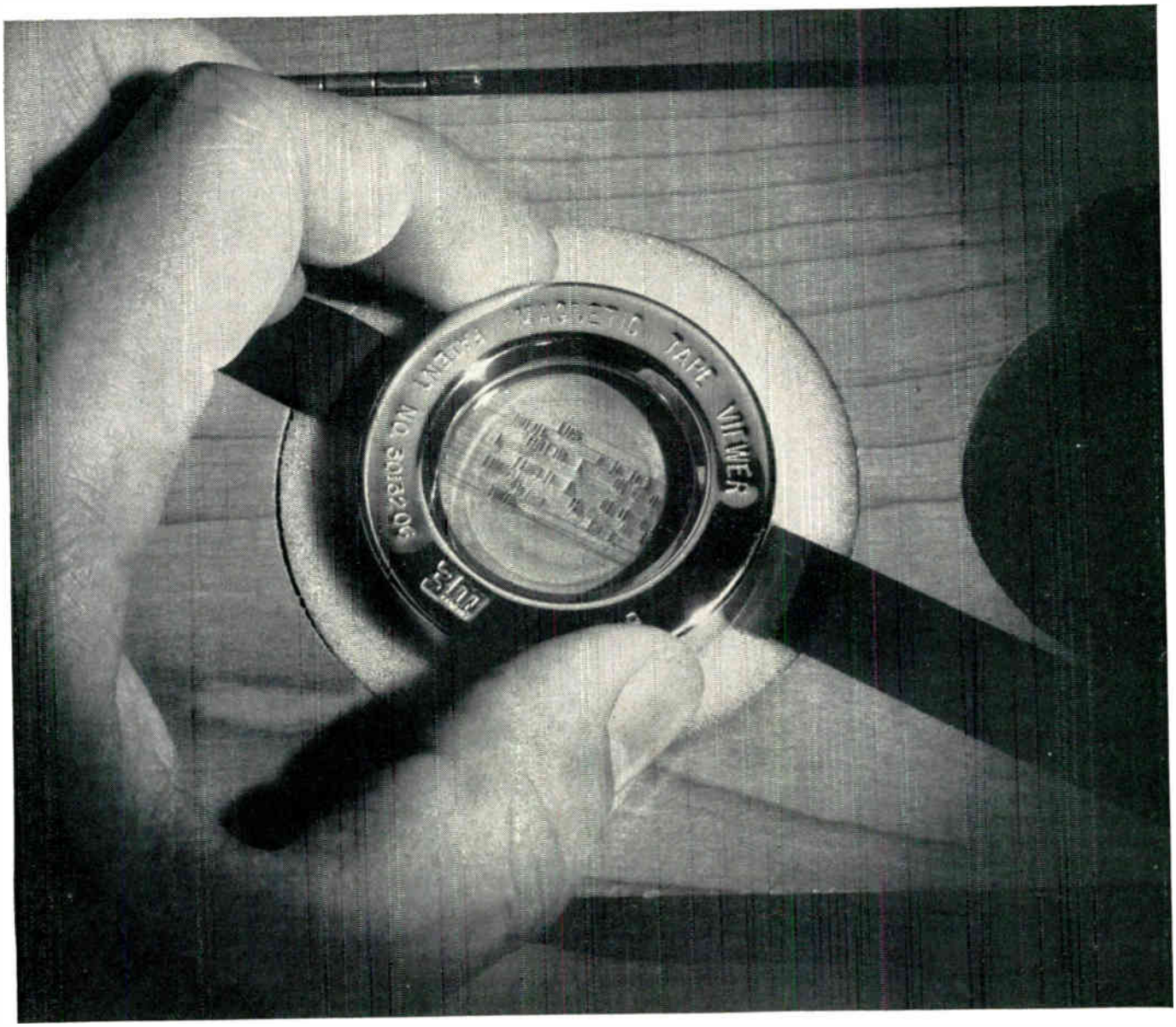
Circle 235 on Inquiry Card

Sealed Connectors

Hermetically-sealed connectors and headers designed for max. resistance to radiation, high temp., thermal shock, and corrosive environments are described in a new bulletin from Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 236 on Inquiry Card

World Radio History



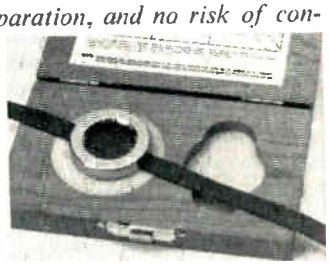
TROUBLE TRACKER...

New magnetic tape viewer lets you actually see recorded signal instantly!

New patented development! Now you can have a fast visual check on digital recordings without damaging tape. The new SCOTCH® BRAND Magnetic Tape Viewer makes recorded signal visible instantly. Tells you whether a tape is recorded or not. Lets you check placement, spacing, and width of tracks. Lets you see pulse definition, interblock spacing, dropout areas. Simplifies making corrective adjustments.

No chemicals, no tape preparation, and no risk of contaminating tape. Just rub viewer to remove any previous image, place tape on viewing pad with oxide coating up, set viewer on tape, tap viewer with finger and watch the image appear.

Viewer also shows the pattern of recorded sound in audible range applications. Even determines whether tools, heads, or guides are magnetized.



"SCOTCH" Magnetic Viewer No. 600, complete with durable wooden case...$50.

"SCOTCH" IS A REGISTERED TRADEMARK OF MINNESOTA MINING & MANUFACTURING CO.. © 1963, 3M CO.

Magnetic Products Division 3M COMPANY
Dept. MBR-113, St. Paul 19, Minnesota

Please give me a demonstration of the "SCOTCH" BRAND Magnetic Tape Viewer.

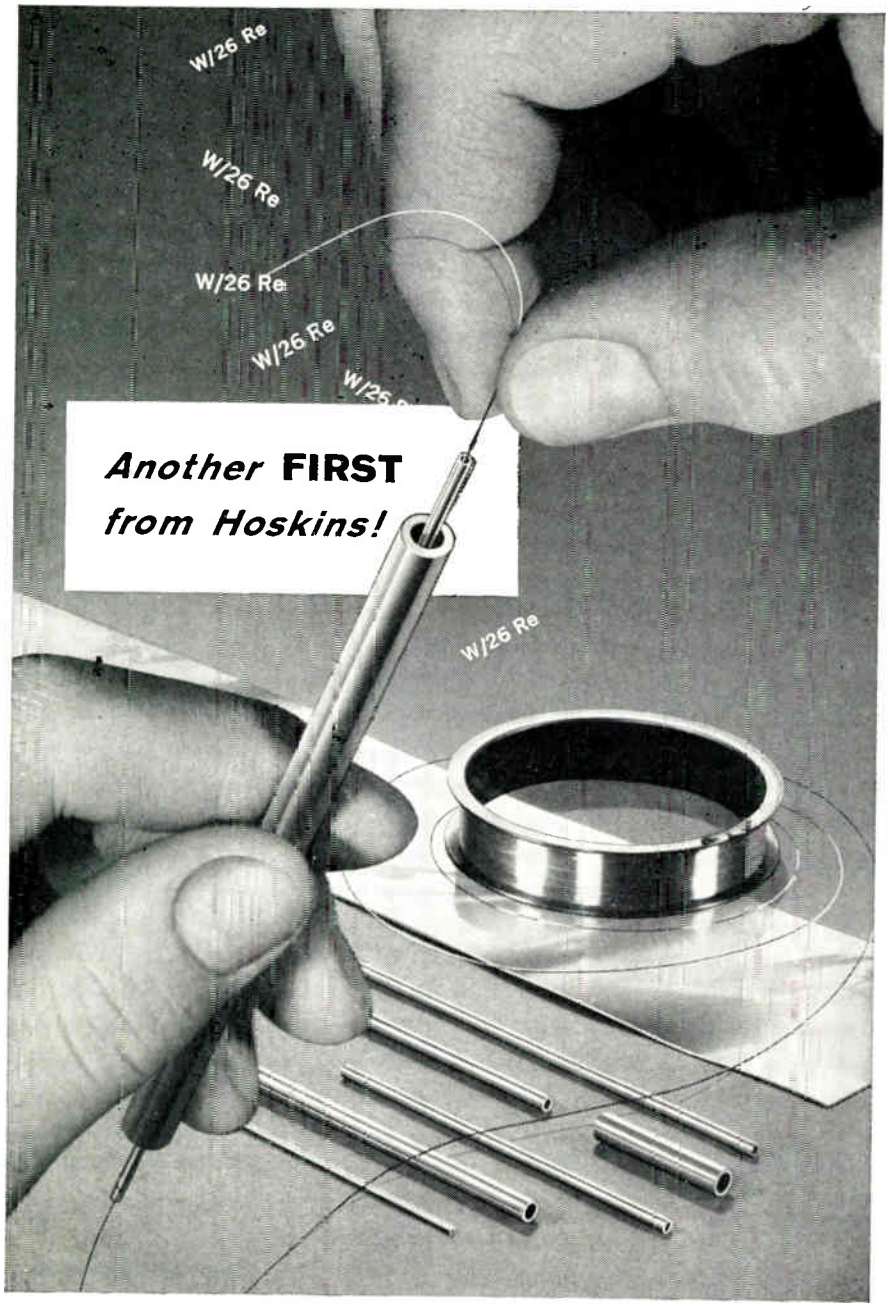
Name _____

Title _____ Firm _____

Street _____

City _____ State _____

World Radio History



Tungsten/26 Rhenium Seamless Tubing for nuclear and thermionic applications

First to offer Tungsten/Rhenium alloys as calibrated thermocouple wire for accurate measurement of ultra high temperatures. ☐ First to supply these refractory metal alloys in strip form for structural applications. ☐ Now first again to produce Tungsten/26 Rhenium seamless tubing to meet the critical requirements of advanced nuclear reactors and thermionic devices.

Properties of interest to interested persons include: Very high melting point, approximately 5800°F. Good room temperature ductility. Good weldability. Excellent hot strength. Stability in vacuum, hydrogen and inert atmospheres. Good emission characteristics. Compatibility with nuclear fuels. ☐ Detailed technical data plus price and delivery information available upon request.

HOSKINS

MANUFACTURING COMPANY • 4445 LAWTON, DETROIT 8, MICH.

Exclusive Producers of Chromel/Alumel® Thermocouple Alloys in Wire and Seamless Tubing Form

Circle 105 on Inquiry Card

NEW TECH DATA

Microwave Catalog

This short-form catalog contains 24 illustrated pages which describe a line of equipment from antenna pattern recorders to contour plotters. Photos of the equipment are given, along with descriptions and operating characteristics. Antlab Inc., 6330 Proprietors Rd., Worthington, Ohio.

Circle 237 on Inquiry Card

Calorimeter Handbook-Catalog

A handbook-catalog on calorimeters and loads contains measuring, calibration, and formula data. From these formulas may be derived the pertinent data applicable to measure and absorb any microwave energy by calorimetric techniques. Chemalloy Electronics Corp., Gillespie Airport, Santee, Calif.

Circle 238 on Inquiry Card

Capacitors

The Alumalytic® capacitor offers a +20% tolerance. Extremely low initial leakage current decreases during use. A leakage-current value of 0.3μa for a 10μf, 50v. unit drops in 2000 hrs. to 0.05μa. Depending on storage conditions, shelf life is claimed to be almost indefinite. General Electric Co., 392 S. Stratford Rd., Winston-Salem, N. C.

Circle 239 on Inquiry Card

Metallized Ceramics

Bulletin No. 632 contains technical facts on metallized ceramics. The 20-page color booklet contains tables, charts, photos, and descriptions of: high and low temp. metallizing, metallized patterns, electroplatings and dip coatings, and other processes. A glossary of terms is given. American Lava Corp., a sub. of 3M Co., Chattanooga, Tenn.

Circle 240 on Inquiry Card

Connectors

A new line of high-voltage, miniaturized electrical connectors, developed especially for exploding bridge wire ordnance systems, is available from Matrix Science Corp., 3311 Winona Ave., Burbank, Calif. Designated series 117, the new mated pair connectors can be used with the extremely high-voltage, high-current and short pulse characteristics required for electrical triggering of the EBW system explosive.

Circle 241 on Inquiry Card

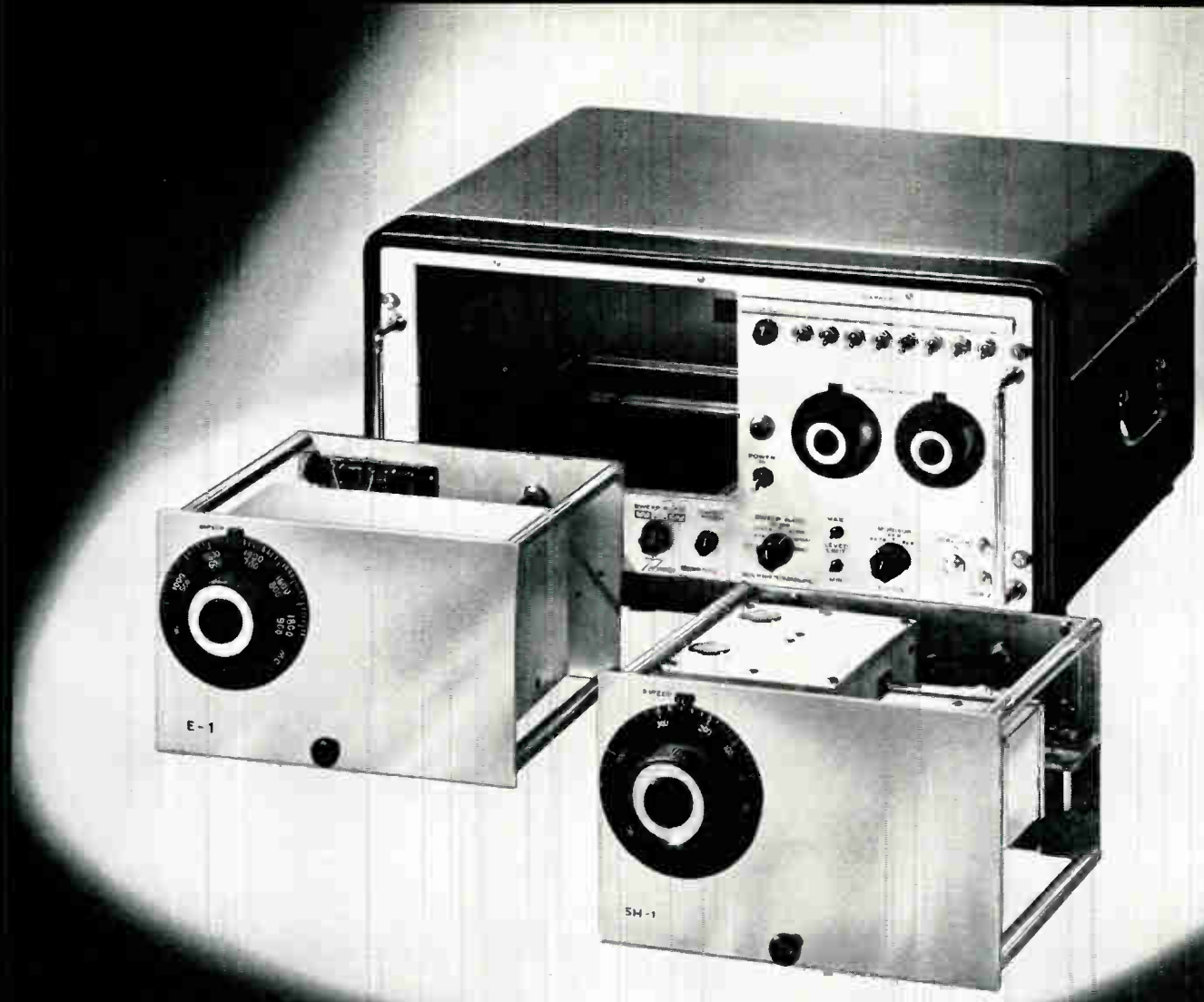
Interference Terms

A 12-page booklet entitled "A Short Glossary of EMI Terms," lists some of the more frequently encountered terms in electromagnetic interference (EMI) work. Definitions include such terms as attenuation, cell-type enclosure, "hash," TVI, RFI, EMI, spectrum signature analysis, etc. Available from Ace Engineering & Machine Co., Inc., 60 Tomlinson Rd., Huntingdon Valley, Pa.

Circle 242 on Inquiry Card

Circle 106 on Inquiry Card →

World Radio History



640,000,000 cycles-free!

The engineer who has determined the profitability of using sweep generator techniques now has another 22 pleasant discoveries awaiting him. That's the precise number of oscillator heads that conveniently plug into Telonic's SM-2000 Sweep Generator.

The trio shown above, for example, consists of an SM-2000 with just two of these heads, an SH-1 and an E-1. Together they cover a frequency range of 500 Kc to 1840 mc, **over 600 mc further than any comparable instrument and at several hundred dollars less cost.** Add to this the flexibility of being able to utilize any of 20 other oscillators and you have an instrument that obsoletes anything available for precise frequency generation and response testing.

General Specifications

Display linearity	Better than 1.2:1
Source VSWR	Below 1.3:1
Vernier attenuation	0 to 10 db
Horizontal sweep	Approx. 15 volts
Zero base line	Oscillator off during return sweep
Frequency markers	Birdy By Pass
Sweep rate	Line frequency, 50-60 cps
Frequency range*	
SH-1 oscillator head (variable marker optional)	500 Kc to 460 mc
E-1 oscillator head (variable marker optional)	460 mc to 1840 mc
Prices	
SM-2000	695.00
SH-1	400.00
E-1	750.00

*There are 22 different plug-in heads available for the SM-2000 covering audio to 3000 mc in various frequency ranges and sweep widths. Prices range from 300.00 to 995.00. Complete catalog on request.

Telonic® INDUSTRIES, INC.

60 NORTH FIRST AVENUE
BEECH GROVE, INDIANA
PHONE STATE 7-7241 AREA CODE 317

TWX 317-635 4748

Representatives in
Baltimore, Boston, Chicago, Cleveland, Dallas, Dayton, Denver, Huntsville, Indianapolis, Los Angeles, New York City, Orlando, Philadelphia, San Francisco, Seattle, St. Louis, Syracuse and principal cities throughout the world.

❖ SWEEP GENERATORS ❖ RF ATTENUATORS ❖ CW OSCILLATORS ❖ COAXIAL SWITCHES

World Radio History

A MODERN PLANT, LABORATORIES AND TESTING FACILITIES

Go into the making of this grommet and into the making of any Western custom designed industrial rubber part. Western grommets come in hundreds of standard sizes from natural, all purpose, Neoprene, buna N and stereo rubbers and can be ordered in any volume or formulation to fit your specifications from molds already available.

In addition, Western produces lathe-cut washers, gaskets, bushings, molded parts of limitless shape and design and Mono Cord® one piece, no splice round section rings. Write today for an informative brochure or a visit by our sales engineer in your area.

WESTERN RUBBER COMPANY
GOSHEN 14, INDIANA
Molded and Lathe-Cut Rubber Parts for All Industries
SINCE 1902
Circle 107 on Inquiry Card

NEW, RECTANGULAR
KELVIN
Wire-Wound
RESISTORS
for reliability in printed circuit high-density packaging


RECTANGULAR RESISTORS . . .


. . . SAVE MORE SPACE!!

Rectangular and flat in configuration, the new Kelvin Series "P" precision wire-wound resistors offer a circuit designer the ideal solution for high density packaging. The new, flat configuration permits "stacking" one on top of another or laying resistors side-by-side for minimum space requirements, especially in printed circuit applications. All units are wound with a single length of wire (no splices permitted) using Kelvin developed "relaxed" winding techniques. This method, by allowing a winding tension of only 1½ to 3 grams, minimizes resistance drift with age and "opens" or "shorts" resulting from over-stressed wire. Units are further stabilized by artificial aging and temperature cycling prior to final inspection. Vacuum encapsulation eliminates voids.

General Specifications

*Wattage Ratings: based upon maximum ambient temperature of 125°C, derated 5%/°C above 125°C.
Windings: card type
Temperature Coefficient: ± 20 ppm/°C; (as low as ± 2 ppm/°C — limited temperature range). Resistance wire having low thermal E M F. to copper is used exclusively.
Temperature Range: —65° to + 125°C.
Standard Tolerances: 1%, 0.5%, 0.1%, .05%, .025%, .02%, .01%.
Connections: welded.
Encapsulating Material: high temp epoxide resin.

KELVIN TYPE	COMMERCIAL WATTAGE*	MAXIMUM OHMS	MINIMUM OHMS	SIZE	MAXIMUM VOLTS	LEAD SPACING	LEAD DIA.
446-P	.200	2 Meg.	1	⅛" x ¼" x ½"	100	.250	#20
447-P	.125	1 Meg.	1	⅛" x ¼" x ¼"	100	.125	#20

Our experienced engineers will answer your high-density packaging application inquiries promptly. Send specifications or requirements to:

Representatives in principal cities

KELVIN ELECTRIC COMPANY
5907 Noble Ave., Van Nuys, Calif., TRiangle 3-3430
New York: Yonkers, 916 McLean Ave., BEverly 7-2500

NEW TECH DATA

Instruments Catalog

This 1963-64 catalog presents the latest instruments and equipment for general research, clinical study, production, quality control and pilot-plant operation. Subdivisions deal with thermistor-based instrumentation, chemically-resistant liquid transfer, metering and vacuum pumps, precision temp. control and heat-treating equipment, and clinical instrumentation. Cole-Parmer Instrument & Equipment Co., 7330 N. Clark St., Chicago 26, Ill.

Circle 243 on Inquiry Card

Solid-State Amplifier

Bulletin P-63198-4 gives photos, description and specs. on a new solid-state ac voltage amplifier which has an open-loop gain greater than 90db. Prices for models 198-4 and 198-5 are included, as well as drawings of typical uses. Taber Instrument Corp., 107 Goundry St., N. Tonawanda, N. Y.

Circle 244 on Inquiry Card

Tank Level System

Information is available on a system which measures the level and weight of liquids in pressurized tanks—regardless of tank shape. Known as the Liquid Level/Weight Gaging System, it consists of a transducer and readout device. Installed entirely within the tank, it is insensitive to tank pressure up to 2000psi. Constructed of Monel, the transducer is unaffected by corrosive environments or foreign material in the measured liquid. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 245 on Inquiry Card

Substrate Material

Data sheet T-4 describes Smooth Strate®, a specially processed thin glaze upon high-aluminum ceramic. The surface finish of the substrate is better than 100Å. The surface is uniformly flat to ±0.001 in. Electro-Ceramics, Inc., 2645 S. 2nd West, Salt Lake City 15, Utah.

