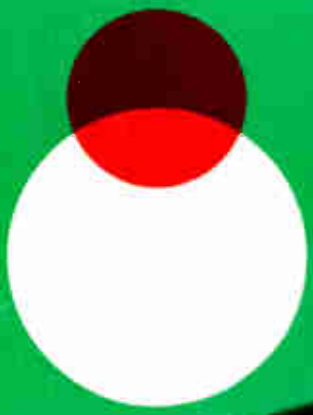
ELECTRONIC INDUSTRIES



JANUARY 1963

Designers guide to:

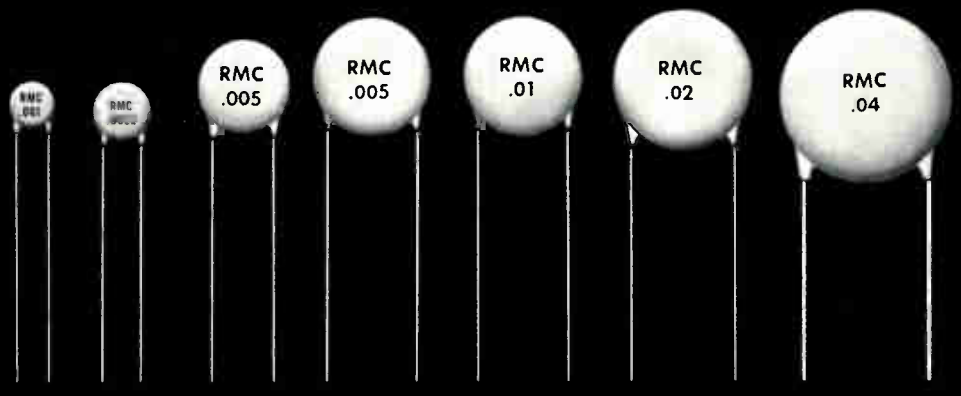
Lamps

Indicator lights

Illuminated switches

Top Performance at Lower Cost!

RMC TYPE B DISCAPS



150	680	.0015	.0033	.0047	.0068	.01	.02
220	750	.0018	.0039	.005	.0082	.02*	+80%—20%
330	800	.002	.0047*	2x.002	.01*	+80%—20%	.04*
470	820	.0022	.005*	.01*	.02*	2x.004	+80%—20%
500	.001	2 x 800	2x.0015	±20%		2x.005	
560	.0012	2 x .001	2x.002*	.02*			
				+80%—20%			

*Rated 500 V.D.C.W. Flash test 1250 V.D.C.
Life test per EIA RS-198

Disc sizes under ½" diameter have lead spacing of .250. Discs ½" diameter and over have .375 spacing.

SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)

POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 2000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic—vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

Type B DISCAPS are rated at 1000 working volts yet cost no more than ordinary lighter constructed units. Designed for by-passing, coupling or filtering, applications, Type B DISCAPS are available in capacities between .00015 and .04 MFD. They meet or exceed all EIA RS-165 specifications for Z5U ceramic capacitors and show a minimum capacity change between +10° C and +85° C.

Type BTM values to meet MIL C 11015B available on special order.

DISCAP CERAMIC CAPACITORS

rmc

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 4242 W. Bryn Mawr Ave., Chicago 46, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card

SHELBY A. McMILLION,
Publisher
BERNARD F. OSBAHR,
Editor

ELECTRONIC INDUSTRIES

CAN WE SOLVE OUR MANPOWER PROBLEM?

As we enter 1963, business forecasts for the electronic industries are optimistic. Factory sales of $15 billion are estimated for this year, compared to $13.1 billion for 1962. Military business will account for $9.0 billion in 1963, against $7.6 billion in 1962.

By 1975 there will be 230 million people in the United States. This will mean at least a 25% increase over today's market for consumer electronic products.

Another growth area is industrial electronics which is now $2.4 billion and should reach $4.0 billion by 1966—an increase of 66%.

The growth pattern of our industry has been spectacular, until now. However, there is genuine concern that it may be slowed by the critical shortage of technical manpower in the next ten years. More than any other industry, we must have vast numbers of scientists, engineers, and technicians.

Today, over 60% of our scientists and engineers are directly or indirectly employed by the U.S. government. This creates a serious problem of finding engineers to support the forecast growth in the consumer and industrial market.

For the engineer to be fully effective, he needs supporting technicians to breadboard, test and report on the circuits he designs. Recent studies show that we now have about one technician per engineer. It is estimated that each engineer should have the support of three or more technicians. Apparently, we are paying some handsome salaries to engineers for technicians work!

We believe industry must take a hard look at the educational system needed to support our ambitious growth plans.

Better electronic technicians are needed—men who know more than how to use a soldering iron and identify a resistor or a capacitor. A good technician should have adequate training in science and mathematics so that the engineer can communicate with him effectively.

The two-year community colleges could be the answer. These colleges offer two-year technical extension courses of an open-end or terminal type. In the open-end course, it is presumed that the student will proceed to a university and secure a degree. The terminal course graduate would be a well-trained and competent technician.

A number of excellent private institutions now serve this area. But we need quantity as well as quality, and there just are not enough of these schools to meet manpower requirements.

We believe industry should actively support the community college program by assisting in the development of curricula and the placement of graduates.

It is time that we stop lamenting the shortage of engineers and do something about it. A constructive technician training program will strengthen our industry and release engineers to create the products we must have to reach our industry goals for 1970.

ELECTRONIC INDUSTRIES

Vol. 22, No. 1 January 1963

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

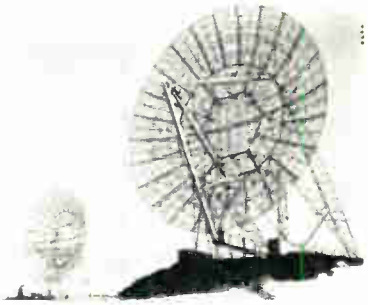
DEPARTMENTS

ELECTRONIC INDUSTRIES, January, 1963. Vol. 22, No. 1. A monthly publication of Chilton Company. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa., (Area Code 215) Sherwood 8-2000. Controlled circulation postage paid at Philadelphia, Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr., $18.00; 2 yrs. $30.00.

HIGHLIGHTS

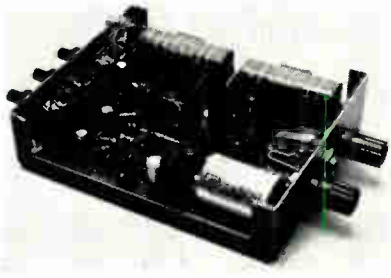
of this issue

Coaxial Magnetrons



Digital Communications Networks

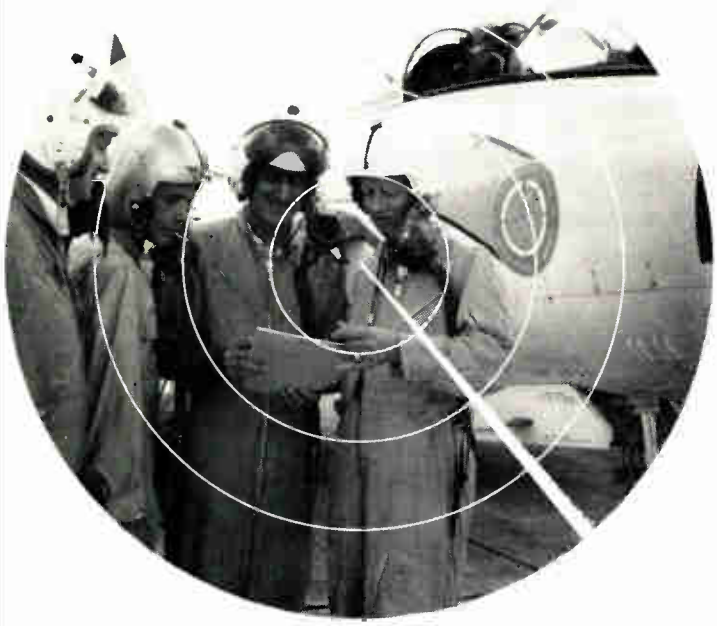
Lamps, Indicator Lights, Illuminated switches



Automatic Gain Control

RADARSCOPE

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



PLOTTING AIR SAFETY

Four Federal Aviation Agency pilots plan schedule in which they will face 24,000 possible mid-air collisions to help find a fool-proof method to avoid flying mishaps. Instead of being airborne, however, they will "fly" in a simulator at the Federal Aviation Agency's center in Atlantic City, N. J.

EXPORT PUSH is being planned by the Commerce Dept. New executive position has been created, "Assistant Secretary for Domestic and International Business." Both imports and exports are now at all-time highs, and exports are increasing more rapidly than imports, helping to narrow the gap in the nation's balance.