Circle 246 on Inquiry Card

Shaft Position Encoder

Bulletin 306 describes the size 11 encoders which provide parallel contact closure outputs in natural binary form. Brushes are rated for 3ma at 30vdc. Unit meets Mil-E-5400E and other specs. Life rating is 2 x 10^6 revolutions at 100 RPM. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 247 on Inquiry Card

Wirewound Resistor

Bulletin 103 describes this wirewound resistor whose vitreous enamel insulation is molded—not dipped—on the axial lead. The series 99 have an insulation thickness that guarantees 100vac insulation breakdown. Consistent form and dimensions facilitate use in automated assembly of circuit boards, etc. Ohmite Mfg. Co., 3678 Howard St., Skokie, Ill.

Circle 248 on Inquiry Card

World Radio History

LITTON ELECTRON TUBES

SHORT, SHORT SUMMARY OF LITTON ELECTRON TUBES, DISPLAY DEVICES, ACCESSORY EQUIPMENT

1 meter to 4 millimeters milliwatts to megawatts

AMPLIFIER KLYSTRONS Peak powers to 30 Mw. Frequency coverage in P, L, and S bands. Litton specialties are broadband, both fixed and tunable, and hollow-beam tubes. Inquire about our CW types.

TRAVELING WAVE TUBES Lightweight, compact, reliable TWT's for P, S, C, and X band applications. Powers from 20 mW to 10 kw. Small signal gains from 33 to 70 db. Includes CW and pulse models. Most are PPM focused.

DISPLAY DEVICES High-resolution (half-mil centers) cathode ray tubes. PRINTAPIX® types for electrostatic printing, Fiber Optic varieties, and character writing Composipix® types. Broad line of CRT operational accessories, including Flying Spot Scanners, Electronic Printers, Video Amplifiers, and Power Supplies.

MILLIMETER WAVE TUBES Floating drift tube klystrons, reflex klystrons, magnetrons, and monitor diodes. Frequencies from 12 mm to 4 mm bands. Powers from .03 W to 50 W.

MAGNETRONS CW and pulse types, cube miniatures and super powers. P to Ku band. Peak powers to 2 Mw. CW powers to 500 W. White noise BARRATRON® types also available.

M-BWO's Compact, voltage-tunable CW oscillators for L, S, C, and X bands. Minimum powers from 150 W at higher frequencies to 200 W at 1000 Mc.

CROSSED FIELD FORWARD WAVE AMPLIFIERS • ELECTROSTATICALLY FOCUSED KLYSTRONS • LASERS Litton has made significant advances in these new devices. Some models are now available.

SWITCH TUBES INJECTRON® high-power beam switching types with 95% efficiency. Fast rise times and low control power. DC collector capabilities to 350 kV at 30 A. Floating deck modulator versions in production.

ACCESSORY EQUIPMENT Microwave power sources operating from 350 mc to 10,475 mc and in the 12-mm to 4-mm regions use Magnetrons, M-BWO's, and Floating Drift Tube Klystrons. Peak powers to 2000 W, depending on frequency. Litton also offers TWT amplifiers, millimeter wave power supplies, focus coil supplies, water loads, and other tube accessories.

CATALOG—Write for additional information or a copy of our new condensed catalog. We make a complete line of microwave tubes, display devices, and accessory equipment.

LITTON INDUSTRIES ELECTRON TUBE DIVISION

In U.S.—960 Industrial Road, San Carlos, California In Europe—Litton World Trade Corporation, Box 110, Zurich 50, Switzerland

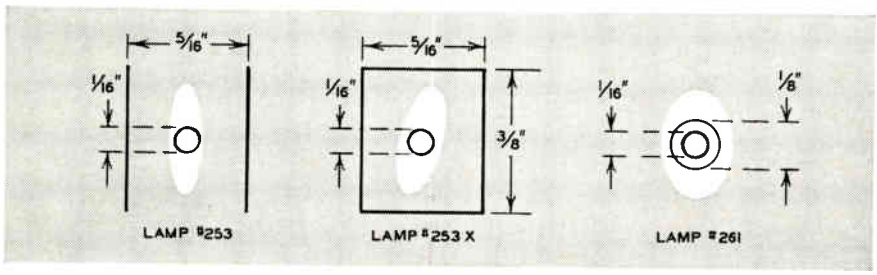
World Radio History

For fast, reliable punched card and tape reading, try General Electric's new line of lens-end lamps

253 253x 261

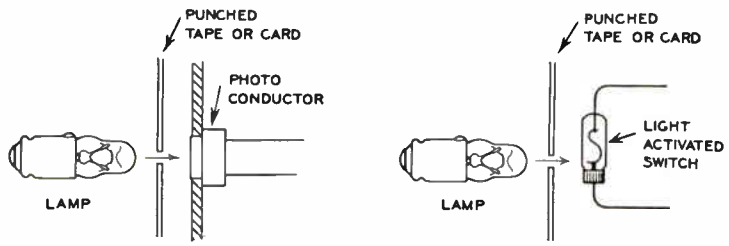
(Actual Size)

Each lens-end lamp in General Electric's line has an average life in excess of 10,000 hours. It operates on only 2.5 volts, yet concentrates a minimum of 750 footcandles over a 1/16″ diameter area at a distance of 3/8″ from the end of the lamp.



Shown here are the beam patterns produced by each lamp at a distance 3/8″ from the end of the lamp. Notice the maximum limits within which the beam spot must fall.

The maximum overall length of each lamp is 1-1/16″, diameter 1/4″. The small size, long life and precisely controlled beam of General Electric's lens-end lamps make them ideal for use with photoconductor and light activated switches in isolated optical electronic systems.



The high end-on candle power of the lens-end lamps is also quite suitable for use in projection of visible images in read-out devices. For more information and complete specifications write today to: General Electric Company, Miniature Lamp Department M-318, Nela Park, Cleveland, Ohio 44112.

Accent on VALUE

GENERAL ELECTRIC

LETTERS

Mathematical Models Errata

Editor, ELECTRONIC INDUSTRIES:

I should like to make the following corrections to my article "Mathematical Models for Engineers" which appeared on pp. 39 ff of the September, 1963 issue of "Electronic Industries."

1. The heading "Basic Algebraic Manipulations" should appear at the head of the second column on p. 39.

2. Replace parentheses in Eq. 36a, p. 51, by absolute value signs, to read:

$$|z^n| = |z|^n$$

3. Z^n and Z in Eq. 36b, p. 51 should be subscripts; thus:

$$\theta_{z^n} = n\theta_z$$

4. Exponents of "e" in Eqs. 38a, b and 39, p. 51 should be adjusted to look like:

$e^{j2\pi ft}$ and $e^{j\theta_v}$, respectively.

5. Subscripts in Eqs. 40 and 42, p. 51 should be adjusted as follows:

$$x_a + x_{a+1} + \cdots + x_{b-1} + x_b \quad (40)$$

$$x_a\, x_{a+1} \cdots x_{b-1}\, x_b \quad (42)$$

6. The equation $v(t) =$, etc., which appears below Eq. 63 on p. 55, should be included as part of the caption under Fig. 8.

7. Exponents of "x" in Eqs. 56 and 57, p. 55 should be $2n$ and $2n + 1$, respectively (no space between "2" and "n").

8. Under item "c," second column on p. 57, transpose subscripts of A to read:

$$B_{mn} = A_{nm}$$

9. The matrix **A*** defined by Eq. 83 on p. 59 was incorrectly called the "adjoint" of **A**. Actually it is the *transpose* of the adjoint of **A**, or, more simply, the "cofactor matrix."

10. Delete equation following Eq. 113 on p. 63; this equation appears correctly as part of the caption of Fig. 12.

11. Adjust exponents of "e" in Eq. 124 and 126, p. 67 and 131, p. 69 to read:

$$e^{j\omega t}$$

12. Lower limits of integrals on pp. 67 and 69 should all be "$-\infty$."

13. Ordinate on Fig. 14, p. 69 should be labelled.

$$\delta(t - \tau).$$

Dr. R. S. Berkowitz
University of Pennsylvania

(*Continued on page* 160)

World Radio History

The service comes free.

Every cable sale we make happens because one of our engineers called on a customer to help him solve a particular problem. This service costs nothing. On the other hand, the cable does, as you might expect, but is of such high quality that you may think of it as an investment rather than a purchase.

We make available numerous jacketing materials to use in the cable you need. We test and certify cabling systems for you in our own environmental testing facility. We manufacture molded transitions and molded or potted connectors and terminations. We can design and fabricate prototype, small lot, or volume production quantities for any type of cabling system. We make electronic cable employing nylon or steel strain relief members.

The cable pays for itself.

We produce complex cable types for unusual applications to your exact specifications. Our two plants at Santa Ana, California, and Sidney, N.Y., assure you of fast service wherever you are. For assistance with your cable problems, contact us.

Circle 111 on Inquiry Card

Scintilla Division

THE Bendix CORPORATION

World Radio History

FENWAL ELECTRONICS CAPSULE THERMISTOR COURSE #4

Part 2 of – THERMISTORS – how they measure and control temperature

Thermistors come close to being ideal temperature sensors. Until recently, however, it was simply not possible to produce units which had identical resistance-temperature characteristics. As a result, thermistors could not be supplied which were directly interchangeable, and thermistor calibration or re-adjustment of other circuit components was necessary.

Iso-Curve* Thermistors

Fenwal Electronics has introduced a series of *new* Iso-Curve thermistors which are precision-matched (to within ±0.2 F° if required) to a standardized resistance-temperature curve. A complete line of units is now available to match five standard curves, and are presently in use in many hundreds of industrial and aerospace applications.

The five standard curves which range in resistance from 370 to 100K ohms at the standard reference temperature (77F°) are shown in figure 1 and cover a temperature span of −100 to plus 600 F° in useful increments. These values provide for over 95% of all normal temperature measurement applications.

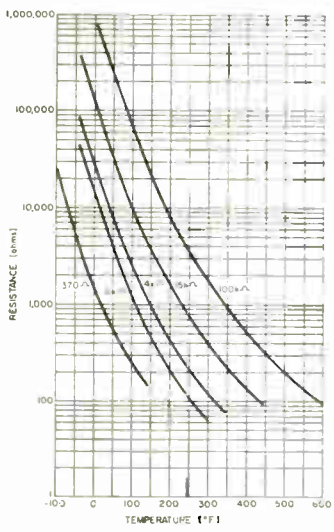


Fig. 1. — Standard Iso-curve resistance vs. temperature characteristics.

Selecting Resistance Value

Selection of a suitable resistance value is usually based on the following considerations: temperature span, resistance values at temperature span extremes, sensitivity.

In general the lower resistance units are better suited for sensing lower temperatures, while the high-resistance units cover higher temperatures.

Maximum resistance at low temperature must not be too high to meet needs of associated circuitry such as amplifier, read-out, etc. A very high resistance at low temperature may induce spurious signal pickup. If high resistance is required, then the use of shielded lines, filters, or DC may be desirable.

Minimum resistance at high temperature must not be too low since error in read-out may result due to contact resistance, line resistance, and line resistance variation with changes in ambient temperature.

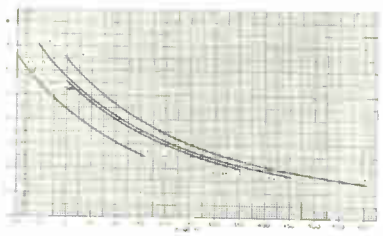


Fig. 2. — Sensitivity (% resistance change/°F.) vs. temperature of standard Iso-curve thermistors.

Sensitivity (% change in resistance per F°) shown in figure 2 should not saturate or overdrive associated circuitry at low temperature; and at the high temperatures, the resistance change should be adequate to provide the required degree of resolution or control — e.g., the 100K Iso-Curve* thermistor at 0 F° will have a resistance change of 3.25%/F° and at 600 F° 0.7%.

Iso-Curve* thermistors provide all of the functional advantages of regular thermistors and are available as beads or glass probes and in metal probe assemblies.

Fenwal Electronics

The only manufacturer of Iso-curve thermistors — interchangeable units with identical resistance/temperature curves.*

*Pat. applied for

63 Fountain Street Framingham, Massachusetts

LETTERS

to the Editor

(*Continued from page* 158)

Broken Wire Strands

Editor, ELECTRONIC INDUSTRIES:

After examining the results of a recent investigation into Broken Conductor Strands (copper wire) here at our plant, we find that we were able to gather sufficient evidence to support all our claims with one exception. The fact that solder is often drawn under insulation during the tinning of the ends ("wicking") led us to believe that this is perhaps the cause of a greater number of broken strands than is generally suspected. However, our data did not include incontrovertible proof that our assumption is correct.

If you could recommend a source where information on this subject might be available, we would be happy to get in touch.

W. J. Decker
Process Engineer,
Radiation Division
Sperry Gyroscope Company
Division of Sperry Rand Corporation
Great Neck, New York

Ed.: Anybody have ideas on this?

"Engineers Are in Business"

Editor, ELECTRONIC INDUSTRIES:

Since receiving *Electronic Industries*, I have enjoyed reading the contents very much. However, I would, and I'm sure other individuals would also, appreciate it if the articles devoted to marketing and business be augmented.

Concerning the editorial in the September 1963 issue, entitled "The Engineer Is In Business, Too!" caused me to wonder how many people agree with it. Although the article did apprise engineers what would be nice to know, I feel it was unnecessary, because most engineers have a basic understanding of their organization. Those who don't, probably wouldn't be interested anyway. I assume that the aforementioned editorial is directed towards the latter.

The editorial also implies that what these engineers don't know about their organization is management's fault. I

(*Continued on page* 162)

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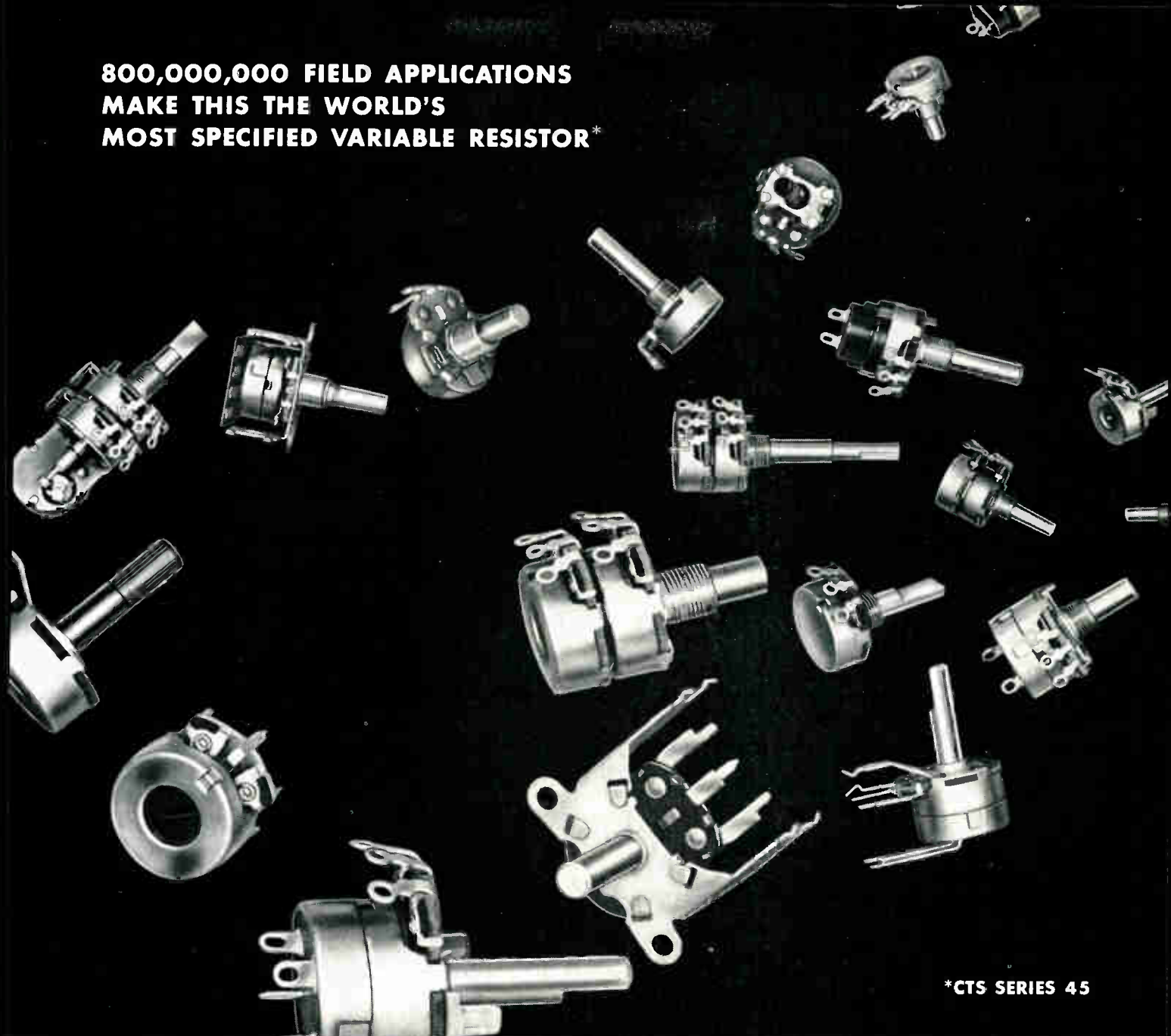
World Radio History

800,000,000 FIELD APPLICATIONS MAKE THIS THE WORLD'S MOST SPECIFIED VARIABLE RESISTOR*



*CTS SERIES 45

PRODUCT RELIABILITY has been proved in over 800,000,000 applications in all kinds of environments. Year after year *Series 45* variable resistors have led the industry to new standards of excellence. Over 300,000,000 are in active service today.

DESIGN VERSATILITY is demonstrated by countless variations of *Series 45* and other controls in today's rapidly changing commercial and industrial requirements. Tomorrow's requirements are even now being met by CTS' dynamic R/D & Engineering programs.

BENEFIT FROM THE VAST VERSATILITY AND RELIABILITY OF CTS VARIABLE RESISTORS

Founded 1896

CTS CORPORATION
Elkhart, Indiana

Sales Offices and Representatives conveniently located throughout the world.

Principal Products
Variable Resistors
Selector Switches
Loudspeakers
Trimming Potentiometers
Microminiature Components & Circuit Packages

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Chicago Telephone of California, Inc., South Pasadena, Calif.
CTS of Canada, Ltd., Streetsville, Ontario

World Radio History

Could be! This new Marco Press-Lite Switch can be used for *all kinds* of airborne, ground support and commercial applications, even in major emergencies. Naturally, Press-Lite Switches have all the qualities that a designer or engineer seeks in panel configuration — they fit everywhere. And there's one important item that these Marcoswitches lack — *size*. They are small in diameter for their rating and you get just what you need — more per panel. Also, each switch forms a good-looking compact package — an extra for the aesthete.

■ Designed to provide a minimum of 25,000 cycles of operation at rated load, these switches are available in momentary contact and alternate action styles in 2 and 15 amp, SPDT models, each model featuring "velvet pressure" pushbutton action. And the efficient light circuit performs entirely separate from the switch circuit. Relamping is simple — the lamp can be replaced from the front of the panel, making switch removal unnecessary. Several cap colors are available — white, red, green and yellow — in various shapes and sizes.

■ Whether standard or custom-engineered assemblies, Marco can meet your specifications. Write today for technical information.

SW 616 alternate action
SW 618 momentary contact
2 amp at 125 volts AC, 75% power factor
⅝" outside dia.
Lamp Size - T 1¾

SW 617 alternate action
SW 619 momentary contact
15 amp at 125 volts AC, 75% power factor
7-½ amp at 250 volts AC, 75% power factor
¾" outside dia.
Lamp size - T 1¾

MARCO-OAK INDUSTRIES COMPANY

207 SOUTH HELENA STREET, ANAHEIM, CALIFORNIA • NATIONAL DIAL 714 KE 5-6037

LETTERS

to the Editor

(*Continued from page* 160)

disagree. Most companies make available to their employees the annual report and other information concerning long range goals. What the company does not furnish, the various trade journals and other trade news media do.

The information is available to engineers. It is up to the individual, with his own initiative, to ask and seek the information. Also, if a question is put to management concerning a specific business function, that management will gladly explain it.

Concerning the engineer's own sense of security and professional development: the engineer who is concerned about forging his way into management will surely find out how his organization operates. The engineer who desires to advance technically will pursue other channels of interest.

Let me remind you—most managers in the electronics industry were, at one time, engineers. The reason why they are managers today is they didn't wait for someone to explain to them the how's and why's of business.

Harry K. Hill
Long Beach, California

Editor, ELECTRONIC INDUSTRIES:

Please let me compliment you on your good judgement in publishing the timely subject matter in your feature article "The Engineer Is In Business, Too!" I think views like yours on "team performance" are spreading throughout the aerospace business. Many other leaders in the aerospace business have recently emphasized the importance of the business minded engineer.

I hope that companies encourage their engineers to become familiar with the facts of business life through company sponsored, college level, night school programs.

Myron Ausloos
Systems Planning Engineer
Bldg. 8, Apt. 2
1032 Remington Drive
Sunnyvale, California
September 13, 1963

World Radio History

We even put a hat on our drum to avoid contamination

This is only one of the ways we protect GENESOLV® D "Electronic Grade," the purest precision cleaning solvent you can buy.

We do everything possible to protect the purity of our precision cleaning solvent.

Even to using this film cover to keep dirt and moisture from settling on the drum top and possibly contaminating the solvent when you open the drum.

Precautions like this help keep Genesolv D "Electronic Grade" *the purest solvent available.* Residue is less than 1 part per million.

Genesolv D fluorocarbon solvent for critical cleaning cuts rejects due to contamination. It penetrates into even the smallest surface openings for easy, fast cleaning. The solvent has little or no effect on plastics, elastomers, paints and varnishes. There are no additives and it's compatible with any cleaning method.

It offers an outstanding combination of dielectric properties, exceptionally high resistivity with low dielectric constant.

Genesolv D "Electronic Grade" is safer to use than other solvents because it's nonflammable, nonexplosive and virtually nontoxic.

It's easy to recover for reuse. This helps keep your cleaning costs down. And our technical people will be glad to advise you on the best recovery set-up for your particular operation and on proper equipment and solvent storage and handling procedures.

Genesolv D "Electronic Grade" is available in non-returnable drums of 65-, 200- and 690-pound capacity, and in tank trucks of 3800 gallons.

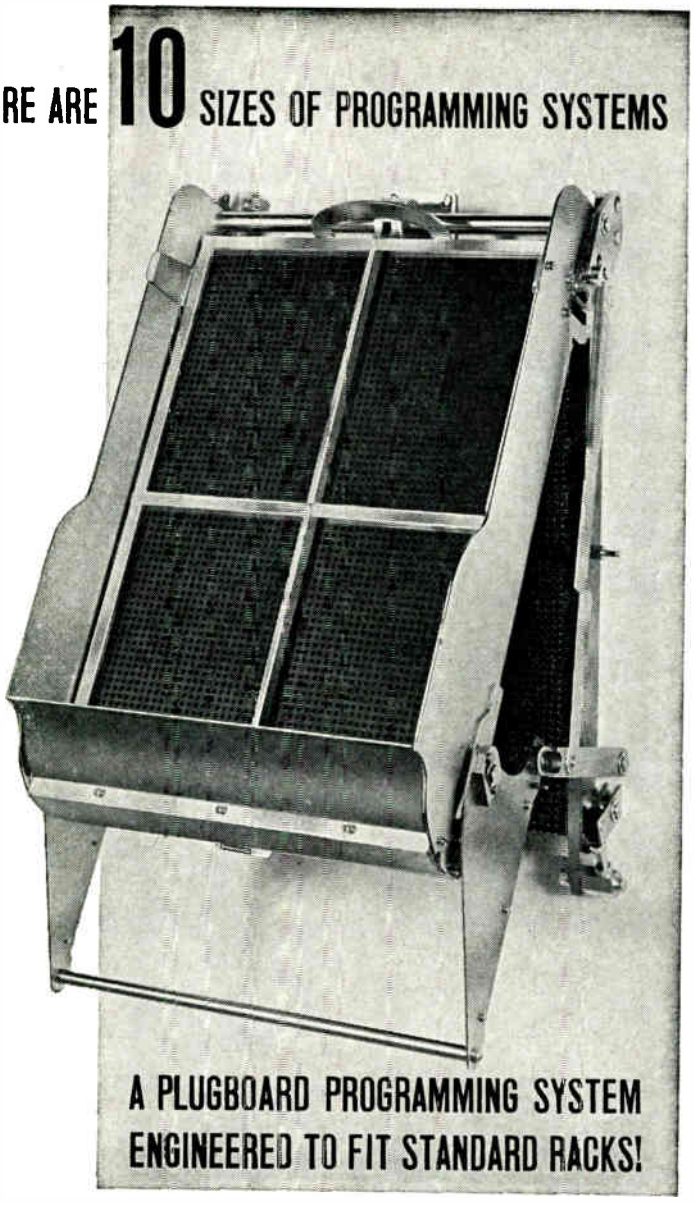
Call on us for answers to any cleaning problems you have. Our years of experience and leadership in supplying high-purity chemicals can help you.

Allied Chemical

GENERAL CHEMICAL DIVISION
P. O. Box 353, Morristown, N. J.

World Radio History

NOW THERE ARE 10 SIZES OF PROGRAMMING SYSTEMS



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MODEL 909 WITH 3264 POSITIONS

MAC Panel Plugboard Programming Systems are designed to meet all your requirements for dependable program control of electronic equipment. Available in sizes ranging from 200 to 5120 positions, systems include receivers, lightweight phenolic or diallyl phthalate plugboards and a complete set of manual and fixed plugwires.

Check the complete line . . . write for catalog, price list and set of receiver mounting dimension sheets.

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EDITOR'S MAIL BOX

IF YOU YELL 'MAY DAY' YOU BETTER MEAN IT — A Racine, Wisc., boy took dad's car for a drive with a pal. Dear pal tried out dad's CB transmitter, faking a report of a disabled plane falling some 500 feet over Lake Michigan. FCC men in Chicago tracked down the bogus SOS to a Racine house where mom admitted that her son had allowed his friend to use the gear. The pal was put on the "rock pile" for 21 days for disorderly conduct.

ELECTRICAL ENGINEERING, predominantly male, again has been invaded by a non-male graduate of reports taking on Miss Irene White, 21, of Washington, D. C., as an electrical engineer at the Bureau of Reclamation Design and Research Center, Howard U. Our Interior Department Denver, Colo., which now has three distaff engineers on a staff of 800—men! Irene, Tau Beta Pi and Society of Women Engineers, graduated in June after winning national student honors from the AIEE and the IRE (now all IEEE).

AN ELECTRONIC DRAFTSMAN is now plotting highway and rail needs for the nine-county Philadelphia, Pa., area. "Dataplotter," by Electronic Associates, Inc., read card-fed data and sends signals to a mechanical hand that transforms data into drafting layout. Data includes present and proposed highway networks of Philadelphia, Camden and Trenton area, some 1200 square miles. Purpose of the Penn Jersey Transportation Study using the Dataplotter is to plan a highway and transportation system to encourage regional growth over the next 25 years.

BACKYARD BRAINCHILD of an Atlanta, Ga., electronics wizard is hailed as an athletic breakthrough. A timing device—a bit larger than a pocket watch—emits a steady, audible beat. It's used now by track coaches, typing instructors, physicians, who suggest walking for heart patients, and swimmers. Called Elecktro-Pacer, the transistorized device lets students or trainees set own pace, from 50 to 300 beats a minute. It's good for activities that need coordination and steady pacing such as music, dancing, typing, football.

(*Continued on page* 166)

World Radio History

CANNON® PLUGS WITH WELDABLE CONTACTS!

A QUICK, RELIABLE METHOD OF CONTACT TERMINATION

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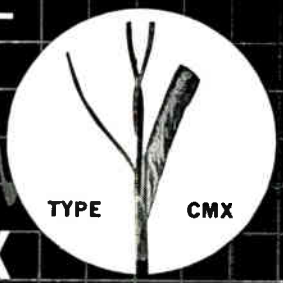
for cleaner signals—

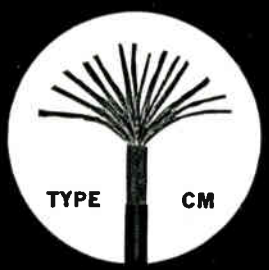
DEKORON

Computer TWIST-EX Thermocouple Extension Wire



Clear, clean control signals are now readily available when you specify Dekoron Computer Twist-Ex thermocouple extension wire.

Twisted pair construction enables the EDP designer to increase wire density and cut installed costs substantially. Twisted pairs with total coverage shield of Mylar® tape with aluminum backing in contact with bare copper drain wire provides maximum electrostatic and electromagnetic noise rejection.



Dekoron Computer Twist-Ex is also available in cables (lower left) of from 4 to 36 pairs per cable in up to 1000 ft. lengths. Wire insulation and cable jackets are color coded to ISA standards. Engineered to highest standards, Dekoron computer wire products assure cleaner signals and lower installed costs. Samuel Moore & Co., Mantua, Ohio.

SAMUEL MOORE

A-9273A

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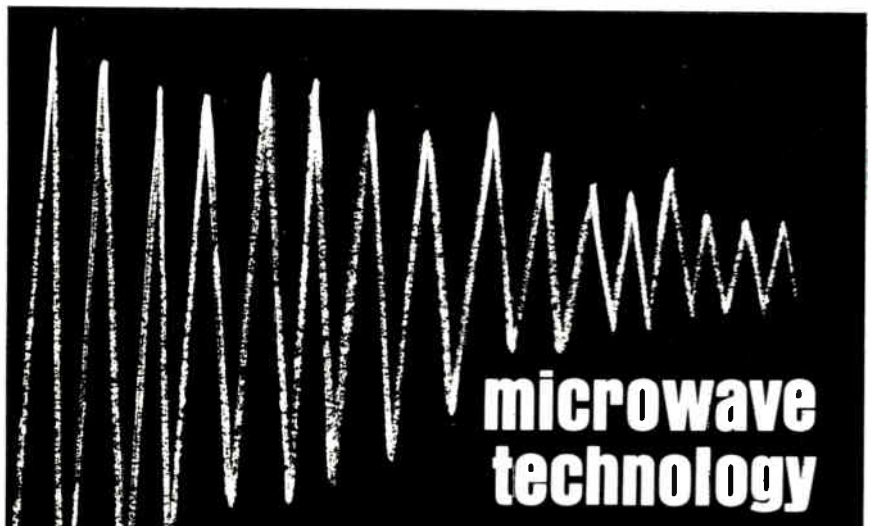

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EDITOR'S MAIL BOX

DIAMONDS FOR SPACE can be ready in five minutes, reports Melpar, Inc. Emeralds can be rushed through in two hours. Nature does the same trick in a few hundred million years. Melpar uses high pressure for the while-you-wait baubles, but it ain't going to shake up jewelers' row one carat. These pseudo-gems are sand-grain size. They're being made for research on how jewels are formed to create new, improved materials needed for space. Researchers hope to make diamonds and emeralds without the impurities of natural ones. A bit messy, that girl nature.

BLAST NOISE from shotguns and dynamite, heard over ten miles or more, could lead to new super-accurate measurements of the earth's surface, say scientists of the Commerce Department's Coast and Geodetic Survey. Electronic distance measuring equipment accuracy depends on precise knowledge of mean air temperature along the line to be measured. The Survey hopes to improve equipment accuracy by using sound to determine mean air temperature.

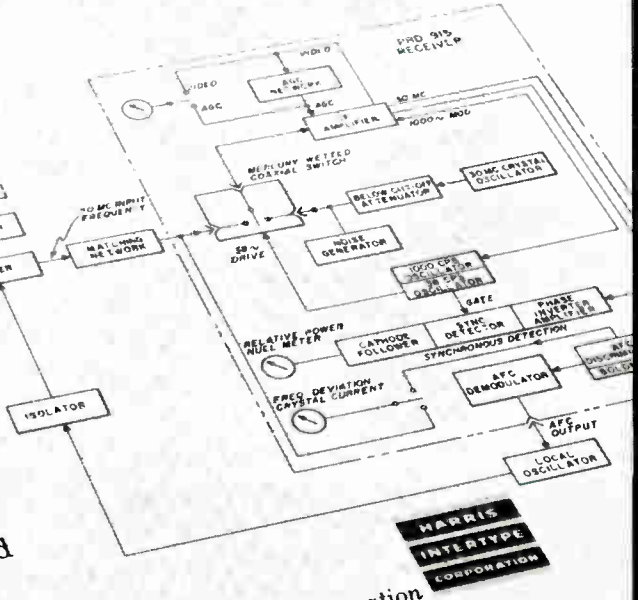
ELECTRICALLY-MOTORED MUSCLES may be the thing for paralytics within ten years, according to a U. S. Vocational Rehabilitation Administration official. Case Institute scientists will try to implant tiny receivers in paralyzed arm muscles and activate them with impulses. Patient "chooses" arm motion with IR beam from his eyeglasses aimed at electronic detector. Detector sets off tape recorder-computer-pulse system. Patient can stop motion by flicking a switch, also on eyeglasses, with an eyebrow wiggle.

ONLY 1000 FIRMS account for about 70% of the nation's industrial output, says Fortune. This is out of a total of some 360,000 manufacturing and mining companies. This tremendous flow of goods is produced in 15,000-odd plants and divisions (of the 1000 firms) scattered in all 50 states. The company with the biggest product diversity is Westinghouse, with products classed in 134 government categories. The county with the largest number of big-company plants is Los Angeles County.

World Radio History

NEW PRD 915 RECEIVER

The PRD 915 Receiver makes accurate measurements over the frequency range from 10 Mc to above 40 Gc, with the appropriate local oscillator and mixer. Attenuation measurements of 100 db can be made in a single step and relative power measurements at levels as low as −120 dbm can be made. The 915 can be used for the attenuation calibration of signal generators, antenna pattern measurements and as an extremely sensitive detector for use in RF and microwave systems. Basically, the PRD 915 is a 30 Mc parallel IF substitution receiver. In performing attenuation measurements, the unknown attenuator is compared to a highly accurate reference attenuator contained in the receiver. This reference attenuator can be removed for calibration by NBS. Send for data!



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MODEL JKTO-60: designed for use where minimum power consumption is mandatory. In 1.0 to 5.0 mc range, it features a proportional controlled oven combined with a dewar flask offering extremely low oven power consumption with a very close non-cycling temperature control. Requires only .75 watt max. at – 30° C. Daily aging stability is 1 x 10^{-8} or better after initial aging. "Varicap" voltage control, optional.

exceptional low power consumption reduces power-loss to an absolute minimum

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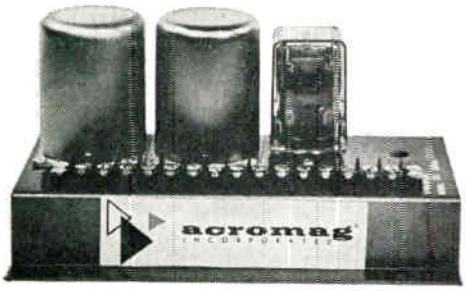

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GE TO INSTALL EQUIPMENT FOR SAMOA ETV SYSTEM

American Samoa will soon have a six-station VHF educational TV system. Some transmitters and studio equipment are expected to be in operation by February 1964. International General Electric (IGE) will furnish three transmitters for the first three channels and all equipment for one main TV studio.

H. Rex Lee, Governor of Samoa, with the National Association of Educational Broadcasters, determined that ETV is a feasible way to improve island education. The present school system is limited owing to geographic division of community centers.

The transmitters, 11 kw each, will be 1600 feet above sea level on the main island of Tutuila, over looking Pago Pago Harbor.

WEST COAST FIRM OFFERS NEW IONOSPHERE SERVICE

Granger Associates, of Palo Alto, is offering a contract Ionosphere Sounding Service for short-term use in propagation research programs and system test operations. It will serve government and industrial laboratories whose programs require recording significant parameters in studies and tests of limited duration.

Operational testing of new high-frequency systems, according to E. W. Pappenfus, engineering vice president, must have actual propagation data available to produce meaningful quantitative results. Ionosphere sounders provide such data, operating in the vertical incidence, backscatter or synchronized oblique modes.

The service can provide 700 complete ionograms per hour and, in the synchronized mode, record actual propagation conditions on 10 independent high-frequency circuits within one minute.

OPENS CONSULTING OFFICE

Richard F. Shea, formerly of General Electric Co., is establishing a consulting engineering practice, specializing in solid-state circuits. His office will be at 14 Coronet Ct., Schenectady, N. Y.

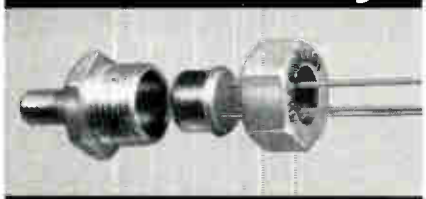
Mr. Shea recently retired from GE after 26 years. He graduated from MIT in 1924, and has also been with Pilot Radio, Freed-Eisenmann and Fada Radio. He is a pioneer in the development of transistors.

World Radio History

REMOVE HEAT

efficiently

economically



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COMPLETE LINE FOR • Low Power through High Power • Case Types such as TO-5, TO-8, TO-18, TO-3, TO-36, TO-38, TO-46.

Tests by leading semiconductor manufacturers* prove the superiority of Thermalloy heat sinks.

Thermalloy's unique design provides contact with the transistor weld-flange — area of maximum temperature — for highest efficiency heat removal. Tapped hole or stud mounting also gives you maximum protection against shock and vibration. The result is a significantly increased electrical and mechanical safety factor in your circuits.

You can fill virtually all of your requirements — 1 watt through 100 watts — from Thermalloy's extensive line of standard production items, with your special needs met by modifications or custom designs.

New products such as dual transistor heat sinks, transistor mounting pads and Beryllium Oxide heat sinks are also available from Thermalloy to give you single-source convenience.

For evaluation samples, catalog and technical information, contact Thermalloy today.

* Write us for copies.

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OCCUPATIONAL HAZARD

Familiar gent is Tal Johns, who not only writes the copy but also appears personally in the ads of Mincom Div., 3M Co. We couldn't believe the lion in one of their recent ads was the real thing. He sent this photo, "See, I'm fixing my cuff."

2 BASIC PARTICLES, NOT 32, TOP PHYSICIST STATES

There are only 2 basic nuclear particles—not 32—says Dr. Victor F. Weisskopf, Director - General at CERN, European nuclear research center at Geneva, Switzerland, and M. I. T. physics professor. He believes the other nuclear "particles" are different forms of the 2 basic particles, or energy quanta.

Dr. Weisskopf refutes the concept of a nuclear system with 30 or more basic particles that have been discovered in the last 10 years.

Dr. Weisskopf says there are only 2 basic particles—the baryon and the lepton—but that physicists have adopted the unfortunate convention of calling each state of these 2 particles an individual particle.

He says that the electron, muon, and 2 kinds of neutrinos are forms of the lepton. Leptons can change from 1 form to another through "weak interactions." The electron is a negative particle that orbits around nuclei to form atoms. Muons are heavy electrons. The neutrino is a chargeless, massless particle.

Protons and neutrons, which make up the atomic nucleus, are forms of the baryon. Protons are positive particles, 930 times heavier than electrons. Neutrons are about the same weight as protons but carry no charge.

The other nuclear "particles"—strange particles, field quanta, and resonance particles—can be thought of as excited states of the baryon (interactions between the baryon and the nuclear force field), or as field quanta and combinations of field quanta.

SWITCH PROBLEMS?

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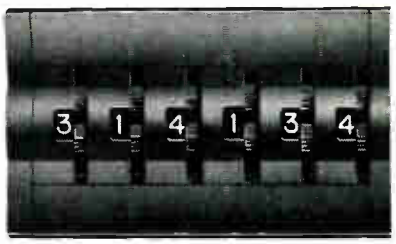
Designed for application where reliability and high performance specifications prohibit printed circuit switch wafers. All modules are sealed to insure long-term performance in severe environments, and can be supplied in any assembly configuration. Features include:

- Silver alloy contacts break 2 amps resistive load
- Long life—low contact resistance
- Decimal outputs per module: to 4 poles 6 positions, or 2 poles 12 positions
- Coded output 1248 (with or without complement)
- In-line readout for any number of digits
- Only 11/16" panel space per module



Sealed switches available as bezel-mounted assemblies, with or without panel seal, or as individual modules for prototype work. Your North Atlantic representative has complete data. Or write for Bulletin SM-400.

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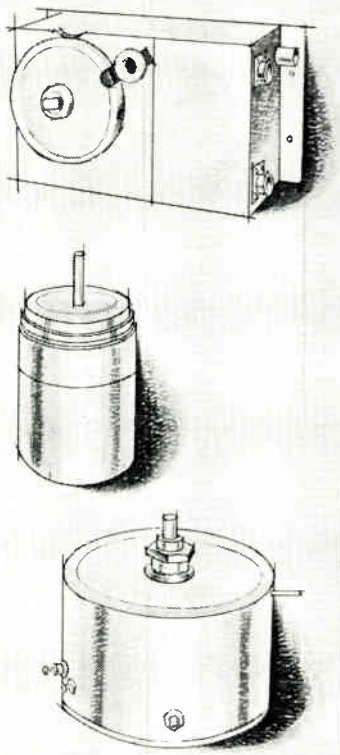

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Send for useful handbook summing up the most important developments to date regarding the theoretical aspects of phase shifter design and application.

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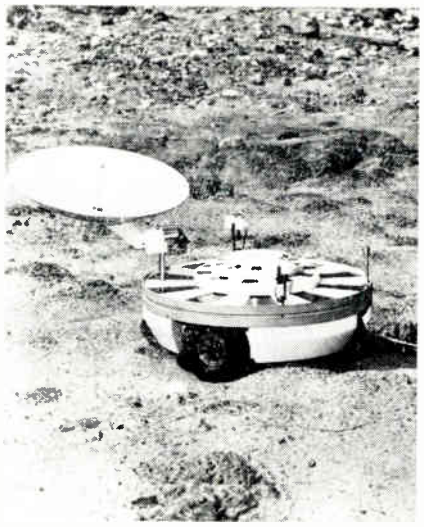
BY THE LIGHT OF THE MOON



Model of a lunar roving vehicle produced by Westinghouse Defense Center. It is designed to roam the moon's surface for 100 miles to locate landing sites for Apollo and others. The vehicle would detect crevasses, and also carry stereo television cameras to transmit surface conditions back to earth receivers.

PHILCO OFFERS LOW-NOISE TUNNEL DIODE AMPLIFIER

Philco has come up with a tunnel diode amplifier with a top noise figure of 4.5 db and 18 to 20 db gain over bandwidths as high as 20%.

The new P701 tunnel diode amplifier is designed as a low noise front-end for microwave systems. It voids the need for cable runs used between antenna and secondary receivers in standard systems.

The amplifiers are also adaptable to existing radars, and are promising for use in more complex phased array systems. The P701 gives stable service despite any mismatch at input or output posts.

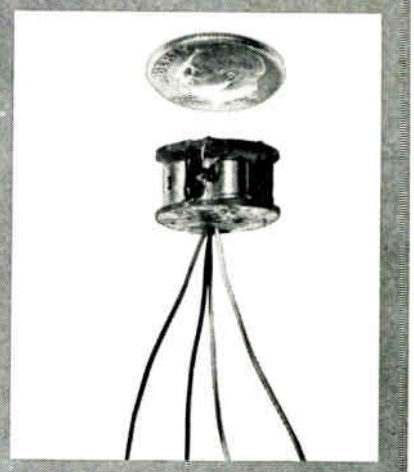
It can be battery-run with a 3,000 hour life, or powered from 110 volts ac.

NAVY ISSUES INTEGRATED CIRCUIT SPECS.

Integrated circuit Mil-specs. have been released by the Navy Dept.'s Bureau of Ships.