NASA WILL PUBLISH the first of a regular series of reports of space research with possible industrial applications within six months. The plan is to make public research findings which might have use in non-space or non-defense industries. Special industrial application experts are being employed who will spot civilian possibilities in NASA and DOD research reports. Periodically they will produce "state-of-the-art" reports for use in industry.

TRANSISTORS SO RELIABLE that they will remain in service more than 100,000 years, were predicted by H. I. Romnes, President of Western Electric Co. at the Radio Fall Meeting in Toronto. This prospect, he said, makes it possible for the company to seriously consider installing transistorized amplifiers and coaxial cables at very close intervals to expand vastly their capacities.

MILITARY RIVALRY has been blamed for the loss of two years and $170 million in development costs of the Advent communications satellite. The House Committee blamed bickering between the Army and Air Force. The subcommittee said the bickering was based on rivalry over letting contracts and lack of man-to-man discussion between services.

MORE THAN 70% OF THE STEREO BROADCASTERS are now losing money. Two young San Franciscans, co-owners of stereo station, KPEN-FM, appealed to the nation's stereo receiver manufacturers to support these stations through increased advertising and promotional guidance. More manufacturers, they said, should follow the example of the few companies which have helped stereo broadcasters with advertising and layouts, news release suggestions, and other forms of promotional assistance. Stereo's future, they said, is "absolutely unlimited."

ELECTRONIC WARFARE

Crewmen of Strategic Air Command B-52 bombers are learning the techniques of electronic countermeasures in this new simulator built by Reflectone Electronics. Simulated flights have ranged up to 2,000 miles, through realistically duplicated hostile radar and missile-attacking environments.

DEPRESSED AREAS will get more aerospace contracts as a result of a comprehensive program by 18 aerospace companies and Dept. of Defense. The program, which was considered a trial effort, will be reviewed by the Aerospace Industries Association and the Director of Economic Utilization of DOD every six months. It will be limited in the beginning to areas specifically designated by DOD. The program will also be confined in its initial stages to five categories of sub-contracting. Common, readily available, and highly competitive product lines have been avoided because their nature would produce a low yield of opportunity. The program is looking to single out sources of (1) electronic devices of a reliability level capable of meeting military specifications (2) optics and opto-mechanical assemblies, and (3) electro-mechanical components of high reliability.

SURVEY OF ENGINEERS was undertaken to assess their attitudes towards professionalism. Three groups of engineers were included in the survey: 110 engineers from a consulting firm, 80 engineers from a Federal Government engineering department, and 61 engineers from an industrial firm. Professional attitude score was computed with three different situations, and differences between the groups were evaluated. The professional attitude for industry engineers was the lowest, computed at 49.89 while the average for engineers employed by the consulting firm was 53.98. Government engineers fell in the middle, with an average of 51.43. Copies of the study are available from the National Society of Professional Engineers, 2029 K St., N.W., Washington 6, D. C.

COMPUTER MANUFACTURERS are stepping up their sales of computer equipment to OEM manufacturers. In the long range picture, this may prove to be a very significant development, since the computer manufacturers have the advantage of being a large primary consumer of their own products. Just last month Univac Div. of Sperry Rand announced that they will market a broad range of electronic equipment to computer, communications, and control equipment manufacturers. Initially the equipment utilized in the line of Univac Computer Systems will be offered. This will include card readers, card punchers, high speed printers, memory drums and magnetic tape units. A market study completed by Univac indicates that "in the next two years, the OEM market for computer peripherals will double in size to approximately $150 million annually and by 1972 to $350 million." The company also plans full engineering, manufacturing and marketing and special equipment and devices, as needed by the original equipment manufacturers.

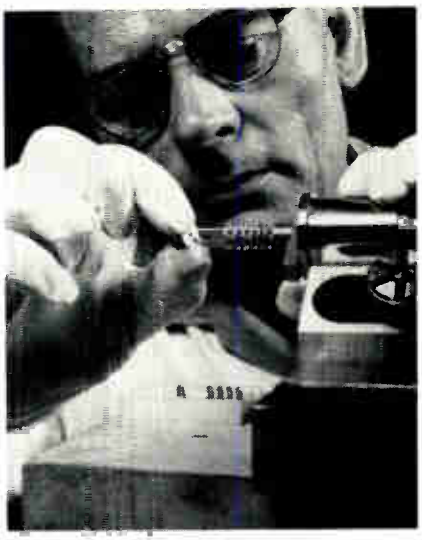
BREAK THROUGH IN OPTICAL COMPUTERS has been achieved at Rome Air Development Center. The aim is the replacement of conventional wires, cores and thin-films with glass fibers carrying controlled light waves as signals rather than electrical impulses. Four agencies are collaborating on the development—RCA, American Optical Co., Stanford Research Institute, and Rome ADC. RCA's applied research activity discovered the ability of these lasering glass fibers to operate in a new computer scheme called Neuristor. RCA is determining the characteristics required to provide suitable lasering fibers and methods of using the fibers in an neuristor logic computer arrangement. Stanford Research contributed the neuristor logic scheme, while American Optical created the chemical glass known as the lasering fiber. Creation of the optical computer could reportedly result in computers 10 or even 100 times faster and much smaller than present-day types.

AFTER NUCLEAR ATTACK

Goodyear Aircraft engineer inspects the aluminized film portion of antenna the company is developing for use after a nuclear attack. The inflatable structure would be stored underground, and would erect and inflate for operation automatically after other structures have been leveled by the nuclear explosion.

AS WE GO TO PRESS

MILLIMETER WAVE TUBE



Technician assembles a "stack" of circuit parts that forms part of a new high power amplifier tube developed by Hughes Aircraft Company. According to company scientists, the tube could eliminate radio blackouts experienced by astronauts by cutting through the ion shield that surrounds a spacecraft during re-entry from orbit.

AFSC INSTITUTES DOD "PERT" PROGRAM

The Air Force Systems Command is reported among the first to put in effect a Dept. of Defense approved PERT program to improve cost control and scheduling of complex R & D projects.

The "PERT" Program (Program Evaluation and Reporting Technique) will be carried out by all three services. Service R & D agencies will use a joint DOD/NASA guide to develop methods for systematic program-cost reports and predictions.

An AFSC PERT/Cost team has been established at the Aeronautical Systems Div., Wright-Patterson AFB, Ohio, to set up program procedures for the TFX (Tactical Fighter Experimental) Program.

The Air Force has never before employed a PERT program for development of a total weapons system. Earlier PERT programs were used for lesser projects.

The AFSC is expected to have the largest PERT/Cost effort within the defense establishment.

FIRST SUCCESSFUL LASER COMMUNICATIONS LINK

The first successful transmission of microwave signals using a light wave as the carrier has been announced by scientists of Stanford Univ.'s Electronics Laboratories.

The achievement was hailed as the first step toward using the wide-band potentialities of laser-produced "coherent light" for communications.

It has been estimated that a single laser light beam could carry as much information as all the radio communication channels now in existence. It could carry a hundred million TV programs at the same time.

A means of putting a microwave information signal on the light beam, or "modulating" it, was developed some time ago. But it has remained for someone to find a way of directly "demodulating" or receiving this information.

Prof. A. E. Siegman announced successful tests of two such devices and plans for a third. He demonstrated one of them, a microwave phototube for visiting scientists and engineers. The microwave phototube is a "traveling-wave tube with a photo-emissive cathode," developed in cooperation with Sylvania Electric.

Another device, a "fast semiconductor photodiode," also has been developed by the Stanford group. It is simpler, more compact and in some respects more efficient than the phototube, but requires the use of an amplifier.

The third device is an "FM discriminator microwave phototube" now nearing completion in the laboratories. It is designed to demodulate frequency-modulated light.

GAS BEARING GYRO

New gas bearing gyro is set up for a test run at Sperry Gyroscope Co.'s Marine Div. Laboratories in Garden City, N. Y. Hundreds of hours on the test stands have shown the drift rate of the Mk. 1 Mod. 3 to be "infinitesimal." Performance data are classified.

SIDE-LOOKING RADAR DATA CONVERTED FOR MAPPING

An instrument designed to rectify a side-looking radar photograph so that it can be used in making accurate maps is being tested by the U. S. Army Engineer Geodesy, Intelligence and Mapping R&D Agency, Fort Belvoir, Va.

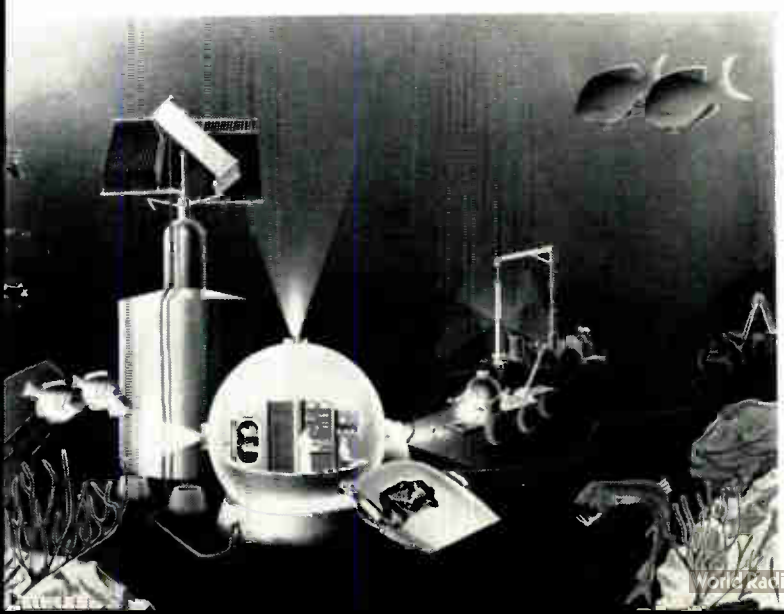
Known as a "Side-Looking Radar Presentation Restitutor," the instrument is part of a radar map compilation system being developed for the Army to permit planimetric mapping from radar photography to a scale of 1:250,000, meeting national map accuracy standards.

The restitutor was built by Belock Instrument Corp.

NEW RESEARCH CENTER

P. R. Mallory & Co., Inc., has opened its Laboratory for Physical Science, a 9,600 sq.-ft. research facility in the Northwest Industrial Park, Burlington, Mass.

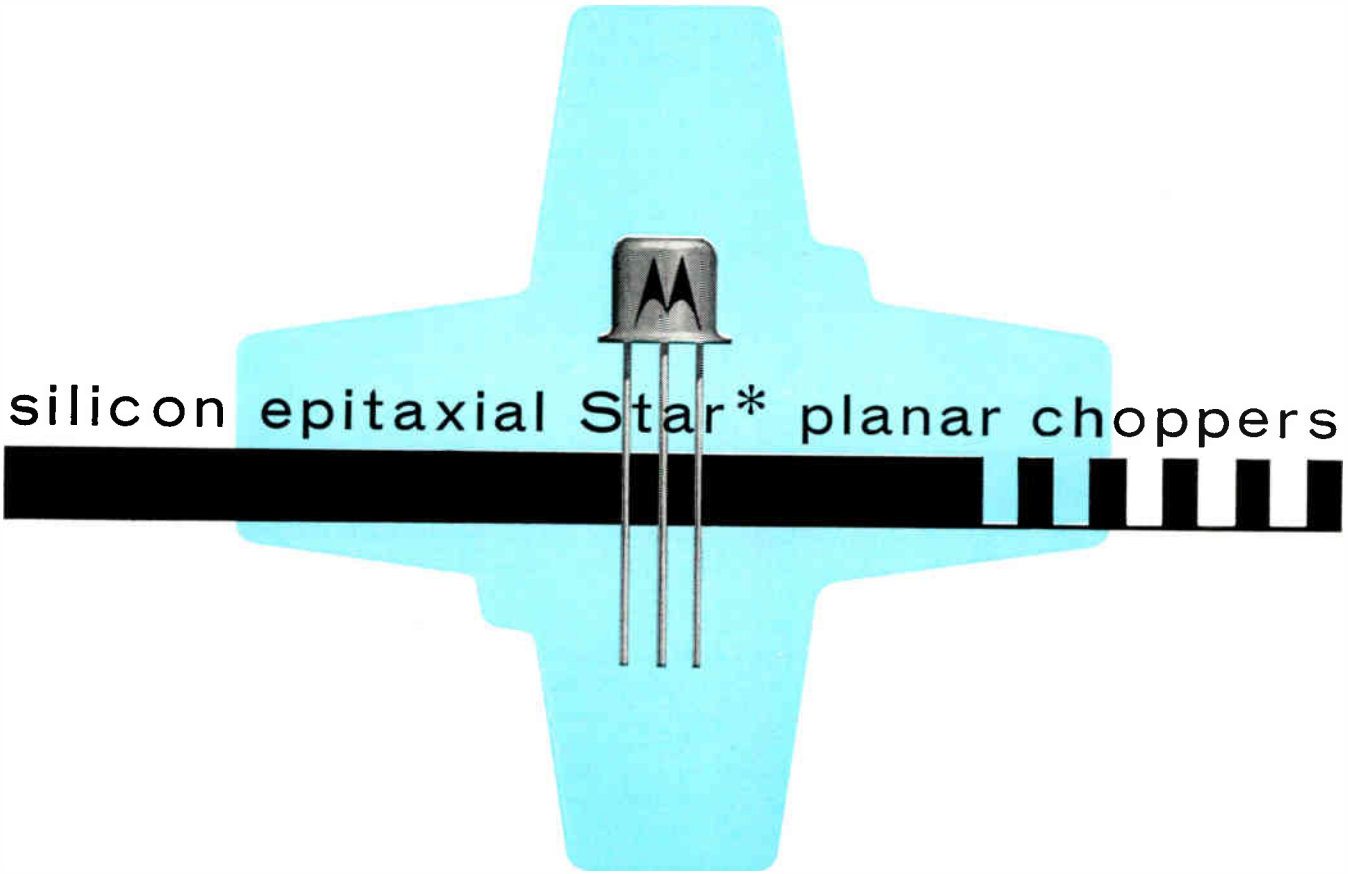
More News on Page 9



UNDERSEA COMMUNITY

Undersea community like one in sketch may be powered by nuclear reactor being designed by Westinghouse. Reactor, using thermoelectric elements would supply 3,000 KW of power. Company is building research sphere called "Deepstar," like one shown here. It would house crew and act as control center for undersea vehicles.

another Si *from* **MOTOROLA...**



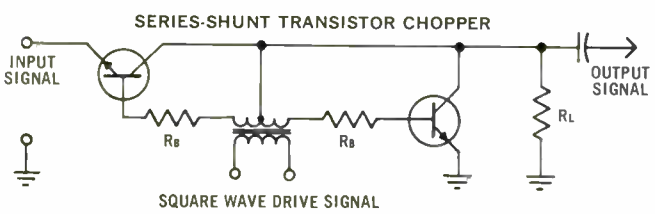
with parameters virtually insensitive to temperature from +25°C to +85°C

The lowest available offset voltage and offset current, combined with extremely low inverse saturation and the highest frequency response of all choppers available today, are yours with the new Motorola 2N2330 (TO-5 package) and 2N2331 (TO-18 package) Star planar choppers. And, you can use these units without resorting to elaborate temperature precautions because they are virtually insensitive to temperature variations from +25°C up to +85°C.

Designed especially for high-speed DC-AC chopping in low-level saturated switching applications, these new devices are ideal for use in telemetry, multi-channel communications, analog computers, and other low-level data handling applications.

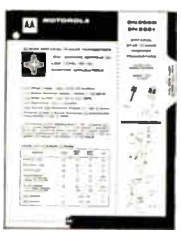
Matched pairs of each type are available on special request for "quasi" push-pull chopper circuit applications. Pairs can be matched with respect to offset voltage, (V_{off}), to within 50 or 100 microvolts.

*STAR is a trademark of Motorola Inc.



Characteristics*	Symbol	2N2330 (TO-5) P_D = 0.8 Watts Min.	Typ.	2N2331 (TO-18) P_D = 0.5 Watts Max.	Unit
Offset Voltage (I_B = 200 μAdc, I_E = 0	$V_{(off)}$	—	0.3	0.75	mVdc
Inverse Saturation Voltage (I_B = 200 μAdc, I_E = 50 μAdc)	$V_{EC(SAT)}$	—	1.0	3.0	mVdc
Small Signal Forward Current Transfer Ratio (I_C = 1mAdc, V_{CE} = 1 Vdc, f = 100 mc)	h_{fe}	1	1.5	—	—
Offset Current (V_{BC} = 2.0 Vdc, V_{CE} = 0, T_A = 25°C)	$I_{(off)}$	—	0.1	1	nAdc
Offset Current (V_{BC} = 2.0 Vdc, V_{CE} = 0, T_A = 85°C)	$I_{(off)}$	—	1	10	nAdc
Emitter Diode Recovery Time (I_B = 1.5 mA nominal)	t_{re}	—	3.5	—	μsec

*All values at 25°C ambient unless otherwise indicated.



Production quantities are available now.