Included are a general spec., Mil-M-23700 (Navy), and eight number-suffixed specs. describing individual integrated circuits. Circuits involved are diode-transistor logic blocks consisting of logic gates, dual inverters and memory diode clusters.

The specs. describe circuits developed by Univac Div. of Sperry Rand and produced by Motorola Semiconductor for the Buships program.



NEW!

Smaller-than-a-dime, Bulova solid state sensor and feedback package assures electronic temperature control to ±.1°C.

Bulova design, circuit and production advances wrap-up in a 5/8" x 7/16", 7 gram package, a precise electronic thermostat — the Bulova TRANSISTAT®*. The TRANSISTAT uses an external thermistor for exact temperature control and a temperature sensitive resistance bridge, DC difference amplifier and silicon controlled rectifier switch (SCR) to replace conventional components. This solid state device is similar to the mechanical thermostats except on-off switching is accomplished electronically with no moving parts, therefore extending operating life and improving reliability. Factory set temperatures run from +25°C to +100°C ±2°C with ±.1°C accuracy. Voltages range from 26 VAC to 120 VAC. Current output is held to 1 amp maximum.

Originally designed for a new line of Bulova high precision temperature controlled ovens, the TRANSISTAT assures accuracy wherever a controlled thermal source is required — wherever size, weight and reliability are critical. Meets environmental MIL specs, too. For technical data sheets or additional information write — Bulova Electronics Division, 40-02 61st Street, Woodside 77, New York.

*Pat. Pending

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361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400

Please send me further information on the items I have circled above.
Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

EI-09 NOVEMBER, 1963

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- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Types of Military Products and Equipment.
- ☐ Mfr. of electronic components, parts, tubes and like products.
- ☐ Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
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- ☐ Independent research, test, design laboratories and independent consultants—not part of a mfg. Co.
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Signature _____

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- ☐ Mfr. of non-military electronic instruments, measuring, control and test equipment.
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- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Types of Military Products and Equipment.
- ☐ Mfr. of electronic components, parts, tubes and like products.
- ☐ Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
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- ☐ Independent research, test, design laboratories and independent consultants—not part of a mfg. Co.
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Introducing the new CEC 5-133 datagraph recording oscillograph

The ultimate achievement of today's recognized leader in oscillography

The 5-133 DATAGRAPH Oscillograph is a rack-mounted or bench-mounted direct-writing instrument producing 36 or 52 channels of data on 12-inch-wide light-sensitive-paper. Superior performance, the maximum in operator convenience, and superb styling have been perfectly blended in an oscillograph that fulfills and surpasses the most critical requirements of modern technology. For additional information on this outstanding new instrument, call your CEC sales and service office or write for Bulletin CEC 5133-X2.

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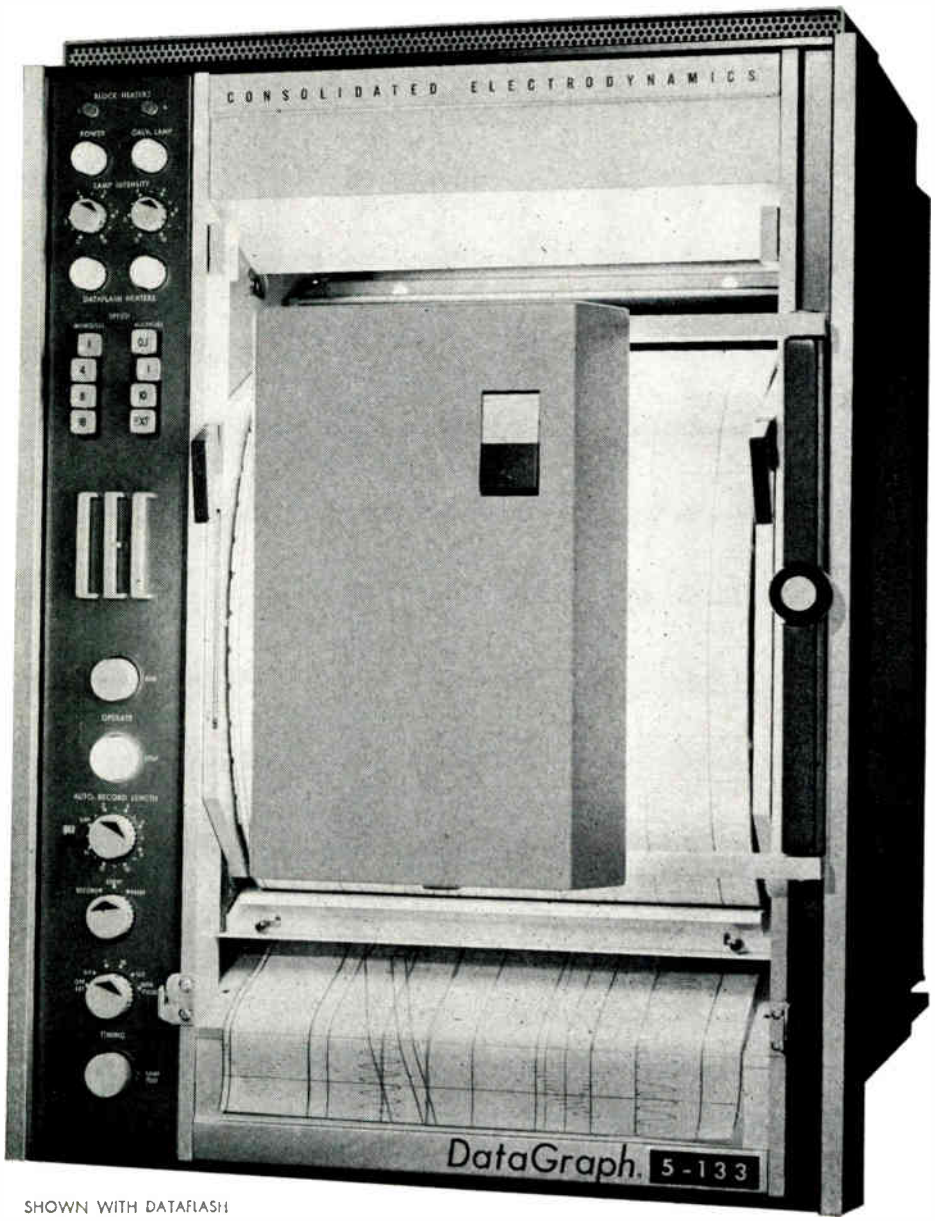

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Features

STATIC MAGNETIC REGULATED LAMP POWER SUPPLY – *provides proper power to lamp regardless of input voltage variations, allows start/restart times of less than one second.*

SLOT-EXIT CAPABILITY – *up to 160 inches-per-second.*

ADJUSTABLE GRID LINE INTENSITY – *continuous variable vernier control.*

NEW TIMING LINE GENERATOR – *electronically flashes timing lines at intervals of 10, 1, 1/10, 1/100, and 1/1000 second.*

RECORD/EVENT NUMBERING – *selected by front panel switch.*

AUTOMATIC RECORD LENGTH CONTROL – *continuously variable from 0 to 15 feet; multiplier extends range to 0 to 150 feet.*

TWELVE RECORDING SPEEDS – *pushbutton selectable speeds of .1, .4, .8, 1, 1.6, 4, 8, 10, 16, 40, 80, and 160 inches-per-second.*

TRACE IDENTIFICATION – *trace interruption and trace numbering.*

VIBRATION ISOLATION – *four isolator mounts on recorder and four on the drive motor/transmission assembly.*

GALVO LIGHT INTENSITY CONTROLS – *manual and automatic controls provide optimum trace quality for each block.*

FILTERED AIR COOLING – *cools and pressurizes the optical module for maximum cleanliness.*

MODULE CONSTRUCTION – *all modules removable as single assemblies.*

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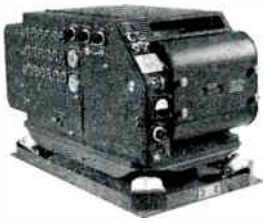
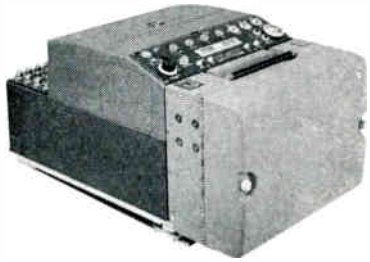
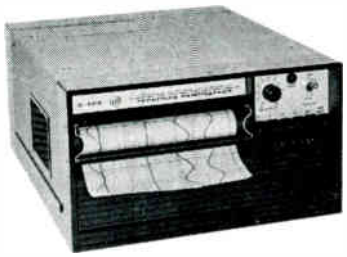
to measure with CEC



CEC's 5-114 DATAGRAPH Recording Oscillograph is available in 18 or 26 trace models; produces 225-ft. records on 7-inch-wide paper. The instrument's DATARITE accessory provides immediate access to records.



CEC's 5-119V DATAGRAPH Recording Oscillograph, the "universal" oscillograph, makes conventional, DATARITE® (Flash Developing Process), or print-out records; 36 or 52 channels, a-c or d-c models with 12″ wide oscillograms. Speed: 0.1 to 160 ips.



CEC's 5-124 DATAGRAPH Recording Oscillograph is portable, direct-writing, weighs only 40 pounds. It is low cost and loads easily. Up to 18 traces may be recorded on 7″-wide-paper. Further data? Call or write for Bulletins in CEC Kit #3472-X2.

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NEW TI PROCESS CAN SPEED USE OF SEMICON NETWORKS

Texas Instruments disclosed new materials and tools for working with and handling semiconductor integrated circuits.

According to TI, reliability of circuits is preserved throughout production, handling and test. Vice President R. W. Olson said the new process and its tools will offer an easy and cheaper means for equipment makers, such as OEM's, to work with semiconductor networks and circuits.

TI and other leading firms are increasing their outputs on semiconductor networks, but there is very little equipment able to realize full value of network reliability.

Olson said that "with these new TI tools, the user of integrated circuits has nearly every item he needs for high reliability equipment assembly."

The TI process includes five items of interest. Plastic carriers will ease handling and storing of single networks. Shearing tools are included to remove networks from the carrier at assembling time.

Metal-clad circuit board materials were developed for making high-reliability welds to networks and other parts. A high-speed welder with automatic controls permits even untried operators to weld both the tiny circuits and standard parts on circuit boards with great reliability.

An automatically programmed tester can perform as many as 36 tests on a network in one and a half seconds.

NEW MICROWAVE SYSTEM FOR PUERTO RICO POLICE

Puerto Rico Police are getting a new, complete two-way radio and microwave system.

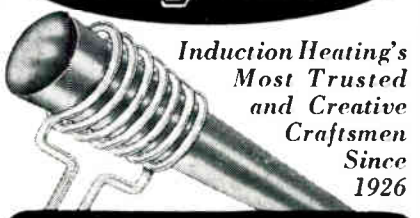
Motorola Overseas Corp. will install the system and also provide operation and maintenance training through its local representatives, Radiotelephone Communicators of Puerto Rico, Inc.

The comprehensive island-wide system comprising VHF mobile communication units, base station installations and MR-20 microwave stations will be in service before July 1964.

The system also will include telephone, teletype, data processing, radio control and alarm channels throughout the island.

Point-to-point facsimile service for all printed matter will be provided.

LepeL



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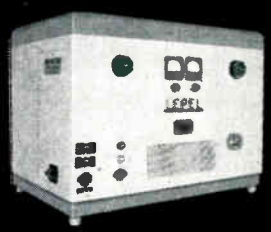

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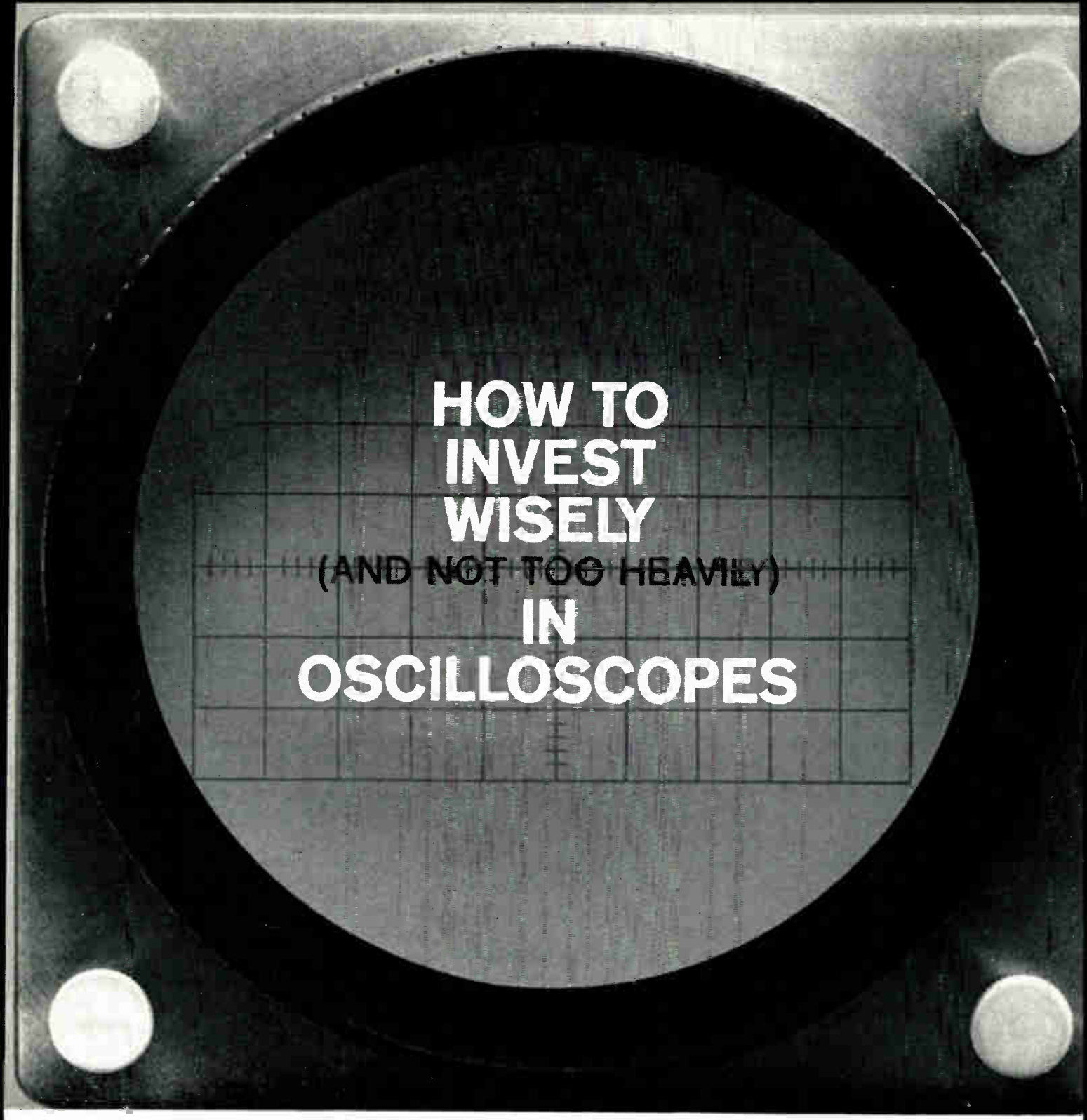


OSCILLOSCOPES aren't necessarily cheaper by the dozen. Not if six will do the work of a dozen. Fairchild's new solid-state line offers you the widest choice of transistorized scopes in the field—so that you can cover all of your requirements with fewer instruments. The versatility is designed in, along with unsurpassed precision.

Consider, too, the advantages of solid-state circuitry. Compactness (the rack model is only 7" high). Low power requirements (no cooling fans needed). MIL reliability (through advanced engineering and Fairchild silicon semiconductors).

Before you invest in another scope, compare features. Compare performance. Then invest wisely . . . in Fairchild.

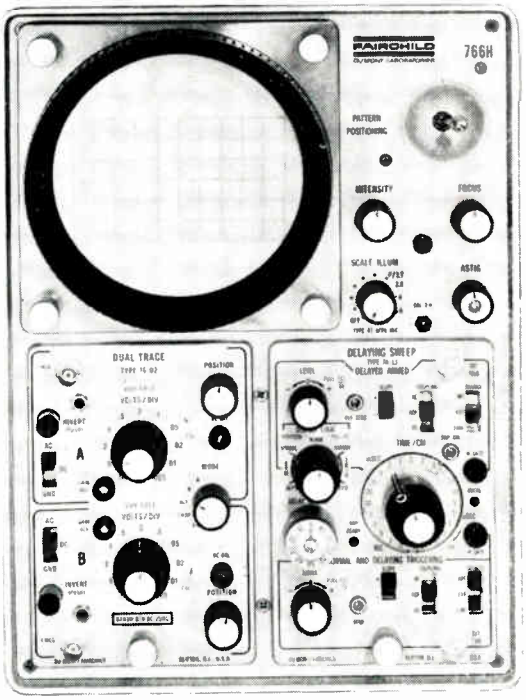
World Radio History

NEW FAIRCHILD SOLID-STATE SCOPES GIVE YOU UNMATCHED VERSATILITY WITH MIL RELIABILITY

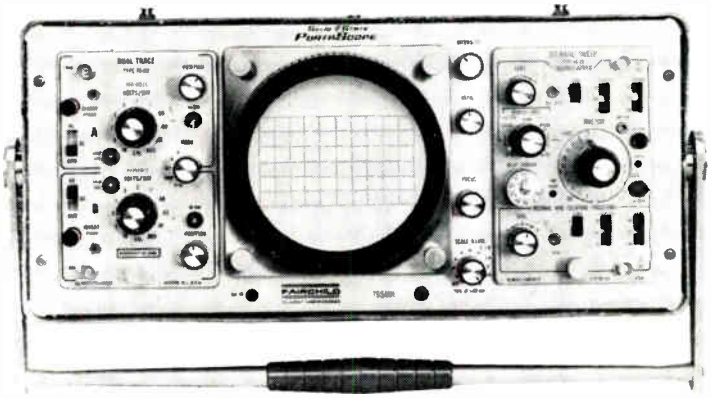
The new 765 Series shown here is made in three basic configurations: bench, rack mounted and truly lightweight portable. The dual interchangeable plug-in units below work into any model in the 765 Series to provide laboratory to production line applications.

Additional versatility is afforded by an option of 5 kv or 13 kv CRT. The higher accelerating potential permits observation or recording of fast transients or pulses with low repetition rates. A no-parallax internal CRT graticule is optional.

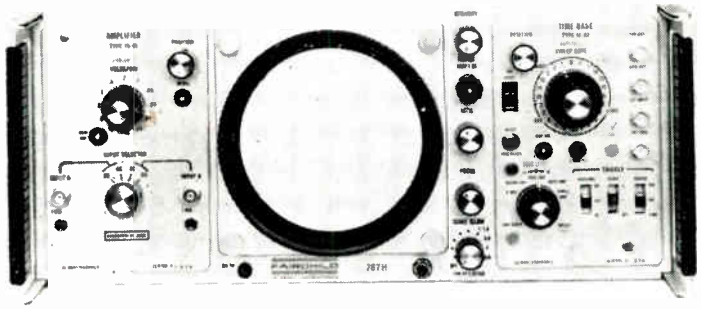
CHECK THESE PERFORMANCE FEATURES • Transistorized for compactness, MIL reliability, low power requirements (185 watts—no cooling fans) • Frequency range: dc-100 mc • Sensitivity: up to 0.5 mv/cm • Rise time: to 0.35 nsec • Sweep rate: 10 nsec/cm—1 min. full scale • 6 x 10 cm display area • No-parallax internal graticule optional • Dual interchangeable plug-ins drive CRT directly for maximum accuracy—no intermediate circuitry



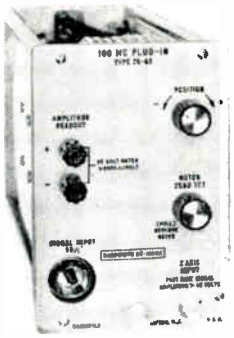
Type 766—Bench model provides high precision measurements in all laboratory or production line applications.



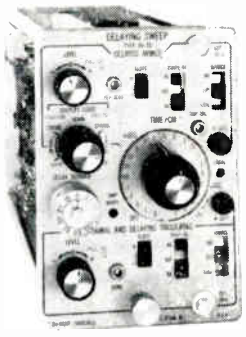
Type 765 "Portascope"®—Fiberglass case is no larger than an overnight bag. Cover of case holds probes, leads, accessories. Weighs only 35 lbs. with case. Also available in militarized version.



Type 767—Rack-mount configuration is standard 19" in width, only 7" high.



Type 76-05—100 mc Plug-In



Type 74-13—Dual Time Base Delaying Sweep

NINE PLUG-INS AVAILABLE TODAY...MORE COMING SOON

Dual interchangeable plug-ins give Fairchild Series 765 scopes the widest range of application. With 9 units available now, 3 being readied for production, and still others in development, your investment in a Series 765 scope is insured against obsolescence for years to come.

Write for New Literature

A new catalog with specifications and prices on Fairchild scopes, scope cameras and accessories is waiting for you. Write for it today. Fairchild Scientific Instruments, Dept. 211, 750 Bloomfield Ave., Clifton, N. J.

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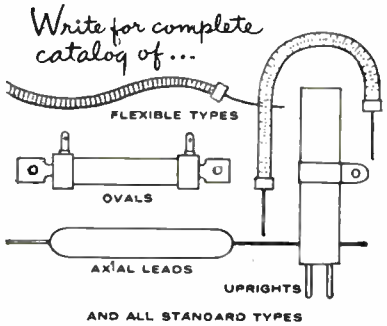
An exclusive Lectrohm development with all the properties desirable in a quality resistor. Design and application insures maximum protection of the all-welded resistor element from moisture, corrosive environments, heat, abrasion, thermal and mechanical shock and vibration. Serious overloads for reasonable periods of time do not impair properties and its high dielectric strength is unaffected by the widest ranges of conditions. Production quantities available from 1 to 10 watts. Sample available upon request.



From 1 to 400 watts, your resistor requirements are best served by Lectrohm. Write Dept. EI-11

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NEW LITTON SECTION DEALS IN MICROWAVE COOKING UNITS

A new Litton Industries division, dealing in electronic microwave equipment for preparing food and for industrial processes, was disclosed by Litton President Roy L. Ash.