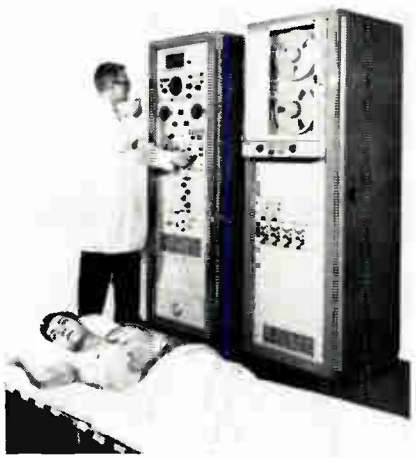
To obtain either type, or if you would like additional technical information, contact your local Motorola District Office or Distributor.

MOTOROLA
Semiconductor Products Inc.
A SUBSIDIARY OF MOTOROLA, INC. 1962

5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

ELECTRONIC SHORTS

THREE-DIMENSIONAL VIEW



View of heart pulsations is seen on oscilloscope by spatial vectorcardiograph (1) and their shape and sound is recorded on magnetic tape by medical electronics system developed by Minneapolis-Honeywell. A Univ. of Tenn. pediatric cardiologist will use the system in long-range study of heart behavior in infants and children.

CARBORUNDUM EXPANDS ELECTRONIC ACTIVITIES

At its new 40,000 sq. ft. Electronics Div. plant addition at Niagara Falls, N. Y., Carborundum, which in 1891 began producing silicon carbide, one of the world's first manufactured abrasives, will soon be making a new micro-miniature silicon-carbide thermistor. It will have an operating temperature of over 500°C. and response time under a second.

Electronic products, which accounted for 10% of Carborundum's $141,176,116 net sales last year and absorbed 25% of its research expenditures, also include custom air and liquid-cooled dummy-load resistive assemblies and special assemblies to protect equipment during development.

FAA ORDERS 66 RADAR SYSTEMS

The Federal Aviation Agency has taken a major step toward standardization of civil and military air traffic control systems with the award of a $10,045,935 contract to Texas Instruments Inc. of Dallas, Tex., for 66 airport surveillance radar systems.

These radars will be installed at continental and overseas U. S. Air Force Bases. Under an earlier FAA contract with Texas Instruments, 36 ASR systems were built and installed at major air terminals throughout the U. S.

The new equipment will pick up airplane targets up to 60 miles distant, at altitudes up to 40,000 feet.

(*Continued on page* 12)

AEC has cancelled a contract for a portable nuclear power plant at Byrd Station in the Antarctic. The contract was cancelled for the convenience of the Government due to cost increases, schedule slippages and because the design as developed did not meet original objectives. AEC has also asked the contractor, Allis-Chalmers Mfg. Co., to submit a proposal for analyzing the over-all plant (designated PM-3B) design against the technical objectives. They are to recommend areas where redesign can effect improvements and perform such redesign work as is approved.

U. S. Naval Academy has purchased six computers for use in instructing midshipmen in analog computer techniques. About 1,800 first and second class (junior and senior) midshipmen will receive instruction this school term in the various applications of analog computation. This is the first full-scale use of computers at the academy for this purpose. The computers are TR-10, solid state units manufactured by Electronic Associates, Inc., Long Branch, N. J.

USAF engineers at Wright-Patterson AFB, Ohio, are simulating reentry from space missions, according to the Air Force Systems Command. The flight conditions are being simulated to obtain information on instruments and instrument displays for future aerospace vehicles. Flight conditions are simulated from 120,000 ft. altitude (about 22½ mi.) and Mach 6 speed (more than 4,500 mph at sea level) to an "earth" landing. Work already completed by the Air Force on the program is being applied to its X-20 Dyna Soar Program. NASA is using the data in the Gemini and Apollo programs.

University of Michigan radio astronomers have successfully measured the intensity of low frequency radio waves in the Milky Way, according to Fred T. Haddock, director of the U-M Radio Astronomy Observatory (RAO). Measurements were made with a 145 lb. rocket-borne instrument package which was lofted 1050 mi. over the Atlantic Ocean from Wallops Island, Va. The measurements were made at 750, 1,200 and 2,000 KC.

A highly precise method for measuring small vibration displacement amplitudes is now being used in calibrating vibration pickups. The method, developed at the National Bureau of Standards for the Navy, makes the measurements even in the presence of considerable "jitter." The technique uses photoelectronic measurement, in place of visual inspection, of an interferometer fringe pattern to identify vibration amplitudes.

Tests with a new Air Force bio-measuring device have shown that an average person driving home from work on a busy freeway may undergo more nervous strain than an astronaut in orbit. He also faces some traffic situations more frightening to him than blasting off a launch pad. Hughes Aircraft Co., developers of the instrumentation pack, tried it out on civilian "guinea pigs" before delivering the equipment to the Air Force. The civilians were instrumented and exposed to common nerve-shattering situations which included navigating the Los Angeles freeway system.

An experimental radio communication system to help assure nonfading reception has been developed by ITT Federal Laboratories, under Air Force contract. System uses 28 ft. dish antennas to send and receive a message over several angularly separated radio beams simultaneously. Advantage is that diversity improvement is attained by a single receiving antenna using multiple beams instead of a receiving system needing either more antennas or a wide radio spectrum or both.

Federal Electric Corp., Paramus, N. J. service associate of ITT Corp., has been contracted to link eight South Vietnam cities with a microwave radiotelegraph communications system. The $2.3 million contract, which calls for a system with a capacity of 600 simultaneous messages, was awarded by the U. S. State Dept.'s Agency for International Development. Two additional cities will be linked to Saigon by a very high frequency tributary system. Project is due for completion late this year.

Prize Crop of Precision Potentiometers

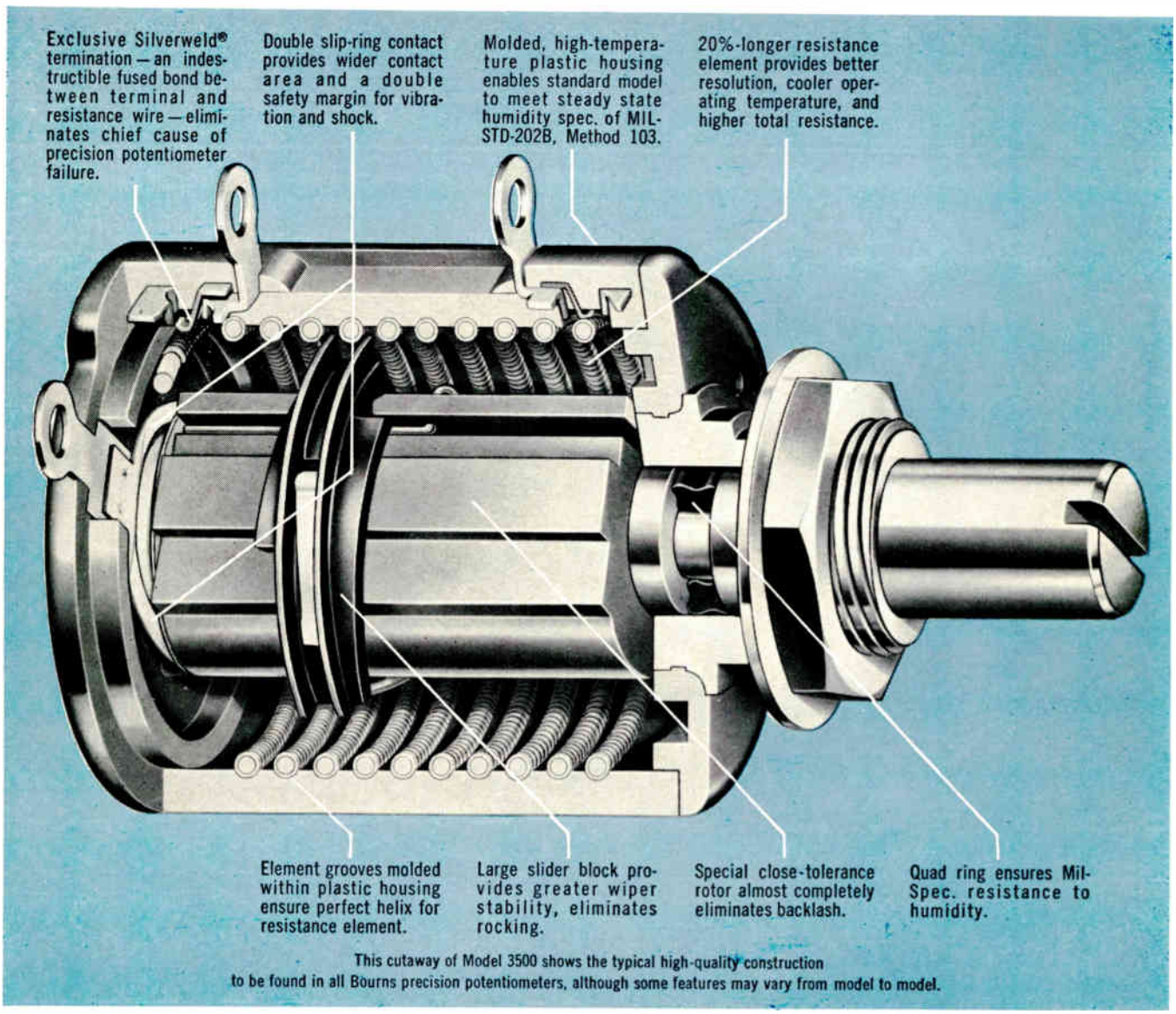
With smaller cases, higher resistances, better linearity, finer resolution, and higher operating temperatures than any other line.

Now you can obtain a 25 to 39% increase in total resistance together with standard linearity as low as 0.2% and resolution as fine as 0.01% — in a potentiometer that's shorter than any competitive unit. Our 10-turn Model 3500, for example, is just 1" long, a full ½" shorter than units available elsewhere. The secret: new design techniques including a thin-wall molded plastic case that lets us put a 20%-longer resistance element in a shorter package.

The new case also improves heat dissipation, thus increasing power-handling ability and raising the maximum operating temperature 20°C above that of potentiometers available elsewhere. Sealed against humidity, these units exceed steady-state requirements, and most can even be specified to meet MIL-STD-202B, Method 106 (cycling humidity). Reliability is further enhanced by the virtually indestructible Bourns Silverweld® termination.

Units are individually inspected and subjected to the stringent double-check of the Bourns Reliability Assurance Program. Prices are competitive and delivery is immediate. Write today for complete technical data.

AVAILABLE OFF THE SHELF AT FACTORY PRICES FROM DISTRIBUTORS ACROSS THE NATION.



This cutaway of Model 3500 shows the typical high-quality construction to be found in all Bourns precision potentiometers, although some features may vary from model to model.

Model 3500 — 7/8", 10-turn
Now: standard linearity of 0.2%

Length (body)	1.00"
Standard linearity	±0.2%
Standard resistances	500Ω to 125K
Power rating	2.0W @ 70°C
Humidity	MIL-STD-202B, Method 103 (steady state)†
Max. operating temp.	125°C
Resolution	0.01 to 0.03%

Model 3700 — 1/2", 10-turn
Now: drastically reduced to only $19.60 each (100 pcs.)

Length (body)	1.00"
Standard linearity	±0.25%
Standard resistances	500Ω to 100K
Power rating	1.0W @ 70°C
Humidity	MIL-STD-202B, Method 103 (steady state)†
Max. operating temp.	125°C
Resolution	0.020 to 0.060%

Model 3520 — 7/8", 5-turn
Length, .678"—resistances to 75K

Length (body)	.678"
Standard linearity	±0.3%
Standard resistances	200Ω to 75K
Power rating	1.5W @ 70°C
Humidity	MIL-STD-202B, Method 103 (steady state)†
Max. operating temp.	125°C
Resolution	0.015 to 0.070%

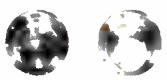
Model 3600 KNOBPOT®* Potentiometer — 3/4", 10-turn
Potentiometer, dial, and knob all in one — operates at 125°C

Length (body)	1.00"
Standard linearity (dial accuracy)	±0.5%
Standard resistances	1K to 100K
Power rating	1.5W @ 25°C
Humidity	MIL-STD-202B, Method 103 (steady state)
Max. operating temp.	125°C
Resolution	.011 to .035%

(Also available without dial)

Model 3510 — 7/8", 3-turn
Length, .549"—resistances to 50K

Length (body)	.549"
Standard linearity	±0.3%
Standard resistances	200Ω to 50K
Power rating	1.0W @ 70°C
Humidity	MIL-STD-202B, Method 103 (steady state)†
Max. operating temp.	125°C
Resolution	0.028 to 0.100%



TURNS-COUNTING DIALS

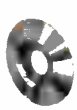
Easy-to-read dials requiring only 1" of panel space are available for all Bourns precision potentiometers (except KNOBPOT units, which incorporate their own dials). Easily mounted — no extra panel holes needed, can be set to less than .1% of total travel. Locking device (optional) positively prevents shift in setting. Anodized finish, black or clear.

KNOBPOT POTENTIOMETER MIL-SPEC COLOR ACCESSORIES
Meeting color requirements of MS-91528B and MIL-STD-242 (ships).

COLORED SNAP-RINGS for color-coding panels or imparting high style to equipment.

COLORED MIL-SPEC SLIP-OVER KNOBS for function, for style. Standard 1" MIL-Spec diameter.

LOCKING DEVICE (BRAKE) to prevent accidental jarring of settings.



STAINLESS STEEL SKIRTS to add a touch of glamour.

All units shown actual size

*U.S. Pat. No. 3,069,646
†Optional feature meets MIL-STO-202B, Method 106 cycling humidity

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AS WE GO TO PRESS

SCIENTIFIC TOOL

Machinist at RCA's Camden, N. J., plant puts finishing touches on the company's 1,000th Electron Microscope. The microscope enables researchers to see and photograph objects 1 million times thinner than a human hair.

UNIVAC ANNOUNCES PLANS TO MARKET MAGNETIC CORES

UNIVAC Division of the Sperry Rand Corp. has announced plans to market a variety of magnetic cores. Within the next six months production will be at the level of 200 million cores per year with at least 10 types of cores offered for sale, according to D. D. Kirsch, mgr. UNIVAC Phila. Defense Marketing. In addition to a full range of cores, the company will market completely wired planes.

AF SATELLITES MEASURE RADIATION BELT

The Air Force has carried special instruments on its military test satellites to measure the trapped radiation in the radiation belt created by the U. S. high-altitude nuclear blast last July.

Measurements from the AF satellites have confirmed the increased electron densities calculated from the early Injun and Telstar data. They show no significant increase in number of protons.

Radiation of the artificial belt has been found to sharply increase above 400 miles altitude at the geomagnetic equator, extending upward into the lower Van Allen belt. It reaches intensities of 100 to 1,000 times normal above 1,000 miles altitude.

ARMY INVESTIGATES NIGHT VIEWING METHODS

The U. S. Army Mobility Command is studying new methods of image intensification in its long-range program to provide the U. S. soldier with improved night viewers. These methods would require only starlight, moonlight or skyglow to produce visible images.

Besides current research with vacuum tube image intensifiers, MOCOM is studying use of blocks of semiconductor and other materials to accomplish this purpose. If achieved, this method may be cheaper and more reliable.

The non-vacuum tube image intensification program is being conducted by Electro-Optical Systems, Inc.

SUPERCONDUCTING

Three-axis, cryogenic accelerometer developed by Minneapolis-Honeywell has been successfully operated at a temperature of about 5°K. Company says it could be used with any high accuracy inertial navigation system. Transformers in the instrument help generate current which create a magnetic field to support a superconducting spherical mass in a frictionless bearing. Mass is found in the upper portion of the unit.

ELECTRONIC SUPERVISORY CONTROL FOR PIPELINE

Texas Eastern Transmission Corp., one of the country's largest gas pipeline companies, has installed an electric supervisory system to obtain increased efficiency in pipeline operations. Heart of the system is a Control Data computer.

Data transmission speeds have been increased enormously to a point where this system has the highest used commercially for gas pipeline compressor station control.

The supervisory and data handling system with the Control Point at Shreveport, La., and with the sixth controlled or satellite station at Delmont, Pa., is a medium band, approximately 200 Kc. programmed, solid-state device. Without additional equipment at the Control Point, it can supervise and control 32 satellite stations (or addresses).

The theoretical maximum capacity of the system is the supervision and control of 999 different stations (or addresses).

The supervisory system, when not being called on to perform Control functions or the logging of data, is automatically sequenced into a scan program, during which time all stations on the system are continuously scanned in sequence for alarms or other upset of station operating conditions.

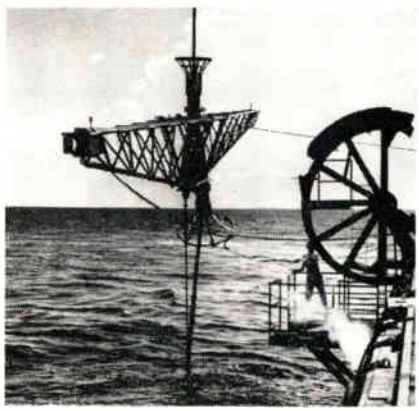
More News on Page 23

ATLANTIC ACOUSTIC RANGE IS INSTALLED

A sensitive electronic "ear" has been permanently installed in deep ocean waters by Lockheed Electronics Co., of Plainfield, N. J. The "ear," more correctly known as the AUTEC (Atlantic Undersea Test and Evaluation Center) acoustic range, is designed to probe the sounds of the sea. It is the first phase of a U. S. Navy program to develop an underwater test and training center to help bolster the nation's anti-submarine warfare capability.