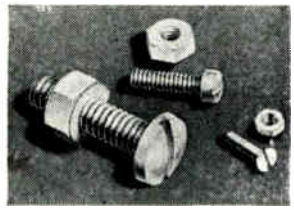
Mr. Ash said that Litton has been supplying microwave components for electronic cooking and heating equipment for several years. Recent technical advances, he pointed out, have wide application to the food service field. Preparation of food by microwave techniques will soon be commonplace.

Litton will concentrate on units for all types of food for the growing away-from-home food service and vending markets.

OPTICAL DIODE BEAMS INFRARED SIGNALS

RCA's type 40044 gallium-arsenide diode can beam infrared light signals for TV transmission. Potential uses include point-to-point military and industrial communications and long-range space communications, ultra-low power indicator lamps, and readout lamps for computers.

GRC



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● GRC's complete line of high quality close tolerance molded screws and hex nuts include screws in standard commercial heads—Phillips or slotted types—in sizes from #4 thru 1/4"; hex nuts in ten sizes (#2 thru 5/16") GRC molded miniature machine screws—half the weight of aluminum—in sizes as small as #10 make more compact designs possible. GRC's single cavity molding technique adds exceptional uniformity, accuracy, economy to Nylon's & Delrin's high strength-to-weight ratio, built-in electrical insulating qualities, stability, resilience and elasticity. GRC's molded fasteners are available from stock in a wide range of types, sizes and lengths.

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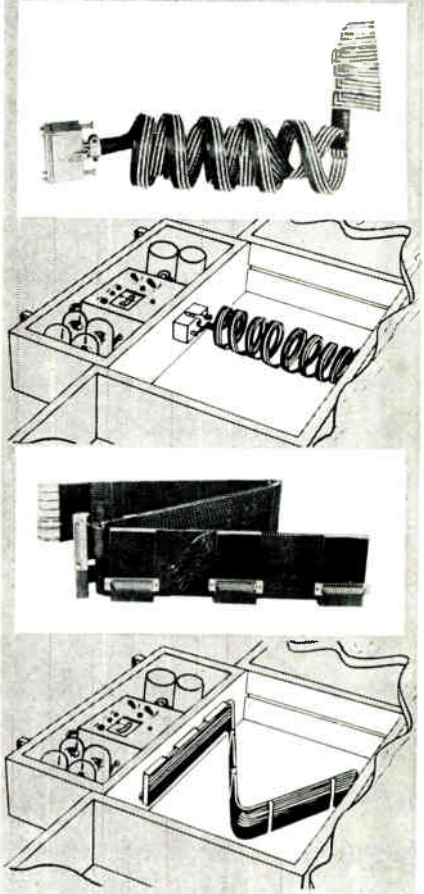

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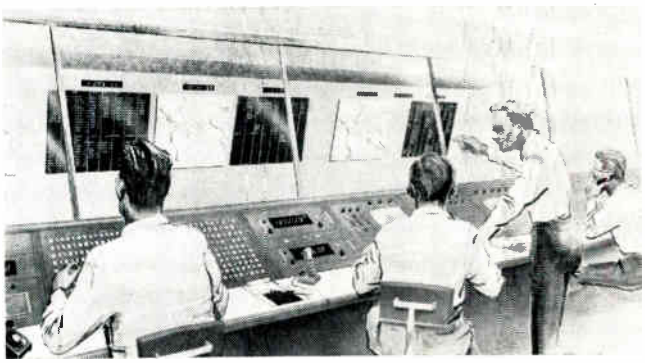
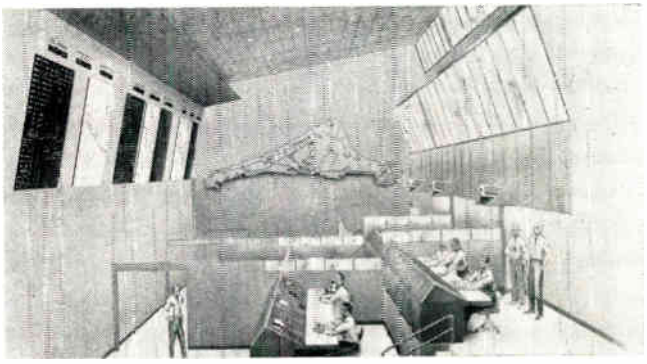


Superintendent of Range Operations Console—Artist's view of nerve core for proposed control center at Cape Canaveral for Atlantic Missile Range. Center permits simultaneous countdowns and supports.



Operations and Display Theater—three-story console area of proposed control center for Atlantic Missile Range contains time data displays, coordination-project office consoles, including 137 units.

NICB SAYS ENGINEERS HEAD INDUSTRY R&D JOB LISTS

Of 302,500 scientists and engineers employed in industrial R&D in 1960, more than 224,000 were engineers, reports the National Industrial Conference Board.

An estimated one-third of the total industrial R&D force in 1962 consisted of engineers and scientists. The rest were technicians, craftsmen, clerks and others assisting professionals in their work.

The difference in job structures reflects different research orientation. Engineers account for 90% of all R&D professionals in electrical equipment, aircraft, machinery, instruments and fabricated metal group industries. Chemists account for more than half of the staff of chemical firms.

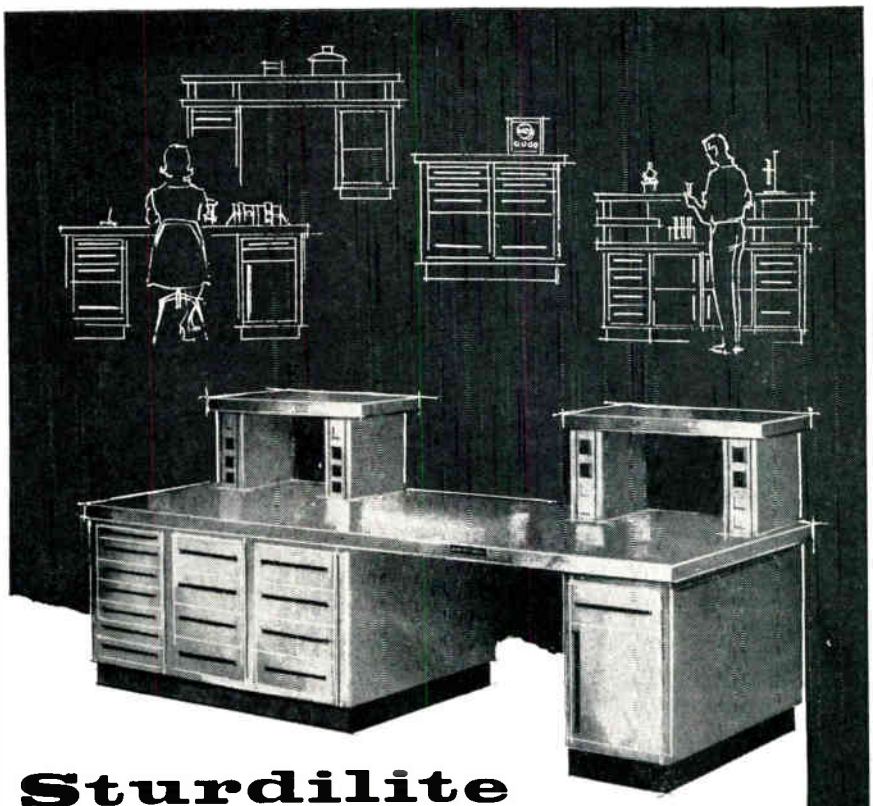
MICROWAVE SERVICE ALERTS, MAPS INTERFERENCE DATA

Microwave system protection and coordination service, and market research of the microwave community, is offered by Microwave Services International, Inc.

For coordination, the Denville, N. J., firm offers map preparation on existing microwave systems and characteristics. This is a valuable tool for microwave market researchers.

For protection against new interference, MSI alerts a client of new system construction. Alerting and data service provides data on new construction. Data and Engineering Service alerts and estimates new system interference.

A complete interference service called Potential Interference Evaluation provides all of the above. It also offers interference calculations, recommendations and briefs.



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MICROWAVES A CHEAP TEST FOR SOLID-FUEL MOTORS

Recent studies at Atlantic Research Corp. show that microwaves and low-frequency ultrasonics have strong prospects for routine testing of solid-propellant rocket motors and materials.

Microwave—or radar—energy used for quality testing can be focused, reflected and directed at the test sample. It can go through large masses of non-metal matter. The energy is absorbed by certain materials at discrete frequencies and passes through them with ease at other frequencies.

R. C. Stinebring, Supervisor of Nondestructive Testing at Atlantic Research, with R. H. Harrison, has used this phenomenon for detecting undercuring in rocket motor propellants. They have detected errors in formulation of propellant and adhesive systems, and in motor construction.

Internal parts of a rocket motor can be checked and inspected without harming the finished product through these testing techniques.

Atlantic Research feels that the use of these new techniques will result in improved reliability. They are cheaper to use than destructive tests.

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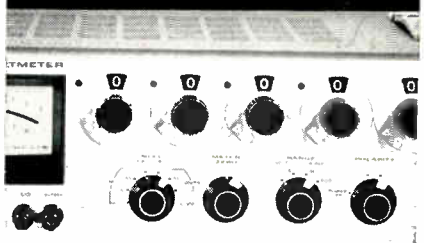

New Differential Voltmeter

Keithley 660 measures dc voltages with the accuracy and stability of a laboratory standard and the ease and low cost of an ordinary VTVM.

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World Radio History

NEW AF SYSTEM IN TEST MAY PENETRATE PLASMA

First flight tests have begun on a new communication system, designed to penetrate the plasma sheath around spacecraft re-entering the earth's atmosphere. Plasma results when air in front of the craft heats up to 20,000°F. or more.

The system, developed by RCA for the X-20 (Dyna-Soar), will undergo a series of air-to-ground tests at Greater Wilmington Airport, New Castle, Del.

Plasma is a good conductor of electricity. Its flow is affected by a magnetic field. Air in its normal state has neither property. Varied techniques have been under study to find a way to send r-f signals through plasma. The approach looked on as most feasible is to use super high frequencies.

RCA concentrated on this theory. The new system will use super high frequencies (SHF) in an effort to get through the sheath. With success, it will be possible to maintain constant contact during the critical re-entry period, and help X-20 pilots avoid radio blackout.

HONEYWELL ENGINEERS CITED FOR NEW GUIDANCE SYSTEM

Six Honeywell engineers have been awarded the Air Force Systems Command Award for Outstanding Achievement for finding a new air and space craft guidance technique.

The development, an all-fluid control system, was credited by the Air Force with "reducing the complexity, size and cost spiral associated with conversion of electrical-mechanical control systems."

The Air Force described the new technique as a "technological breakthrough."

Engineers honored were Werner Egli, Richard A. Evans, Louis J. Guertin, William J. Lewis, David L. Paine and Richard J. Reilly.

SEA PRESSURE TANKS

Facilities to simulate extreme pressures to which deep sea research vehicles and instruments are subjected are being installed at Westinghouse's Defense Center in Baltimore.

Equipment will include two steel tanks in reinforced concrete to duplicate pressures of 5000 and 7000 lbs. sq. in. found at depths of approximately 11,000 and 16,000 feet respectively.

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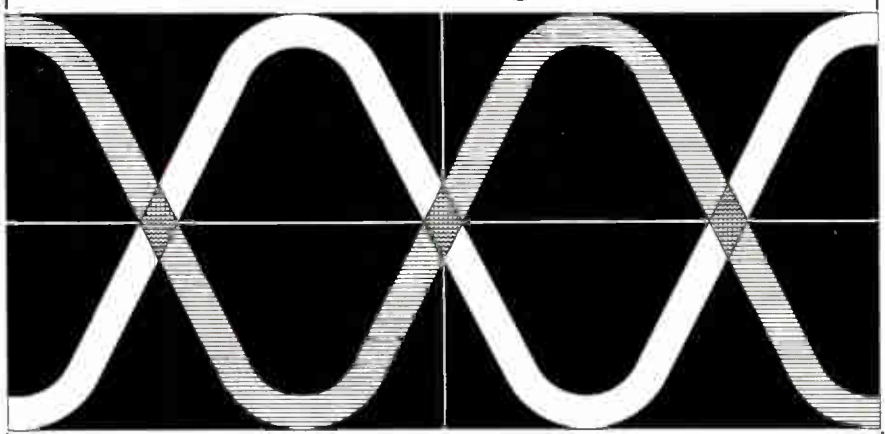

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MICROWAVE SYSTEM TO LINK MAJOR NEW ZEALAND CITIES

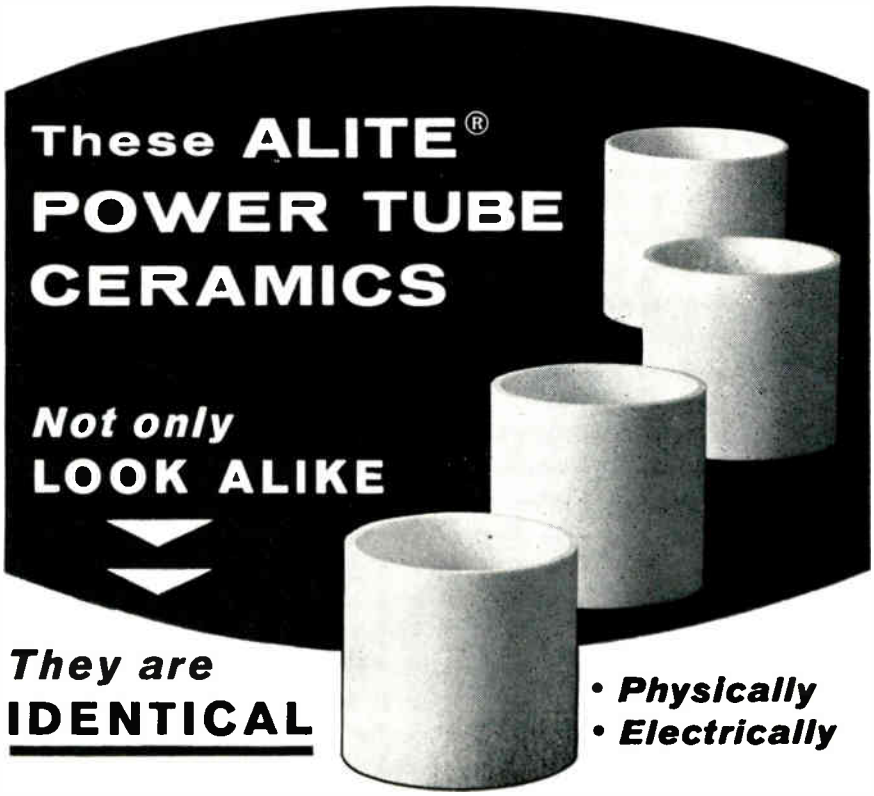
Post Office officials in New Zealand have given an $800,000 contract for a 425-mile microwave radio system to General Telephone & Electronics International, Inc.

The specs call for a Type 76 microwave system for telephone communications made by Lenkurt Electric Co., Inc., a GT&E subsidiary. Lenkurt is expected to produce and install the system by the end of 1964.

Type 76 system has a capacity up to 960 telephone channels at once. Produced primarily for the domestic communications market, the system also has been exported to Canada and the Middle East.

The New Zealand system will provide links between its capital city of Wellington on the south end of the North Island and major cities along the east coast of South Island.

Earlier in the year Lenkurt delivered $350,000 worth of microwave equipment linking major cities in the north end of North Island.



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INDIAN OFFICIAL OFFERS 'INFINITE MARKET' TO U. S.

An "infinite" market exists in India for U. S. electronics firms that set up plants there, according to an official of the Indian government.

Dr. Arun K. Ghosh, first secretary of the Indian Embassy, called the electronics segment of his country's economy "very crucial," while demand continues to grow steadily as the health of the economy segments improve.

He said a top-level Government committee headed by the chairman of the Indian Atomic Energy Commission has been formed to study the electronic needs of the nation.

He held out such lures to foreign investment as tax concessions, a pool of well-trained manpower and an assurance of non-discrimination against foreign-financed enterprises.

Dr. Ghosh admitted that Indian taxes are high. He also noted a 1% to 5% depreciation rate during the first five years of operation of a plant financed by foreign funds.

DATA CONSOLES DELIVERED TO THE NAVY FROM HUGHES

First production models of data display consoles for the Naval Tactical Data System (NTDS) have been delivered by Hughes Aircraft Co.

C. H. Brubaker, Hughes vice president and ground systems group executive, said that additional consoles, enough to equip more than 20 ships of the U. S. fleet, are scheduled.

The Navy received test models of the consoles in 1958 and they underwent successful testing at the Naval Electronics Laboratory in San Diego.

Consoles being delivered by Hughes, will be used for target evaluation, situation analysis, and weapons assignments. They will cover operations from air traffic control to tactical decision making.

MELPAR GOES INTEGRATED

Another firm has entered the integrated circuit field. Melpar, Inc., of Falls Church, Va., has begun production and marketing of four integrated circuits, according to E. M. Bostick, president of the firm.

The four circuits are: Single Nand Gate, Dual Nand Gate, R. S. Flip-Flop, and an operational amplifier. The firm plans to devote a major part of integrated circuit efforts to specialized customer circuits.

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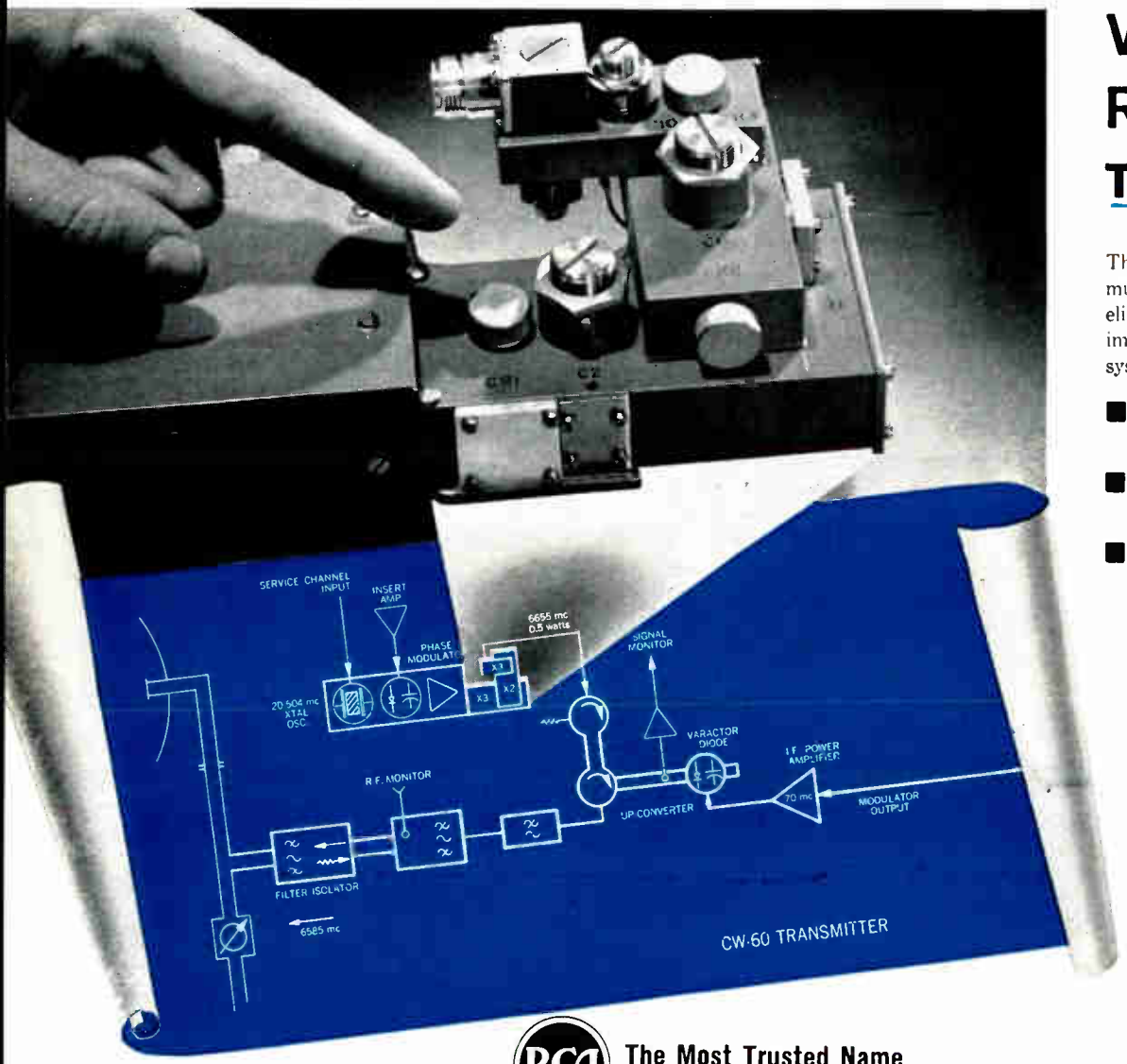

Varactor Multiplier Cavities Replace Tubes in RCA CW-60

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These unique building blocks (shown at left) convert VHF to microwave frequencies by multiplication. The use of varactor multiplier cavities and other solid-state devices eliminates all tubes and relays in RCA CW-60 microwave systems. It is one of the most important reasons why this equipment is now being purchased for modern microwave systems. Other important reasons include the following:

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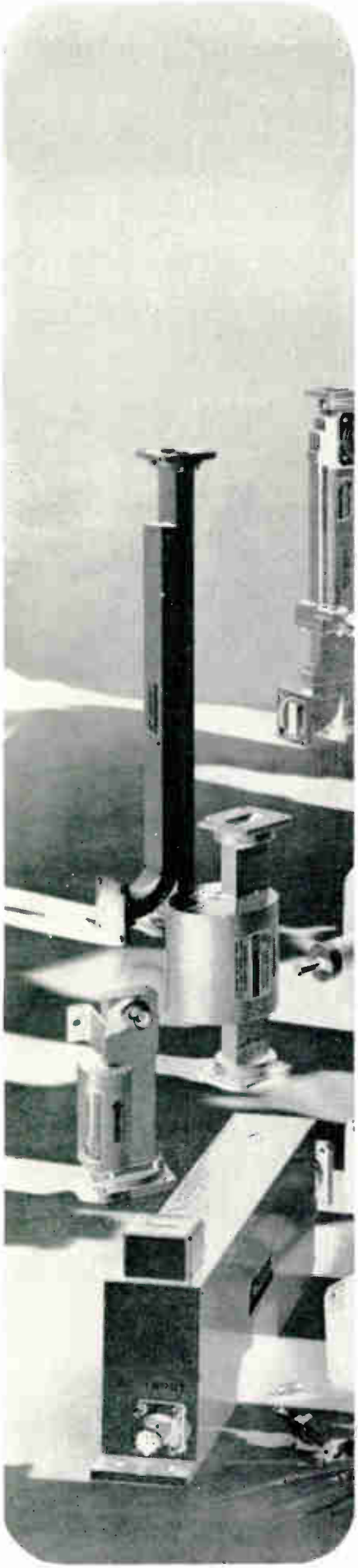

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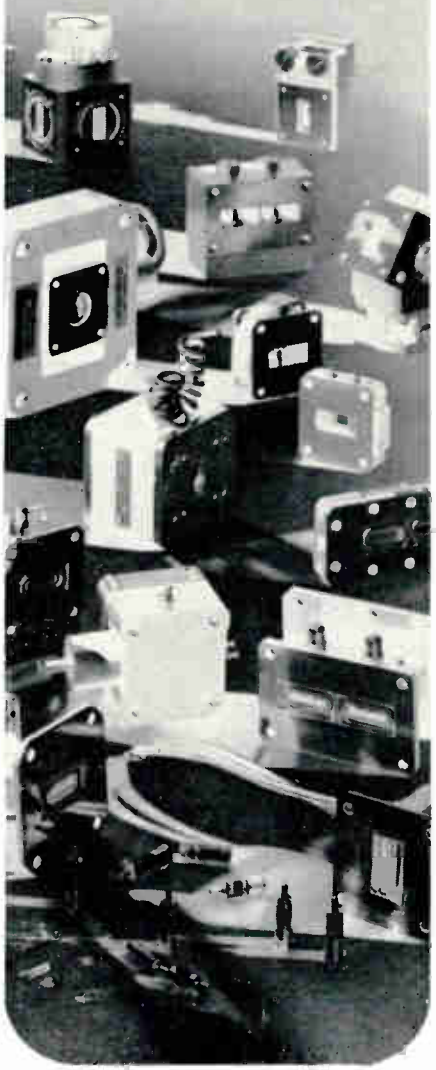

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World Radio History

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LONG-RANGE ANTENNA

The compact Helicyl antenna facilitates long-distance communications with missile-tracking ships. Engineered by ITT Federal Laboratories, it comprises a remotely-tunable helical loading coil plus top-hat loading. The tuning range is 2-30MC with an SW ratio of less than 2. Efficiency is 40% at 2MC. Power-handling capability is reported to be over 10kw peak envelope power.