Data gathered during the studies will add to basic knowledge of undersea sound, and may also prove useful in developing better undersea defenses.

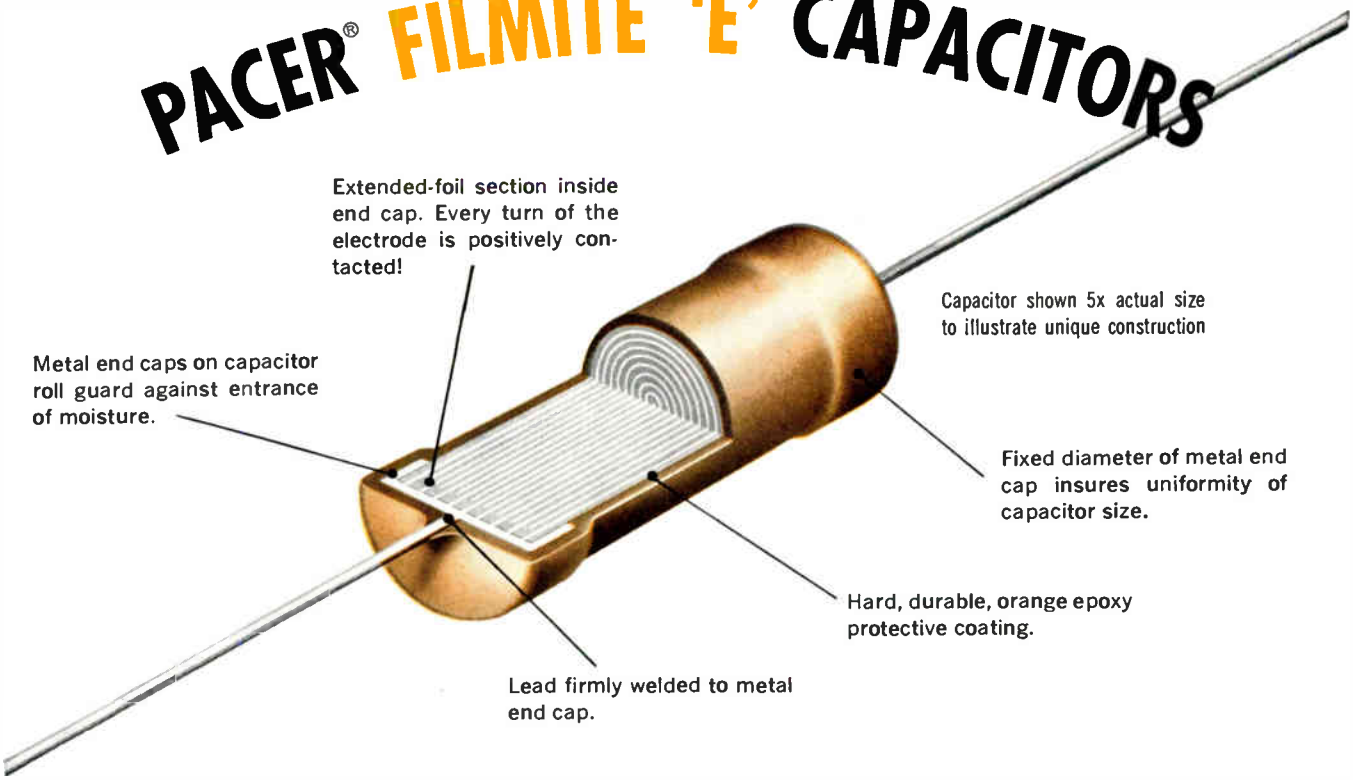
Range consists of three basic parts: an electronic array to detect, amplify and transmit sound; a mooring system capable of holding the array in its precise position; and a deep-sea cable system to connect the various parts of the array.



Girder-like arm being lowered into the water holds hydrophones which are used to detect undersea sound during test operations at the U.S. Navy's new AUTEC acoustic range.

New from Sprague!

PACER® FILMITE® 'E' CAPACITORS



Multi-advantage Construction in a Low-cost Film Capacitor!

MINIFIED SIZE—
Rating for rating, Pacer Capacitors are almost one-third the size of conventional paper or paper-film tubulars, making them ideally suited for transistorized circuitry and other space-saving applications where small size with dependability is an important consideration.

BEST POSSIBLE NON-INDUCTIVE SECTION—
Metal end caps over extended foil sections assure non-inductive capacitors, since all turns of the electrode are contacted beyond question.

IMPROVED HUMIDITY RESISTANCE—
End caps act as effective moisture barriers. Capacitor sections are further protected by hard, durable, orange epoxy coating.

UNIFORMITY OF SIZE—
Unlike other epoxy-coated units, the end caps on Pacer Capacitors assure the rigid fixed diameters needed for use with automatic insertion equipment. The two smallest sizes are identical with resistor and diode sizes, making them especially suitable for 'cordwood' packaging.

For complete technical data on Pacer Capacitors, write for Engineering Bulletins 2066 and 2067 to Technical Literature Service, Sprague Electric Co., 233 Marshall Street, North Adams, Massachusetts.

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MICRO-CIRCUITS	TOROIDAL INDUCTORS	ELECTRIC WAVE FILTERS

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

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Type AX Hermetic

Similar to Type MX but to close on temperature rise. Wide selection of terminals and mounting provisions, highly responsive brass 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. Also supplied as double thermostat "alarm" type. Turret terminals or wire leads. For ratings, etc., Bulletin 5000.

Type A Hermetic

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A-7192A

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COMING EVENTS

...in the electronic industry

JANUARY 1963

Jan. 13-18: Nat'l. Winter Mtg., AChS; Cincinnati, Ohio.

Jan. 15: Gen'l. Mtg., Ass'n. of Electronic Parts & Eqpt. Mfrs.; Chicago, Ill.

Jan. 19-20: Southeastern Div. Conv., ARRL; Miami, Fla.

Jan. 21-23: 31st Annual Mtg., IAS; Astor Hotel, New York, N. Y.

Jan. 22-24: 9th Nat'l. Symp. on Reliability & Quality Control, IRE (PGRQC), ASME, ASQC, EIA; Sheraton-Palace Hotel, San Francisco, Calif.

Jan. 22-25: ERA Annual Conv.; Mark Hopkins Hotel, San Francisco, Calif.

Jan. 23-25: 1st Inst. for Int'l. Eng., Univ. of Colo., Consulting Engrs. Cncl., Colo. Reg. Export Expansion Cncl., Colo Soc. Engrs., U. S. Dept. of Commerce, SBA; Univ. of Colo., Boulder, Colo.

Jan. 23-26: Mtg., APS & AAPT; Statler-Hilton Hotel, New York, N. Y.

Jan. 26-28: Joint Annual Mtg., MAA, AMS (AMS meets Jan. 24-28); Univ. of Calif., Berkeley, Calif.

Jan. 28-31: 14th Annual Plant Eng. & Maintenance Show, Clapp & Poliak, Inc.; McCormick Place Exp. Ctr., Chicago, Ill.

Jan. 28-Feb. 1: 1963 AIEE Winter Gen'l. Mtg. & Electrical Eng. Exp.; Statler-Hilton, New Yorker Hotels, the Coliseum, New York, N. Y.

Jan. 29: 12th Annual Quality Control Clinic, Minn. Sec., ASQC; Leamington Hotel, Minneapolis, Minn.

Jan. 30-31: 9th Annual Midwest Welding Conf., ARF; Hermann Hall, Ill. Inst. Tech., Chicago, Ill.

Jan. 30-Feb. 1: Nat'l. Winter Conv. on Military Electronics, IRE (PGMIL); Ambassador Hotel, Los Angeles, Calif.

FEBRUARY

Feb. 4-8: ASTM Annual Committee Week; Queen Elizabeth Hotel, Montreal, Que., Canada.

Feb. 4-10: 1963 Western Electronic Week & Pacific Electronic Trade Show (Feb. 8-10), AED; Shrine Exp. Hall, Los Angeles, Calif.

Feb. 5-7: 18th Reinforced Plastics Div. Conf., SPI; Edgewater Beach Hotel, Chicago, Ill.

Feb. 11-13: 1st Annual Conv., Electronic Sales-Marketing Ass'n.; Americana Hotel, New York, N. Y.

Feb. 11-14: Semiannual Mtg. & Exp., ASHRAE; Statler-Hilton Hotel and the Coliseum, New York, N. Y.

Feb. 18-19: 4th Electrical/Electronic Trade Show, Electrical Reps. Club, Electronic Reps. Ass'n.; Denver-Hilton Hotel, Denver, Colo.

Feb. 18-20: 13th Nat'l. Conf. on Standards, ASA; Biltmore Hotel, New York, N. Y.

Feb. 20: 4th Annual Reliability Symp., Los Angeles Sec., ASQC; Statler-Hilton Hotel, Los Angeles, Calif.

Feb. 20-22: 10th Int'l. Solid-State Circuits Conf., IRE (PGCT), AIEE, Univ. of Pa.; Univ. of Pa., Sheraton Hotel, Philadelphia, Pa.

Feb. 21-22: Quality Control Conf., Western Reg., ASQC; Flamingo Hotel, Las Vegas, Nev.

Feb. 22: Gen'l. Mtg., Ass'n. of Electronic Parts & Eqpt. Mfrs.; Chicago, Ill.

Feb. 23: AMS Mtg.; New York, N. Y.

Feb. 24-28: AIME Annual Mtg.; Dallas, Tex.

Feb. 26-Mar. 1: 19th Annual SPE Tech. Conf.; Statler-Hilton and Biltmore Hotels, Los Angeles, Calif.

MARCH

Mar. 1-2: APS Mtg.; Rice Univ., Houston, Tex.

'63 Highlights

IEEE Int'l. Conv., Mar. 25-28; Coliseum and Waldorf-Astoria Hotel, New York, N. Y.

ICEAS, Int'l. Conf. & Exh. on Aerospace Support, Aug. 4-9, AIEE, IRE, ASME; Sheraton-Park Hotel, Washington, D. C.

WESCON, Western Electronic Show and Conf., Aug. 20-23, IRE, WEMA; Cow Palace, San Francisco, Calif.

National Electronics Conf., Oct. 28-30, IRE, AIEE; McCormick Place, Chicago, Ill.

NEREM, Northeast Research and Eng. Mtg., Nov. 4-6. IRE; Boston, Mass.

Mar. 2: 7th All-Day Seminar, Dayton Sec., ASQC; Engineer's Club, Dayton, Ohio.

Mar. 3-7: Gas Turbine Conf. & Prodcts Show, including Aviation & Space Conf., ASME; Statler-Hilton Hotel, Los Angeles, Calif.

Mar. 4-8: Pittsburgh Conf. on Analytical Chem. & Applied Spectroscopy, Pittsburgh Analytical Chem. Soc., Pittsburgh Spectroscopy Soc.; Penn-Sheraton Hotel, Pittsburgh, Pa.

Mar. 5-7: 1963 Microminiaturization Cong., AWI; Sheraton Hotel, Philadelphia, Pa.

Mar. 5-7: Southeastern Plant Eng. & Maint. Show & Seminar, Southeastern Shows, Inc., AIPE; Merchandise Mart, Charlotte, N. C.

Mar. 7-8: IAS Propulsion Mtg.; Cleveland, Ohio.

Mar. 10-13: AIChE Nat'l. Mtg.; Roosevelt Hotel, New Orleans, La.

Mar. 12: Annual Mtg., Ass'n. of Electronic Parts & Eqpt. Mfrs.; Chicago, Ill.

Mar. 13-14: 13th Nat'l. Conf. on Instrumentation for the Iron & Steel Ind., ISA; Pick-Roosevelt Hotel, Pittsburgh, Pa.

Mar. 15: 10th Annual Quality Control Clinic, Milwaukee Sec., ASQC; Milwaukee Inn, Milwaukee, Wisc.

Mar. 15-16: Information Processing Conf., Computing Devices Committee, AIEE; Calif. Inst. Tech., Pasadena, Calif.

Mar. 15-17: Michigan State Conv., ARRL; Saginaw, Mich.

Mar. 16: Annual Quality Control Seminar, S. Conn. Sec., ASQC; Univ. of Bridgeport, Bridgeport, Conn.

Mar. 18: Workshop - Seminar - Quality Control Mgmt., Boston Sec., ASQC; MIT Faculty Club, Boston, Mass.

Mar. 18-22: ASM Western Metal Exp. & Cong.; Ambassador Hotel and Pan-Pacific Audit., Los Angeles, Calif.

Mar. 20-29: Symp. — "Quantitative Spectroscopy at Elevated Temperatures and Selected Applications in Space Science," AFOSR, AF Cambridge Res. Labs., ARPA, NASA, Inst. Def. Analysis, ONR, Calif. Inst. Tech.; Calif. Inst. Tech., Pasadena, Calif.

Mar. 23: Annual Nat'l. Conv., Intercollegiate Broadcasting Syst.; New York Univ., Univ. Hts., New York, N. Y.

Mar. 25-27: Space Testing & Support Mtg., IAS, ARS; Cocoa Beach, Fla.

Mar. 25-28: IEEE Int'l. Conv.; Coliseum and Waldorf-Astoria Hotel, New York, N. Y.

Mar. 26: 19th Annual Quality Control Conf., Rochester Sec., ASQC; Univ. of Rochester, Rochester, N. Y.

Mar. 26-28: American Power Conf., ASME; Sherman Hotel, Chicago, Ill.

Mar. 27: Spring Mtg., Ultrasonic Mfrs. Ass'n.; New York, N. Y.

Mar. 27-28: Spring Textile Eng. Conf., ASME; Clemson House, Clemson, S. C.

Mar. 30: Quality Control Conf., Battle Creek-Kalamazoo Sec., ASQC; Univ. Ctr., W. Mich. Univ., Kalamazoo, Mich.

Mar. 31-Apr. 3: 41st Annual NAB Conv. & 17th Annual Broadcast Eng. Conf.; Chicago, Ill.

Mar. 31-Apr. 5: Nat'l. Spring Mtg., AChS; Los Angeles, Calif.

APRIL

Apr. 1-3: "Pressure Vessels for Aerospace Applications," 4th Annual Structures & Materials Conf., IAS, ARS; Palm Springs, Calif.

Apr. 1-5: 1st Annual Dallas Ind. Trade Fair, State Fair of Texas; State Fair Park, Dallas, Tex.

(Continued on page 16)

COMING EVENTS

Apr. 10-11: 4th Symp. on Eng. Aspects of Magnetohydrodynamics, IRE (PGNS), AIEE, IAS, Univ. of Calif.; Univ. of Calif., Berkeley, Calif.

Apr. 16-17: 1963 Ohio Valley Instrument-Automation-Electronics Exh. & Symp., ISA, SESA; Cincinnati Gardens, Cincinnati, Ohio.

Apr. 16-18: "Optical Masers," 13th Annual Polytechnic Int'l. Symp., IRE, AIEE, OSA, AFOSR, ONR, ARO, Brooklyn Polytech. Inst. Microwave Res. Inst.; New York, N. Y.

Apr. 16-18: 10th Cleveland Electronics Conf., IRE, AIEE, ISA, Cleveland Physics Soc., Case Inst. Tech., Western Reserve Univ.; Sheraton-Cleveland Hotel, Cleveland, Ohio.

Apr. 17-19: 1st Int'l. Conf. on Nonlinear Magnetics, IRE (PGEC, PGIE), AIEE; Shoreham Hotel, Washington, D. C.

"CALL FOR PAPERS"

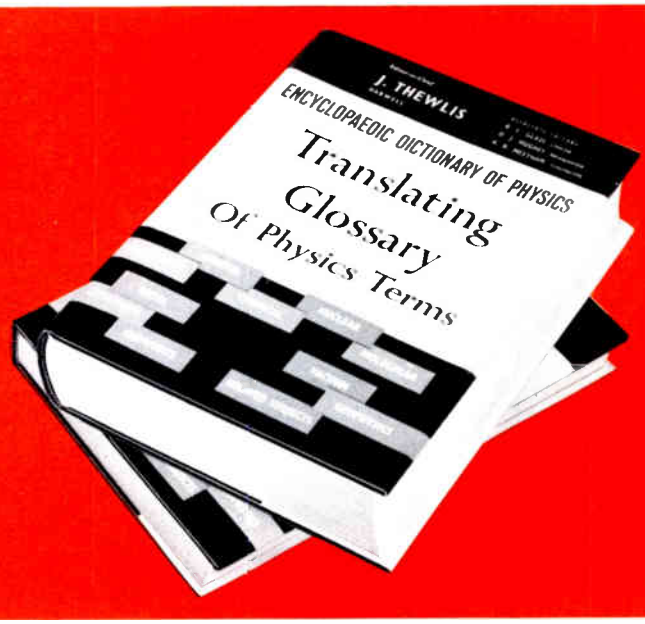
Int'l. Conf. & Exh. on Aerospace Support, Aug. 4-9, 1963. Sheraton-Park Hotel, Washington, D. C. Papers may deal with, but are not limited to, the following subjects: electrical/electronic systems and techniques, mechanical structures, systems and techniques, guidance, control, telemetry, communications, instrumentation and checkout, training, education, management and administration. The deadline for papers is *Feb. 18, 1963.* For complete information, contact: Technical Sessions Committee, P. O. Box 6635, Wasington 9, D. C. Papers may also be submitted through the participating societies, including the AIEE, ASME and others.