A real-time data-processing system for on-line control of a computer from anywhere in the world will be exhibited at the FJCC by Honeywell Electronic Data Processing. The computer will be controlled by standard dial-telegraph networks. To communicate with and control a computer, its number is dialed and the instructions or information is typed in. Incoming information is directed into the random-access memory of a medium-scale Honeywell 400 computer. When called upon, the H-400 will select any single portion of the memory file and transmit its contents within msec. to its destination.

The National Association of Broadcasters has filed objections to the Federal Aviation Agency's proposed criteria for establishing antenna farms for radio and TV transmitters. The criteria proposed by FAA suggests a unilateral rule that gives aeronautical operations primary consideration and completely ignores broadcast requirements. The NAB feels that adoption of such a policy without consideration of the effects of such determinations upon the broadcast industry are contrary to broad public interests.

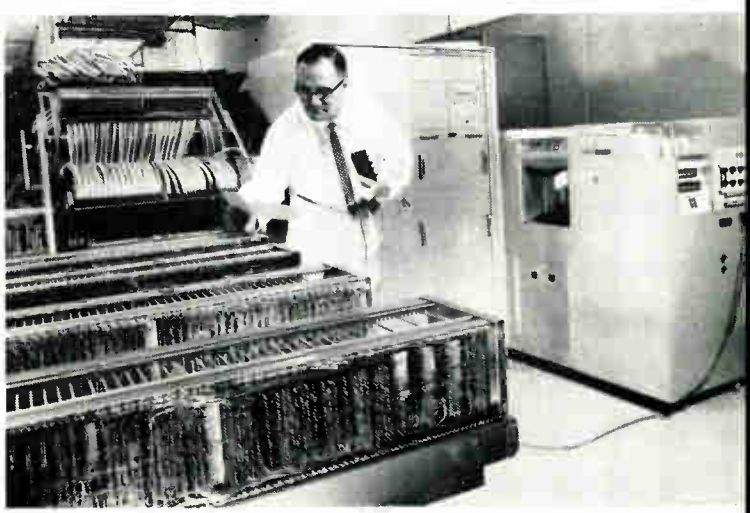
Some broadcast stations are monitoring and divulging the contents of police and fire radio transmissions. And the departments are complaining to the FCC. News bulletins based on intercepted radio messages have attracted so many people that the movement of emergency vehicles was impeded. There have also been allegations that the disclosures have contributed to the escape of fugitives. The Commission is reminding these stations that intercepting and divulging the contents of these messages are in violation of Section 605 of the Communications Act.

The 4,000 towboats and tugboats on the nation's inland waterways may soon have a standardized VHF-FM mobile radiotelephone system, permitting direct ship-to-ship and ship-to-shore communications. This will be possible through a new program sponsored by American Waterways Operators, Inc. The AWO envisions multi-channel VHF-FM sets on all boats and harbor craft plying inland waterways as well as communications with locks and movable bridges. RCA will supply the system.

A single package 28 lb. space radar system, for orbital rendezvous and landing from orbit, is under development at Emerson Electric's Electronics and Space Division. The FM/CW system uses a single 2-ft. diameter antenna that accommodates look angles for both rendezvous and landing. It operates in the Ku band with 0.1w transmitter power. Cooperative rendezvous range extends to 250 nautical miles at range rates as high as 3000 ft./sec. A non-cooperative rendezvous capability can be employed at short ranges as an emergency back-up mode in the event of beacon failure.

FAULT FINDER

The Flexible Automatic Circuit Tester (FACT), normally used to check out missiles, has been adapted by the Stromberg-Carlson division of General Dynamics Corp. to test circuit cards and patch boards for telephone exchanges. During production, FACT checks the wiring on printed-circuit card cells for continuity and leakage. It determines if all wiring meets specifications. The test unit uses automated programming techniques.



World Radio History

CONTROL SYSTEM COMPENSATION

Control systems are designed to meet two conditions— satisfactory steady-state error, and proper dynamic stability. These demands are conflicting, and a compromise must be achieved. This article describes one approach.

IN A FEEDBACK CONTROL SYSTEM, it is customary for the first prototype to be unsatisfactory. There are two conflicting needs which must be satisfied and it is improbable that both conditions will be met without much redesign and compensation. These two needs are satisfactory steady-state error and proper dynamic stability. One method of reaching a compromise between these two conflicting needs is covered here.

* * *

University of Kenutcky laboratory equipment is used by engineer John Sweeney to find the best compensation network.

Phase Lead Compensation

Let's consider the system in Fig. 1a. Fig. 1b represents the feedback control system in Fig. 1a after a phase lead network G_c has been placed in series with the forward gain, G.

One typical phase lead network is shown in Fig. 2. A step-by-step compensation design procedure is outlined here:

1. On a log plot of G, refer to Fig. 1a, find the phase margin. Phase margin is read when G crosses the zero db axis. Note ω.

2. Calculate phase lead needed to give the desired phase margin.

3. From α vs. ϕ_M table, find α. [From graph].

4. Given α and ω, calculate τ from the relation:

$$\omega = \frac{1}{\tau}\sqrt{\frac{1}{\alpha}}.$$

5. Specify the constants for the lead network G_c, as shown in Fig. 1b.

6. Raise gain of the system by a factor of $1/\alpha$. Write the open-loop gain by using the relation:

$$G_{open\text{-}loop} = \left[\frac{1}{\alpha}\right] |G_c|\,|G|.$$

By JOHN S. JACKSON
Assoc. Prof. of Electrical Engineering,
University of Kentucky,
Lexington, Ky.

World Radio History

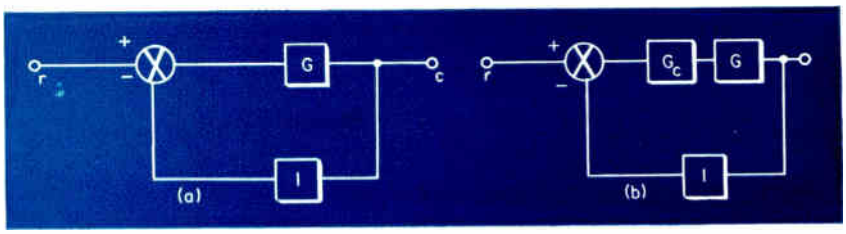


Fig. 1: System being considered for compensation is shown above. Fig. 1b represents feedback control system in Fig. 1a after a lead network G_c has been added.

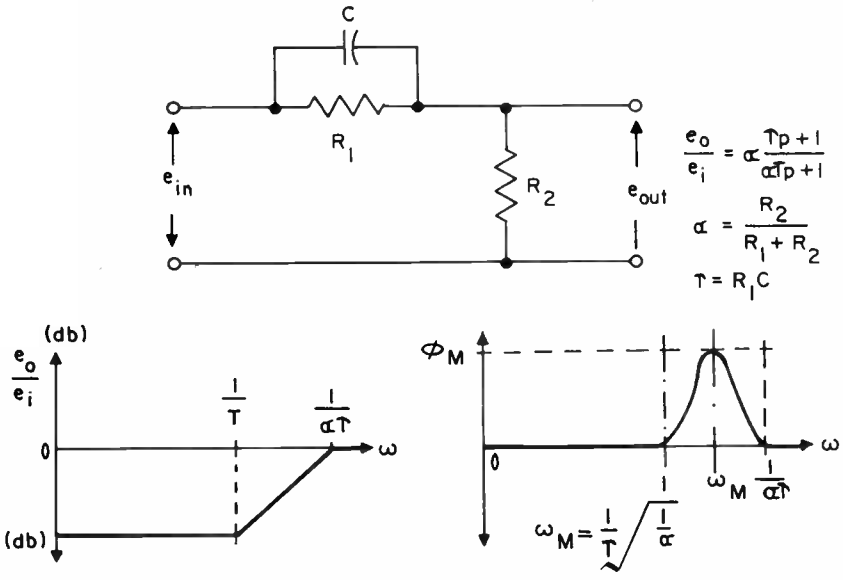


Fig. 2: (left) Phase lead compensation network. Also shown are magnitude (lower left) and phase angle (lower right) plots of the lead compensation net.

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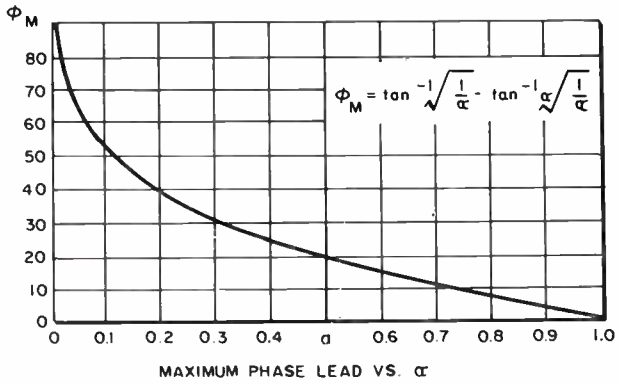
The design chart shown below is used to determine α parameter of phase lead net.



MAXIMUM PHASE LEAD VS. α

7. Make a log plot of this new open-loop gain.
8. Find the new phase margin.

In step 6, the gain must be increased by $1/\alpha$. This compensates for the loss, α, which would have occurred at low frequencies due to insertion of the lead network. This means that low-frequency (l-f) gain of the compensated system is unchanged, but the high-frequency (h-f) gain is increased by a factor $1/\alpha$. This effectively makes the system more sensitive to noise.

This increase in h-f gain has another effect: the zero db gain crossover occurs at a higher frequency than before compensation. Thus, although phase margin at the old crossover is the amount on which the design was based, true phase margin is smaller than the desired design value, due to the increased h-f response.

Due to this effect, phase lead networks designed for leads greater than 50° are impractical. For example, to design a 53° lead network, α must be 0.1. This means that the gain must be increased by a factor of 10, i.e., 20 db. The h-f gain will be increased 20 db, while l-f gain will be unchanged. Gain crossover frequency will be raised to such an extent that the phase margin will be virtually the same as before compensation.

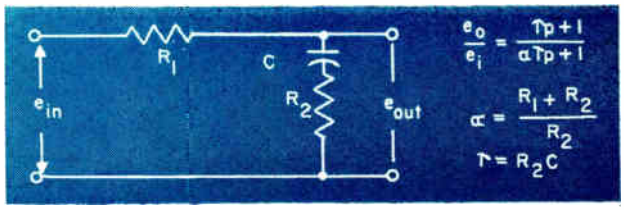


Fig. 3: Phase lag compensation network.

Phase Lag Compensation

Since phase lead networks produce this self-defeating effect, let us now examine the effect of a phase lag network. This network is shown in Fig. 3.

The term "phase lag compensation" is unfortunate. Actually what we are seeking is not more lag, but less. This can be achieved if the gain crossover can

(Continued on following page)

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CONTROL SYSTEM (Concluded)

be made to occur at a frequency where the phase margin is the desired design magnitude. In other words, if the h-f gain can be lowered enough, crossover will occur at the proper point. This is what the lag network shown in Fig. 3 does. The word "gain" should be substituted for "phase lag," since this is actually "gain compensation." A step-by-step compensation design procedure is:

1. Find ω at which desired phase margin exists.
2. Find the reduction in gain needed to achieve the gain crossover at this frequency.
3. Convert db gain to a ratio gain. This ratio is:

$$\alpha = \frac{R_1 + R_2}{R_2} \cdot \quad \text{[See Fig. 3]}$$

4. Choose a design ω one decade below ω_ϕ. Find τ

$$\text{where } \tau = \frac{1}{0.1\ \omega_\phi} \text{ and } \tau = R_2C.$$

5. Specify the phase lag network components from:

$$\tau = R_2C\ ,$$

$$\alpha = \frac{R_1 + R_2}{R_2}\ .$$

Note that in 5, we have three unknowns and two equations. One must be arbitrarily selected. There are two conflicting design criteria: C should be large to achieve a low impedance level, thus eliminating worries about shielding, loading, etc. On the other hand, C should be small because of expense, size, weights etc. Try to make a good engineering guess and proceed.

6. Write the transfer function for the compensated system: G_c, G, Fig. 1b.
7. Make a log plot of the compensated system, and find the actual phase margin.

THE MICROWAVE MARKET IN BRIEF

An analysis of users and customers for microwave products on a percentage basis offers a brief though revealing glimpse of the microwave hardware market:

Market/Customer	Percent of Market
U.S. GOV'T (Defense and Non-Defense)	15%
INDUSTRY	22%
COMMON CARRIER (Telephone, Telegraph)	23%
EXPORT, Overseas (Defense and Non-Defense)	40%

1) Figures include all microwave products
2) Figures do not include Western Electric, largest factor outside of DOD
3) Figures do include firms that sell to Western Electric

If the Electronic Industries total microwave sales estimate for 1963 holds true at $2 billion plus, then some $800 million in microwave products will have been shipped to other nations.

Common Carriers will be using up a larger portion of microwave products on the domestic scene. This is expected to get larger as carriers expand use of microwave systems and ComSat gets into full operation within the next two years.

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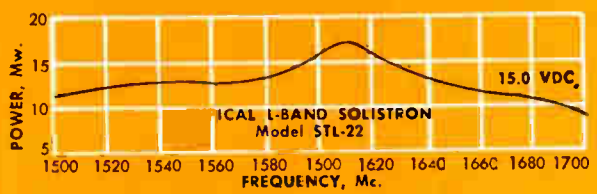

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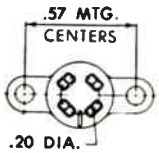

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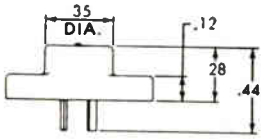

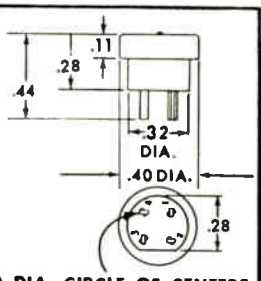

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WHAT'S NEW

ADVANCED RADAR TECHNIQUE

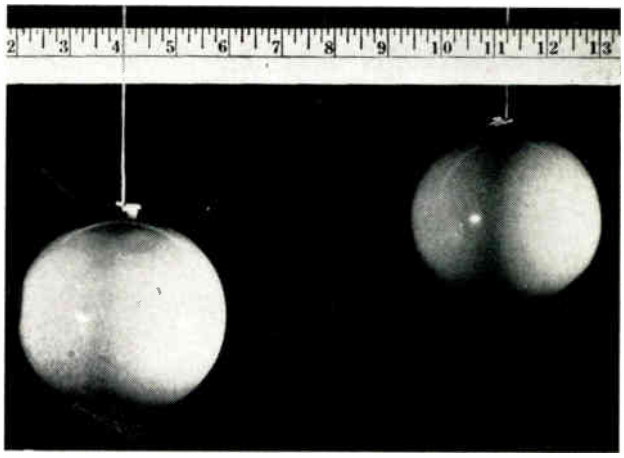
A HIGH RESOLUTION RADAR has been developed at General Dynamics/Electronics, San Diego, Calif.

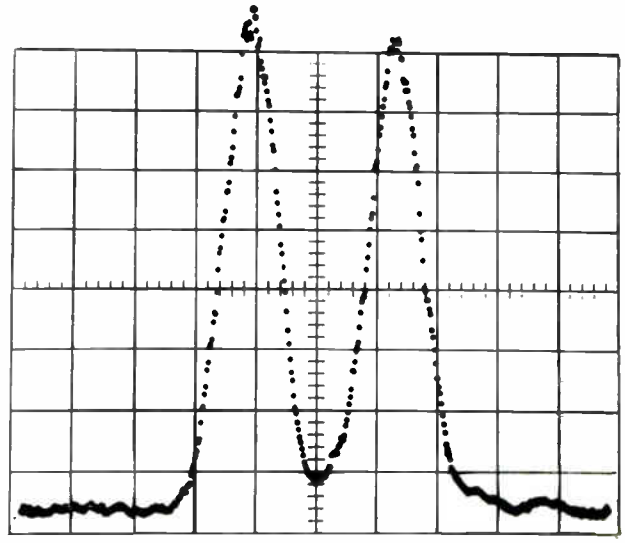
The new method—called Short Pulse Radar—will provide target identification, and discriminate between adjacent objects, separated in range by only a few inches.

This method permits the generation, radiation, reception and display of microwave impulses lasting a fraction of a nsec.

In practice, multiple radar signals are bounced off an irregular shaped object by all radar systems. A normal pulse radar is only capable of detecting the mathematical summation of all of the multiple signals. Use of a radar impulse lasting only a fraction of a nsec. will, however, permit the detection and separate display of each of the multiple signals emanating from reflecting points on the object separated by a few inches.

Side aspect radar return from 4-in. metal balls is shown. Return is photographed on an oscilloscope screen adjusted to display 3 inches of target separation per each major horizontal division.





World Radio History

General Dynamics/Electronics began studies on short pulse methods in 1958. Radar signals have long been used in the lab as a research tool to study many physical phenomena. Short pulse methods enable a researcher to separate the unwanted signals from the signals emanating from the object under test. It is felt that short pulse radar will be a good basic research tool for many of these uses.

Because of its ability to isolate the target from surrounding "clutter," Short Pulse Radar is a valuable tool for locating objects in "clutter." Short Pulse Radar's ability to present separate displays of multiple targets makes a target stand out from the clutter.

Tests using a low power transmitter showed that the radar return from people can be distinguished from other objects at ranges in excess of 1000 ft.

Some potential uses for the radar include high range resolution surface radar; radar cross-section and scattering measurements, and as high range resolution airborne radar.

Use of the short pulse method as a high range resolution surface radar would include airport and harbor traffic control and surveillance, and warship and aircraft identification. In battlefield surveillance, the method would enable military men of the future to distinguish between men and their equipment at great distances.

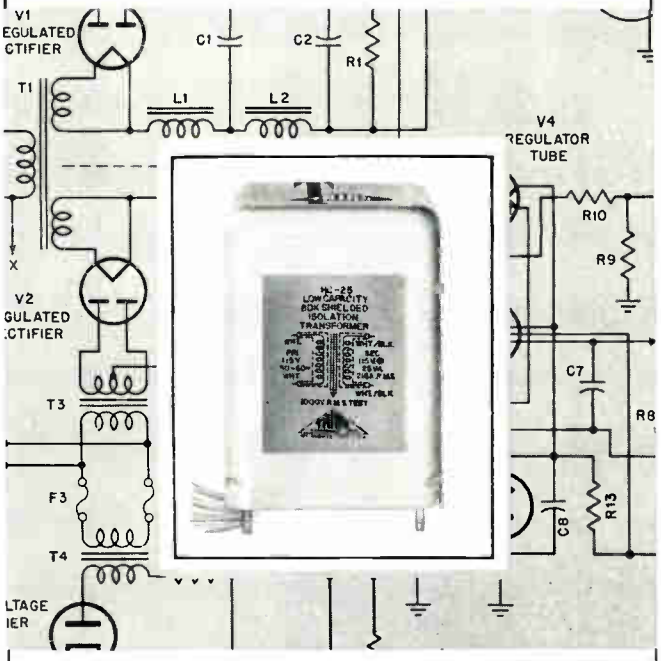
Another use is the determination of the locations of imperfections in waveguide and other types of transmission lines.

It can evaluate the radar cross-section of individual scattering points on complex geometric shapes, such as a nose cone or missile.

Used as a lab tool, it is very useful in the study of signal delays which may take place under varying atmospheric conditions, such as clouds, temperature and varying types of weather.

COMPUTERS AND EMPLOYMENT were discussed at a recent hearing of the Senate Subcommittee on Employment and Manpower. Isaac L. Auerbach, President, International Federation for Information Processing, called for two lengthy programs to cope with the impact of technology on jobs. One deals with education; he stressed complete revision of grade and secondary school curricula; provide training in information sciences; speed up development and use of programmed-instruction techniques. The second program deals with an early-warning system to detect areas of declining employment long before the vital stage. He suggests a mathematical model of data on employment status in most U. S. areas. Model can be built and handled on a computer. We could test a number of strategies designed to raise employment in an area.

SOLUTION!



If you're wrestling with a difficult design problem involving transformers — look to Triad. Over 1,600 off-the-shelf transformers are available for immediate delivery. Many of these transformers were developed to meet exacting military and commercial needs.

Typical of this advanced Triad technology are box-shielding techniques developed to hold winding-to-winding capacity to less than 0.03 mmfd and offer common-mode signal rejection to over 130 db for interferences of less than 400 cps. Other Triad transformers carry equally impressive specifications, from the smallest miniature transistor models to the largest heavy-duty power transformers.

Next time you have a design problem, check with your local distributor. Chances are great that there's just the right Triad transformer for your needs in stock. In the meantime, write for our latest catalog: TR-63/64.

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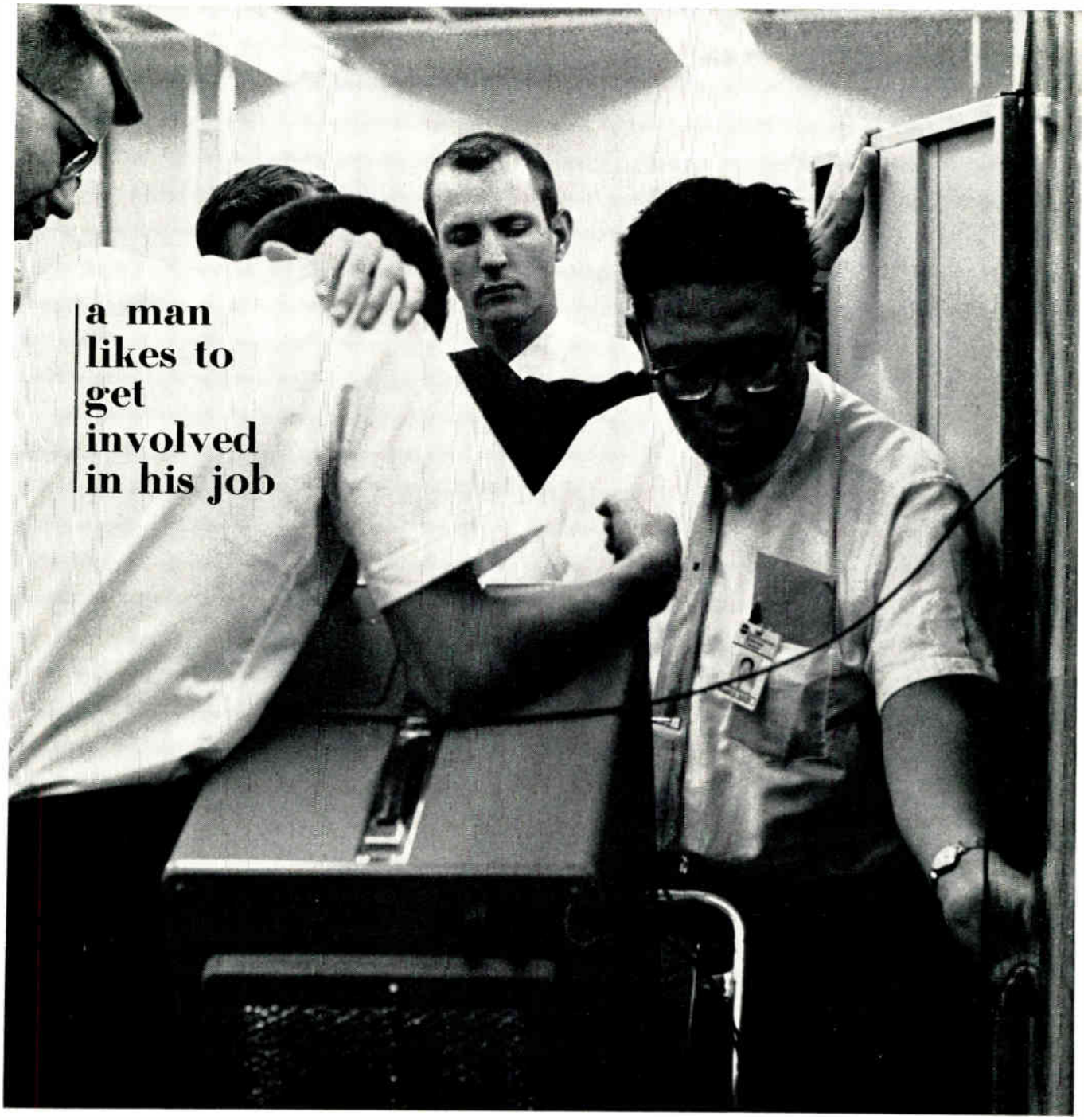

You have, no doubt, experienced the difference between working on a project and being involved in one. Involvement is what you are offered at Collins.

We're looking for the man who won't be satisfied with being just another engineer on a project. We're looking for the man who puts something of himself into everything he does. We want the man who can come to grips with a problem and solve it. Sometimes alone. Using his knowledge, his experience, his initiative, his imagination, and his creative talents. We're looking for the man who will give his best to a project, not to impress, but because his professional pride won't let him do anything else.

Maybe this sounds like flag waving. It's not. The scope of our work, the challenges presented in such diverse fields as Data Processing, Space Communication, Avionics, Microwave, Antenna Systems and HF, VHF and UHF Communication to mention a few, offer professionals of this caliber every opportunity for growth, involvement, job satisfaction.

If the kind of men we're looking for sounds like the kind of men you'd like to work with, you'll want more information on a career with Collins. Write in confidence to our manager of professional employment, Dept. 120.

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PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers
Development Engineers
Administrative Engineers
Engineering Writers
Physicists
Mathematicians
Electronic Instructors
Field Engineers
Production Engineers

EIA ENGINEERS PUBLISH NEW VE TRAINING MANUAL

Electronic Industries Association's Engineering Department has published new guidelines for educating personnel at both management and technical echelons in the practical application of Value Engineering.

The publication—"Value Engineering Education Training Manual"—contains outlines of short orientation programs for management, and detailed formats for complete seminars, designed for personnel on all operating levels of industrial and military organizations.

A two-hour program for top management provides quick understanding of VE. A six-hour session acquaints middle-management with VE principles.

A two-week program of half-day seminars gives participants new outlooks on the relationship between value and performance. A two-week, all-day course covers all business conditions and is slanted toward personnel in all operating areas.

The publication sets forth recommended schedules for 10 VE workshops, and is available from the EIA Engineering Department, 11 W. 42nd Street, New York 36, N. Y., at $2.50 a copy.

SCHOOL-AGE JOBS IS SUBJECT OF DEPT. OF LABOR ANALYSIS

Unemployment among young persons under 25 years of age was put at 1.2 million in October, 1962 by the U. S. Department of Labor. This total was about 150,000 less than the year earlier. About 875,000 of the jobless were not in school.

A 10% growth in the number of working students over the year to 3.6 million brought total employed of the 14 to 24 age group to 11.8 million. This reflects an increase in the number of persons in these ages enrolled in school.

From a Department of Labor report "Employment of School Age Youth, October 1962," some 1.2 million young persons 14 to 24 years old who were looking for jobs in October 1962, 300,000 were still in school. The rest had either quit school or had finished high school or college.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 198.

ILLINOIS TECH. REPORTS RECORD STARTING SALARIES

It pays to be an engineer in view of record starting salaries reported for Illinois Institute of Technology graduates.

Says Earl C. Kubicek, IIT Director of Placement, they start out with a figure three times greater than the average national per capita income listed by the Department of Commerce.

The average starting salary of $601.00 per month for IIT grads represents an all time high at the Institute. The 4.5% increase over 1962 starting salaries reflects the nation's growing demand for engineering talent.

Electrical engineers seem to take home the biggest paycheck. In 1962 electrical engineers received an average starting salary of $585.00 a month. In 1963 the figure rose to $607.00—an unprecedented increase of $22.00 a month.

MATHEMATICIAN SCARCITY IS A NATIONAL PROBLEM

Math PhD's are the scarcest. Only about 350 are conferred each year around the country—not enough to meet national demands.

The big reason, according to Dr. Melvin Henriksen, graduate committee chairman for Purdue's Mathematical Sciences, is that mathematicians work in an area so abstract they can't simplify it for laymen in order to attract recruits.

H.S. SCIENCE TEACHERS GET COMPUTER COURSE IN MASS.

A computer technology course for science and mathematics teachers in Massachusetts high schools has been put in operation under the State's Department of Education and Honeywell Electronic Data Processing.

The course, 16 weekly lectures, will familiarize teachers with the basic concepts, operating principles and applications of computers.

Teachers are instructed in various phases of computers, including numerical systems used, the format of computer languages, and methematical and logical techniques employed.

ENGINEER COUNCIL PREDICTS RISE IN ADVANCED DEGREES

Projections for advanced engineering degrees by the Engineers Joint Council show an optimistic strain in a report on the current state and fundamentals of the nation's engineering manpower.

The report suggests that the current 9,000 and some masters degrees in engineering will rise 22% during the next five years, while the 1,200 doctorates in engineering will almost double.

SCIENTIFIC RECRUITING

Robert H. Rydell, vice president of Dyna-Search Control, Inc., operates Bell System Model 35 Teletypewriter to transmit and receive qualifications on available technical personnel throughout the U.S. The firm, located in Minneapolis, uses a high-speed computer to locate the right man.

World Radio History

THE OTHER SIDE OF THE ENGINEER SHORTAGE!

Is there really an engineer "shortage," or is it that engineers are being wasted? Many engineering jobs still go begging each year. Here is a report that may startle many people.

THERE HAS BEEN A GREAT DEAL OF TALK about the "engineer shortage." Figures published by the Scientific and Engineering Manpower Commission and a study performed by Dr. Nichols DeWitt for the National Science Foundation, which compared the number of engineering graduates in the U. S. with those in Russia, have emphasized this fact. Yet, despite these figures, there is thought that the shortage is more apparent than real. It is quite possible that the manpower problem lies in utilization—not supply.

Utilization

Some time ago Sen. Howard Cannon of Nevada, a member of the Senate Armed Services Committee and the Senate Space Committee, suggested the Government conduct an inventory or survey to learn if the jobs held by our scientists and engineers made full use of their capabilities. To date, no such survey has been made.

To further investigate the utilization theory, the research department at Careers Inc. analyzed the working status and qualifications of those registered with us in Dallas, Los Angeles, Boston, and Chicago. In the first place, 17% of those with degrees were unemployed. Breaking down this figure we found aeronautical and aerospace sciences and the data processing professions had the smallest unemployment percentage—3% for the former and 9% for the latter. The greatest number of unemployed were electrical, chemical, and civil engineers, with 17%, 18% and 22% respectively (Table 1). Those who classified themselves as "industrial engineer" had a 20% unemployment ratio. When interpreting these figures, bear in mind that they do not represent the percentage of unemployed in the field as a whole, but they are merely those who were interested in obtaining a new position.

Another method of interpreting these statistics is to see the percentage of unemployed in each field of specialization. These figures, of course, reflect the same relative situation as those just mentioned. For example, 11% of the total unemployed were in the electrical and electronics field, 10% in physics, 5% in math and statistics, 7% in industrial engineering, and 1% in data processing. To double check these figures, we examined the registrations at the Career Centers from the opposite point of view. In other words, we looked at the demand for the registrants according to their field of specialization. The Career Center figures give a good picture of this, as we know how many requests for interviews each registrant receives. To present this picture clearly, we broke down our registrants according to field of specialization, and according to the number of interview requests received.

The figures showed that 27% of the data-processing people received five interview bids or more, while not a single civil engineer received five bids. Within these extremes we found that 18% of those in physics received five or more interview bids, as did 23% in electrical and electronic sciences. Only 1% of the chemists or chemical engineers got into the five-bid class.

If you look at the fields least in demand the same picture is revealed. A staggering 91% of the civil engineers registered got no interviews. Sixty-four percent of the chemical engineers and 51% of the mechanical engineers similarly received no bids. All

By WILLIAM A. DOUGLAS
President,
Careers Inc.
770 Lexington Ave.,
New York 21, N. Y.

World Radio History

told, 54% of the degree-holding applicants failed to receive a single request for interview. But please bear in mind that the employers represented at the Centers are major defense contractors.

A third verification of these figures can be seen from the research department's classification of Center registrants. These people are primarily those who are either out of work or dissatisfied with their present employment. Hence, it would be logical to expect that the largest numbers of registrants would be found among those specialities least in demand. This assumption proved to be true as far as chemical, mechanical, and electrical engineers were concerned. These groups made up 38% of the total Career Center registration. Civil engineers, the other group in low demand, only accounted for 5% of the total registration. This low percentage could be the result of advance knowledge on the part of most of them that there is virtually no demand for their services among major defense contractors.

A look at the city-by-city breakdown shows that the turnout of mechanical and civil engineers was particularly heavy in Chicago, while there was a greater concentration of electrical, electronic and chemical people in Los Angeles. Otherwise, city-by-city figures pretty much conformed to the national averages.

Possible Solution

The preceding material lends support to the belief that our technical manpower is not being fully used.

(*Continued on page 199*)

Despite the fact there are usually more jobs open than applicants, many engineers fail to receive a single interview.

TABLE I

REGISTRANTS BY FIELD

(Dallas, Los Angeles, Boston, Chicago)

	Unemployed	Employed	Total
Aeronautical & Aerospace	1	29	30
Electrical & Electronic	25	122	147
Chemical	21	110	131
Mechanical	23	165	188
Civil	14	50	64
Industrial	17	70	87
Physics	14	76	90
Math & Statistics	11	46	57
Data Processing	3	30	33
Business Administration	29	90	119
General & Unclassified with Degree	24	113	136
Non-Degrees	52	131	183
TOTAL	235	1031	1267

A large percentage of the engineers registered at the centers are unemployed.

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ELECTRONIC INDUSTRIES Professional Profile

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name _____ Tel. No. _____

Street Address _____ Zone _____

City _____ State _____

☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth _____

Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area _____

Salary Desired to Change Jobs and relocate in another area _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

STATE ANY FACTS ABOUT YOURSELF THAT WILL HELP A PROSPECTIVE EMPLOYER EVALUATE YOUR EXPERIENCE AND JOB INTERESTS. INCLUDE SIGNIFICANT ACHIEVEMENTS, PUBLISHED PAPERS, AND CAREER GOALS.

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139
This resume is confidential. A copy will be sent only to those Companies whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

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ENGINEER SHORTAGE (Concluded)

The professional who finds that industry has no need for his talents faces the same problem as the blue collar worker who finds his job automated. Both are victims of fast-moving technology. The Government has established a retraining for the blue collar worker, but nothing for the professional. It seems inescapable that many of our engineers and scientists also need to be "retrained," so as to best fit their skills into the new disciplines and update their academic knowledge.

Conclusion

Using the figures that we have accumulated as a guide, it seems that there may be considerable substance to the theory that our so-called "technical manpower shortage" is really just as much a question of proper use of our engineers and scientists as it is a question of a purely numerical shortage. Moreover, with the prospect of turning out greater numbers of graduates dim at best, at least for both the near and intermediate future, it seems that the most promising area of attack on the "shortage" would be in the realm of utilization. The "retraining" of professional people is still a somewhat unfamiliar and novel concept, but it is one worth a great deal more study and investigation by the Federal Government, the technical societies, industry, the universities, and all of us who are interested in seeing that American technology and American technical manpower deliver the best of which they are capable.

SPIRAL ANTENNAS

THE ARCHIMEDES SPIRAL ANTENNAS essentially maintain constant impedance and pattern performance over better than 4:1 frequency bands; gain level is 7 to 8db over better than a 2:1 band. They are designed for broadbeam, broadband applications and have been successfully used in surveillance, telemetry, direction-finding, command/control, and a variety of other systems. They feature a compact, lightweight configuration especially suitable for flush mounting. Units are available in overlapping bands from 0.5 to 12.0gc. Custom models can be provided. American Electronic Laboratories, Inc., Box 552, Lansdale, Pa.

Cavity-backed antenna used in surveillance, telemetry, direction-finding, command/control systems.

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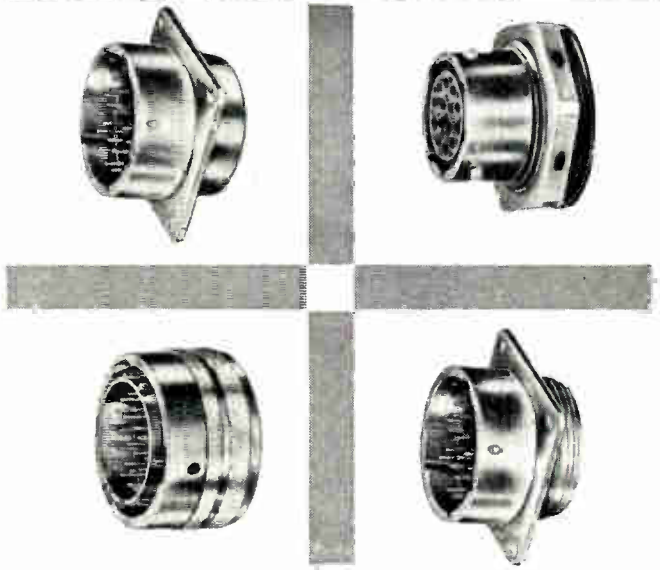

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How important is the masters degree? What part does specialization play? What is considered a reasonable salary? These questions, and others, are answered by a technical recruiter.

WHO IS THE 'UNEMPLOYABLE' ENGINEER?

EI Attends a Recruiting Conference . . .

THOUSANDS OF ENGINEERING JOBS in the electronic industry are going unfilled. Yet quite a few engineers are unemployed, or find it difficult to change jobs. The logical conclusion would seem to be—there is a shortage of certain types of engineers.

Which engineer is currently greatest in demand, and which is least? To find this answer, ELECTRONIC INDUSTRIES contacted Mr. A. C. Sugalski, Director of the Aerospace and Electronics Division of Bennett Associates, a Philadelphia personnel management service. The companies represented by Bennett Associates encompassed a large cross section of the electronic industry: from coast to coast in almost every product and systems line. Thus, there is no imbalance between companies dealing in commercial products and those dealing heavily in military contracts.

Rather than give EI an unsubstantiated answer to our questions, Mr. Sugalski invited us to a Staffing Center currently being held in Philadelphia. Assistant Editor John Hunter attended.

The ten companies participating represented areas from Florida to California, including the local Philadelphia area, the Middle Atlantic States, New England and the Mid West. These companies were looking to fill 1200 engineering and scientific positions. For these requirements Bennett Associates screened over 300 engineers in its Philadelphia engineering index and scheduled 104 candidates. These appeared to qualify for the open requirements of the participating companies. All candidates had degrees and were currently employed in the electronic industry.

A. C. Sugalski (L) and R. E. Wallace, president of Bennett Assoc., screen applicants in preparation for a Staffing Center.

At the conclusion of this Staffing Center the statistics showed that 253 interviews were conducted. The participating engineer received on an average 2.4 interviews. In reviewing the interviews with the companies, approximately 25% of the men interviewed will be made offers. However, eleven men received no interviews and twenty-nine received only one interview. This represented 38% of the participating engineers and scientists. Were these candidates unqualified and where does the fault lie?

Problem Areas

What were the qualifications of the candidates? We asked to see the resumes of the men receiving the greatest, and least, number of interviews.

For those greatest in demand we found:

1. They had a BS (or ideally an MS) in E.E.
2. Their experience ranged between 3-7 years.
3. They had a background in solid-state and digital networks.
4. Their salary was usually in the area of $12,000.

Mr. Sugalski answered our questions on other aspects of the employment situation:

Q.—What are generally the weakest points in a man's educational and professional background?

A.—As far as education is concerned, I would say the lack of graduate work. Less than 25% of the engineers go on to receive their masters. As for professional background, overspecialization causes more unemployable engineers than any one factor.

Q.—But the demands of modern industry usually cause an engineer to specialize. How can the engineer avoid it? (*Continued on page 202*)

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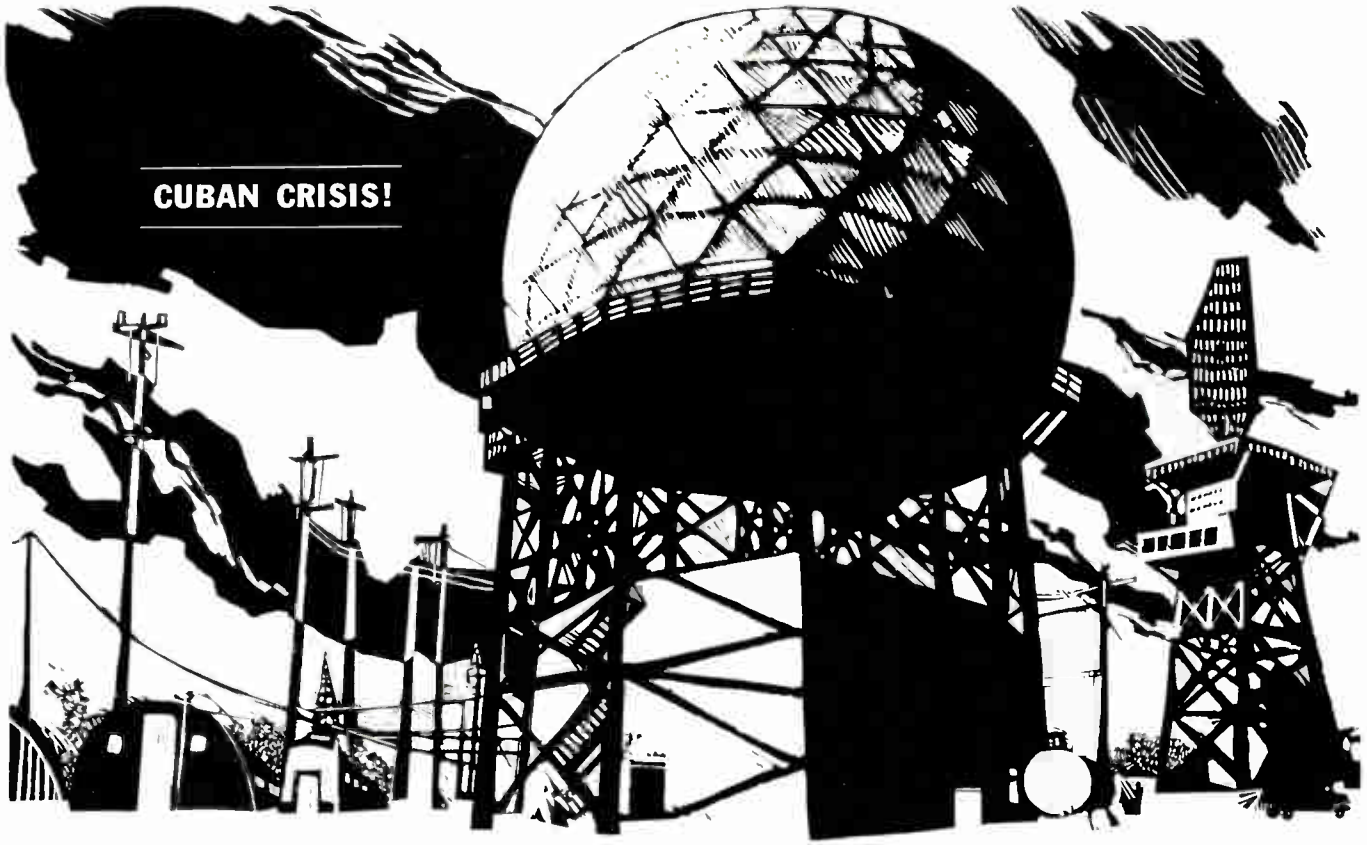

AMERICA'S WATCHFUL RADAR EYES... ZENITH MADE THEM SHARPER

Zenith's Electron Beam Parametric Amplifier on Key West AN/FPS-37 radar improved range 40% during critical period. When the Cuban crisis developed last year, a prototype of the exclusive Zenith Parametric Amplifier was operating on a Navy radar at Key West. Another was being tested on an Army installation at Fort Bliss. During the Cuban crisis, the Fort Bliss unit was flown to Key West, at the request of the Air Force, and fitted by Zenith engineers to another radar channel.

The operation of these EBPA units increased the range of Key West radar by a minimum of 40% . . . a substantial improvement in America's detection capabilities at this vital defense position.

Zenith's unique Parametric Amplifier selected for Navy and Army radars. As a consequence of this and other important tests, Zenith Radio Corporation has received government orders for parametric amplifiers to retrofit the Navy's operational AN/FPS-37 radar units and the Army's AN/FPS 71-75 radar units. *Standard units are presently available up through "L" band.*

Many exciting developments now taking place at Zenith. Qualified engineers can work in many diverse areas such as: medical electronics, sophisticated circuitry, special purpose vacuum tubes, microwave communications, acoustics and such solid state fields as semi-conductors, lasers, infrared, luminescent and opacity devices.

Send your resume to Mr. Edward P. Passow, Chief Engineer—Special Products Division, Zenith Radio Corp., 6501 W. Grand Avenue, Chicago 35, Ill.

UNIQUE OPPORTUNTIES FOR SCIENTISTS AND ENGINEERS NOW AVAILABLE AT ZENITH

Engineering Manager—Systems. Group head to lead in developing and applying system engineering principles to military engineering problems involving statistics, information theory, operations research techniques and practices, radiation and propagation, stability and control, dynamics and performance analysis. Ph. D in EE, Phy. or equiv. plus 6 to 8 yrs. in development of modern military systems involving radar, fire control, missile guidance, communications or computers.

Engineering Specialists—Infrared Devices. To perform theoretical studies and aid laboratory developmental work on infrared sensors and their application. Established optimum device characteristics to meet requirements. MS in EE or Phy. 5 to 8 yrs., 3 of which were directly concerned with IR device development and application.

Engineering Manager—Communications Equipment. To direct group in development and design of communications systems and apparatus. Perform theoretical studies and direct appropriate lab. experimental efforts. MS in EE or Phy. 5 to 8 yrs. engineering development, 3 of which were directly concerned with development of advanced communications systems.

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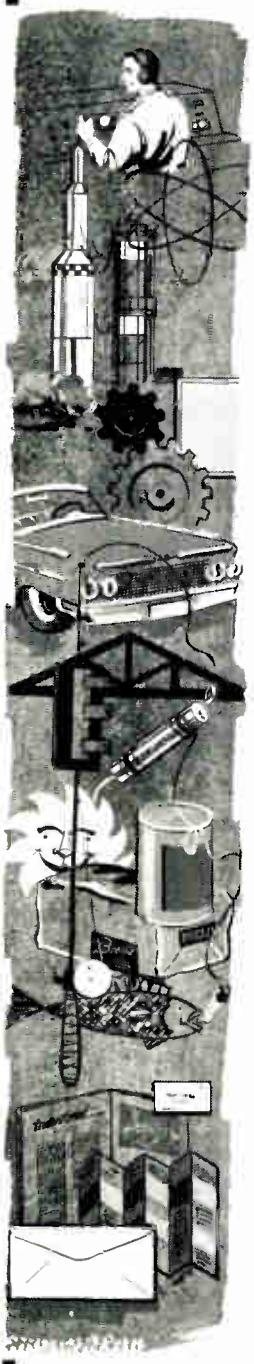

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Committee of 100
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Please send detailed information on the Daytona Beach Industrial Area.

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TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____
STATE_____

All inquiries held in strict confidence.

Circle 155 on Inquiry Card

THE UNEMPLOYABLE ENGINEER (Continued)

A.—Unfortunately he can't. He can, however, keep up with the developments in other adjacent and related areas of engineering. With an overall technical change occurring every three to five years, it becomes quite easy to fall behind in the latest developments. Technical journals in the electronic industry do an excellent job in presenting these new developments, but many men won't take the time to read an article that is *too technical or not directly related*.

Specialization produces obsolescence in another way. In industry there is an overall program change every two to five years. Hence, specialists find themselves with a specialty that is no longer needed.

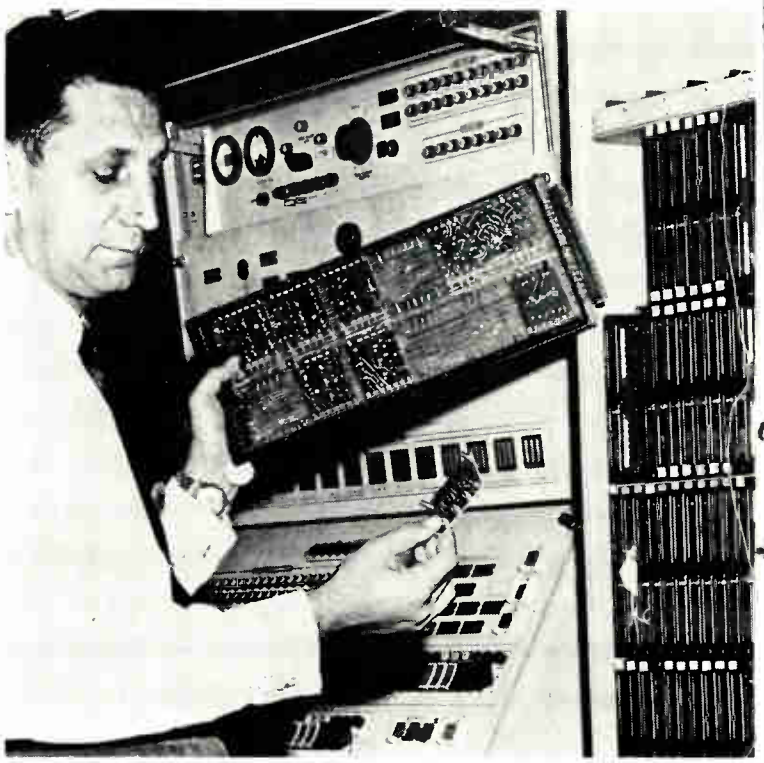
Q.—How much emphasis is placed on the MSEE?

A.—The MSEE is probably one of the engineers' greatest assets. It almost guarantees continued employment. Most companies will hire a man with a masters even if he isn't too familiar with the latest developments or techniques (providing he is not overpriced). This man, they feel, can be more easily trained because of his advanced knowledge in mathematics and electronic technology.

Q.—Many engineers feel the MBA is a better choice because it offers an opportunity to advance into management. Is this true?

A.—Rather than answer that question directly, let's examine the qualifications of a good manager: To be effective, the manager must possess technical, human and conceptional skills.

The sought-after advanced systems engineer is generally the best candidate for the engineering management positions.



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The technical skill requires him to know his area and related areas as well. The man who has been specializing and hasn't kept up with changes hardly meets this qualification.

The human skill requires that he be able to work with people and get results through people.

The conceptional skill requires the manager to understand the overall problem and system, or the big picture. He must be able to recognize and anticipate problems that will arise in activities in his area and in related areas.

The MBA does not necessarily qualify a man to an engineering management position.

Q.—How many engineering management positions are open each year?

A.—In relation to the number of engineering positions available, very few.

Q.—What part does a man's salary play in determining if he gets the job or not?

A.—Salary is an important factor. Again we must consider the situation. If a company receives a large contract and must fill the positions immediately, salary is less of a problem. Most of these men, however, are hired to do a specific job. When the job terminates, so do they. This leaves us with a man whose salary requirement far exceeds his ability. Unless he can move to another contract, he may find himself unemployable because of salary.

Salary, however, does not always disqualify a man. The right man with applicable experience will be hired regardless of salary.

Q.—Finally, what type engineer is in greatest demand?

A.—The advanced system engineer. This man conducts studies and keeps up with the state-of-the-art and assists his company in product planning and proposal preparation. As important, however, are the design and development engineers, for they finalize the concepts and ideas to products and systems. The advanced systems engineer is generally the best candidate for engineering management positions.

● A REPRINT of this article is available from ELECTRONIC INDUSTRIES Reader Service Department

MICROWAVE COMPONENTS AND TUBES

The estimate for total sales for microwave components in 1962—except for tubes and antennas—is placed at $110,000,000.

Totals for tubes and diodes are:

KLYSTRONS	59,000,000
MAGNETRONS	42,000,000
TRAVELING WAVE	53,000,000
DIODES, mixer, detector and parametric	12,000,000

Information on antennas is difficult to obtain because of its proprietary nature at present.

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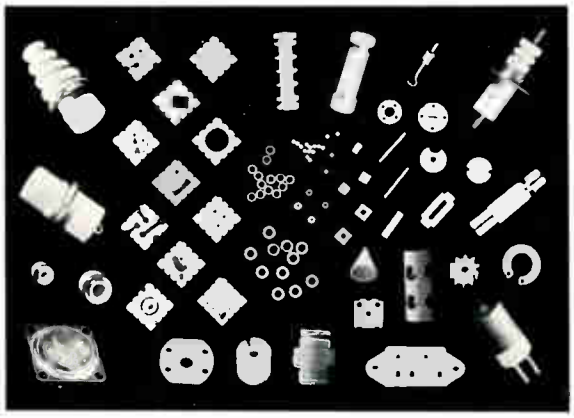
Equipped with the latest metallization techniques and a complete line of modern productive facilities, **Kyocera** is always ready to manufacture finished ceramics as accurately as you specify, using any selected ceramic materials.



Kyocera Ceramics have fine textures and can be finished with microscopically smooth surfaces. **Kyocera** finished ceramics have the surfaces free from any blebs, scratches, cracks, pinholes or the like. Where especially smooth surfaces of ceramics are required, **Kyocera Ceramics** will be found most satisfactory.

For detailed information, please write or call:

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KYOTO CERAMIC CO., LTD.
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World Radio History

First and only tower of its kind

Are *ordinary* towers giving you antenna siting headaches? Facing this problem, Alberta Government Telephones directed Stainless, Inc., and their Canadian subsidiary, Walcan, Ltd., to muster all their engineering skills to lick it. They did just that.

The result is the unique guyed structure you see above—the first and only of its kind—one of several now *in and working* on a multi-hop TD-2 system in northwestern Canada! The two platforms will support up to six horn antennas per tower at any height from 25 feet to 500. Orientation of horns is a full 360°. Normal cost of tower materials, installation and maintenance is reduced one-third.

So when you need special towers—for microwave, radio or scatter transmission—call upon Stainless. Their experienced staff can handle the whole job—from planning to installation.

Ask today for your free booklet describing many Stainless installations.

Stainless, inc.
NORTH WALES • PENNSYLVANIA

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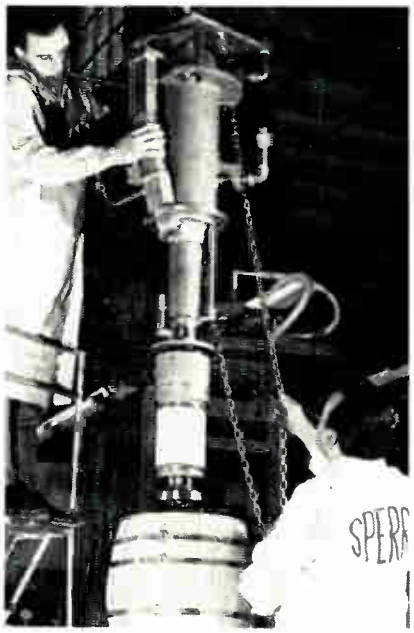
24-MEGAWATT KLYSTRON



One of 72 giant klystron amplifiers from Sperry Rand to drive one of world's most powerful linear accelerators. Designed to generate 24 megw pulses of microwave energy, klystrons will be installed along two-mile-long accelerator being built by Stanford University for the AEC. The 5-ft. tubes will provide 20-billion electron volts to break an atom's nucleus to smaller bits.

ITT DOING RESEARCH WITH 500-JOULE LASER

A specially designed laser, believed the world's most powerful, is being used for materials and biomedical research by International Telephone and Telegraph Corp.

ITT said that its new pulsed ruby laser has an energy output of 500 to 700 joules. The firm said the new laser makes available light at energy levels not before attainable.

COMPUTER WILL DIAGNOSE IN-FLIGHT ASTRONAUT ILLS

Future astronauts who go through giddiness or fatigue may have their symptoms flashed to a computer system on earth.

The system will diagnose the trouble and suggest correcting measures. That is, if tests being conducted at ITT Data and Information Systems Division in Paramus, N. J., prove right.

Psychologists and engineers at the division are trying to observe, measure and classify behavior patterns of humans under stress and fatigue. They want to automate diagnostic techniques.

ELECTRICAL ENGINEERS

Melpar's Communications and Intelligence Departments have an immediate need for electrical engineers experienced in:

MICROWAVE RECEIVER DESIGN

These openings include positions of major responsibility for Senior Engineers as well as unusual opportunities for advancement for recent graduates.

Specific problems include parametric amplifiers, varactor techniques, microwave filters, ultrastable programmable oscillators and dual and triple channel balanced receivers for monopulse and guard antenna gating.

For further details, write in strictest confidence, to:
John A. Haverfield, Manager—Professional Placement

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WITH
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AT
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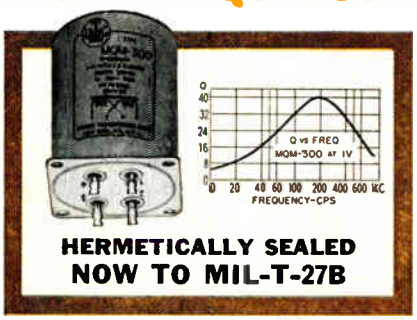

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NOW TO MIL-T-27B

The series inductance values are laboratory adjusted to 2% at 1 V 60 ~. Excellent temperature stability, less than 2% inductance variation over wide temperature range of −55°C to +130°C. Hum reducing lamination structure plus hipermalloy shield engineered for very low hum pick-up. Two identical windings brought out to four terminals permit series, parallel, center-tapped or transformer type connections. "Specials" other than stock units shown available custom built to your specifications.

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MQM-2	2	.5	21
MQM-16	16	4	143
MQM-40	40	10	368
MQM-300	300	75	3700
MQM-600	600	150	5720

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NEW FACSIMILE RECORDER

A new facsimile recorder that will give a 70% larger picture area for NIMBUS photos in automatic picture transmission (APT) ground acquisition systems has been delivered to the U.S. Weather Bureau by Alden Electronic & Impulse Recording Equipment Co., Inc. Aim of the Bureau is to design an APT system best suited to operations.

SILICON TRANSISTOR
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OSCILLATORS

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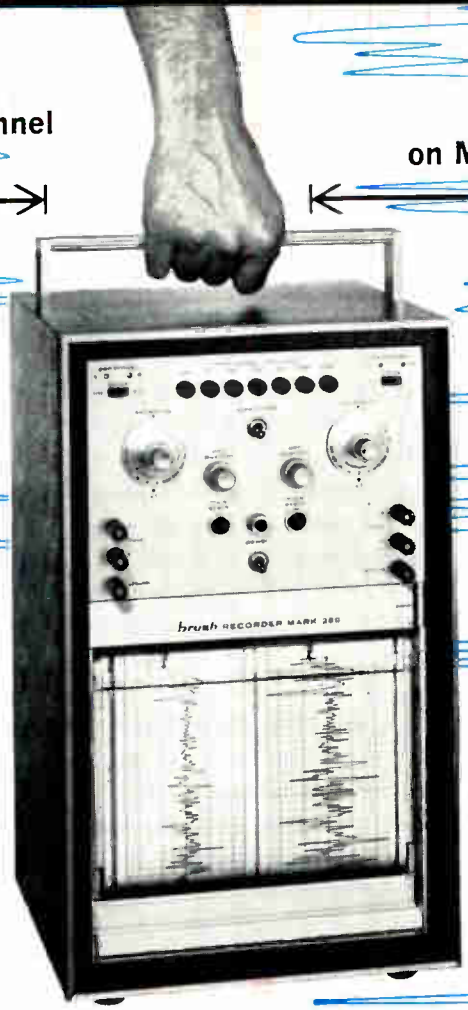
Signal on conventional channel width
40mm

Identical signal on Mark 280 channel width
80mm



New! Brush records 35 cps full scale on 80mm

The new portable Mark 280 doubles resolution of traces without sacrificing frequency response! And . . . you get instantaneous rectilinear ink records of unparalleled accuracy and clarity. Forced fluid writing presents traces, at frequencies to 35 cps full scale, on low cost chart paper. Dual channels each have 50 divisions in an 80 mm width, with trace width constant at one-tenth of a chart division. So now, you can easily detect minute signal variations and take *full* advantage of a ½% system accuracy. Matched solid-state amplifiers provide a sensitivity of 0.5 millivolts/div. Operating controls include attenuator, pen-position, variable gain and 12 push-button chart speeds. No other recorder can match the total capability of the Mark 280. Write for details.

brush INSTRUMENTS
DIVISION OF CLEVITE 37TH AND PERKINS, CLEVELAND 14, OHIO

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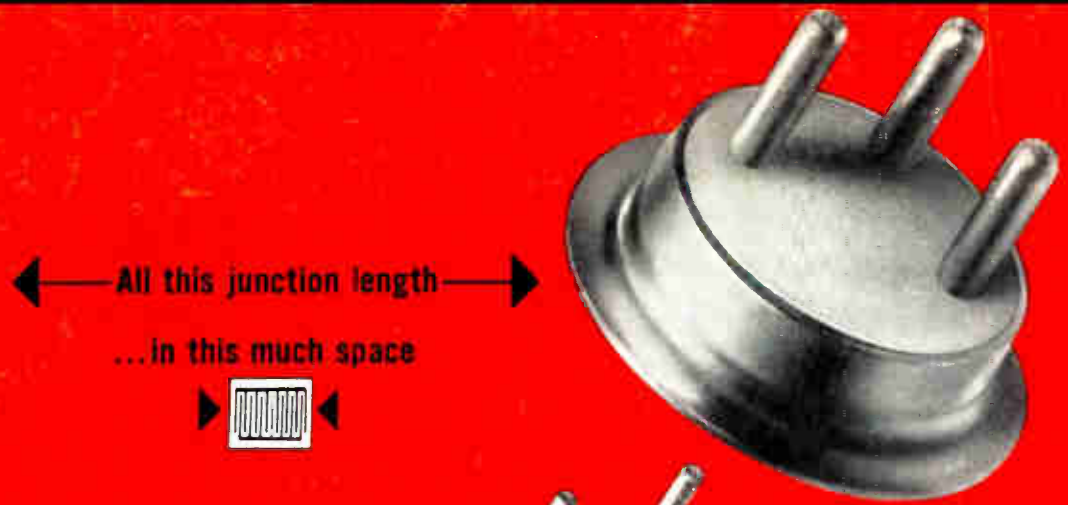

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- Ceramic-To-Metal Feed-Through
- Stud-Mounted Package

10 watts minimum RF power output at 50 Mc...3 watts at 150 Mc

THROUGH UNIQUE STUD PACKAGE AND RCA COMB-STRUCTURE DESIGN

Here's RCA's high-frequency comb-structure silicon transistor in the first package designed specifically for RF power applications—the new RCA 2N2876.

RCA 2N2876 offers • triple-diffused planar construction for high-voltage performance • beryllia platform on copper stud for high thermal conductivity plus complete element isolation • comb geometry for high-frequency power handling. These important design extras bring you 10 watts minimum output at 50 Mc, 3 watts minimum output at 150 Mc.

From pellet to package, RCA 2N2876 represents a major achievement in transistors for AM, FM, and CW, Class A, B, and C power amplifiers and oscillators.

AVAILABLE THROUGH YOUR RCA DISTRIBUTOR

TO-5 CASE VERSION (2N2631) NOW AVAILABLE

Performance similar to 2N2876 and power output to 7.5 watts are available in RCA 2N2631 in the TO-5 case. For further information, consult your RCA Field Representative or write: Commercial Engineering, Section 1J-11, RCA Electronic Components and Devices, Harrison, N. J.

MAXIMUM RATINGS

TYPE	V_{CEV}	V_{CEO} (pulsed) (volts)	V_{EBO} (volts)	I_C (amps)	P_T (watts) @ 100°C T_C	TEMP. OPER. & STG. (°C)
2N2876	80V	60	4.0	2.5	10.0	−65 to 200
2N2631	80V	60	4.0	1.5	5.0	−65 to 200

2N2876 .9" high, 7/16" diameter package

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