ENGINEERING EDUCATION

Short Courses of interest to engineers

X-Ray School

The 44th Norelco X-ray Analytical School will be held *Feb. 4-8, 1963,* at the Henry Hudson Hotel, New York, N. Y. Chemists, metallurgists, physicists, production supervisors, quality control engineers and others interested in the application of X-ray diffraction, diffractometry and spectography are invited to register. The course is offered free. Norelco X-ray schools are also held in Chicago in June and in San Francisco in Sept. For information, contact: Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N. Y.



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IMPORTANT NOTE

Volume I of the Translating Glossary is ready for immediate shipment. This provides complete cross-translating facilities in English, German, Russian and French. Volume II, which provides translating facilities in Japanese and Spanish, will soon be at the printers. Later this year it will be shipped free of charge to Volume I owners. Mail card for complete information.

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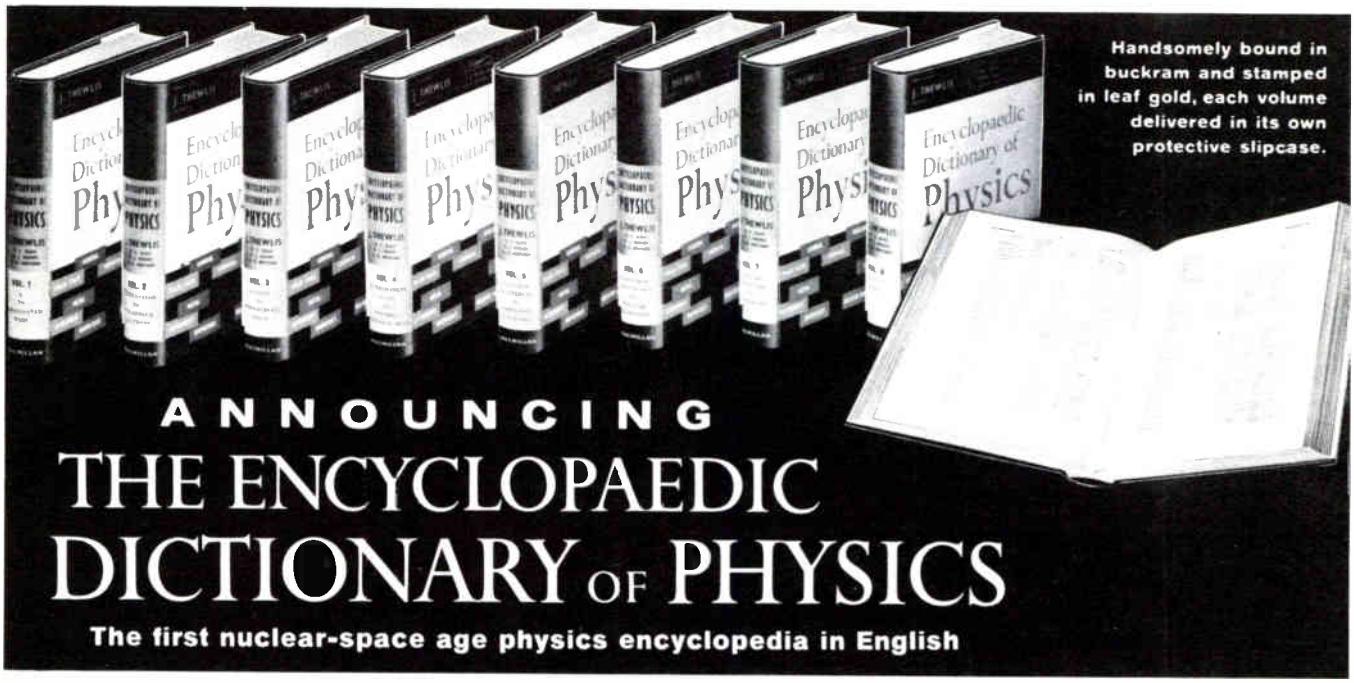

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- GAU-401 . . . . . TO-18 Package / Uncooled. Peak Response at 0.85 micron.

GaAs Light-Emitting Diode

- GAE-402 . . . . Emits at 0.9 micron. Radiates > 1 mw Uncooled. Packaged in UG-88/U type BNC for Maximum Modulation Capability.

Si Photomixer Diode

- L-4501 . . . . Peak Response in 0.7 micron Range. Detects Modulation up to 5 Gc. Photomixer Quantum Efficiency of 85%.

Dewar-Matched Cryostats

Cryostat Type	Compatible IR Detectors
C-100	ISC-301, ISC-501, GPC-201
C-300	ISC-363, IAC-701

Electro Optical Epitaxial Si Planar NPN Transistor

- L-9000 . . . . Responds to Both Electrical and Light Signals. Overall Propagation Time < 0.1 μsec. TO-18 Package With Dome Window.

SPECIAL PRODUCTS OPERATION

PHILCO

A SUBSIDIARY OF Ford Motor Company

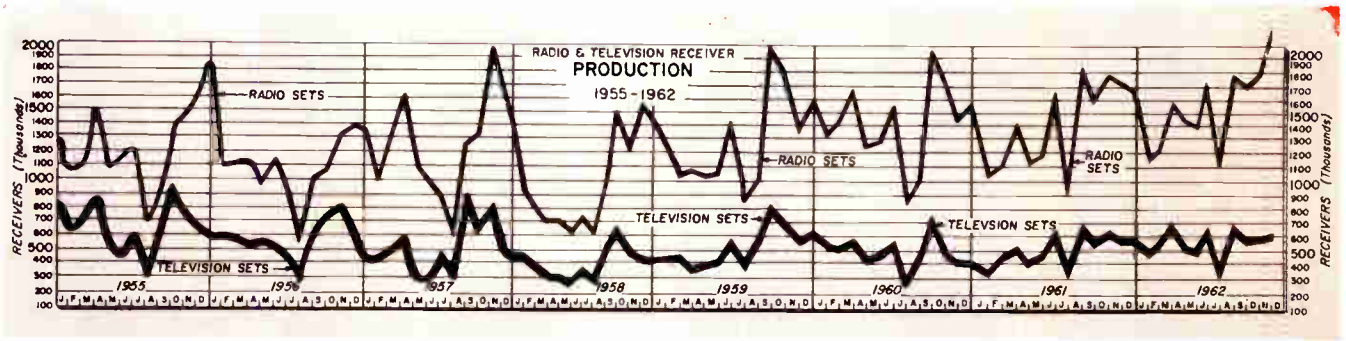
LANSDALE DIVISION, LANSDALE, PA.

IN EUROPE: Avenue de Beauregard 3, Fribourg, Switzerland

Circle 14 on Inquiry Card

MARKETING

Facts and Figures Round-Up



GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in November, 1962.

Accelerometers	26,015
Amplifiers	273,020
Antennas and accessories	912,756
Attenuators, variable	26,200
Batteries	2,642,837
Cable	176,832
Capacitors	55,950
Coil	99,150
Computers	531,617
Converters, frequency	546,400
Counters and Recorders	26,621
Data equipment	52,580
File conversion equipment	750,937
Film Analyzer-Recorders	51,900
Filters	73,515
Generators/Detectors	98,298
Gages, thermocouple	35,338
Headsets	49,927
Indicators, transducers	164,621
Intercom systems	671,135
Inverters	256,190
Laboratory equipment	410,000
Light indicators	25,740
Magnetic tape	226,450
Magnetic tape memory	95,352
Meters	305,541
Microfilm Reader-Printer	158,750
Microphones	26,633
Microwave equipment	330,315
Modules, digital	38,551
Navigation equipment	1,774,019
Oscillators	47,560
Oscilloscopes	1,153,115
Preamplifiers	48,500
Print stations, high speed	315,580
Printed circuit boards	25,110
Programmer tape units	75,760
Radar equipment	2,101,877
Radio equipment	1,186,948
Radio transmitters	41,855
Range finders	1,293,858
Receiver Transmitters	2,618,402
Recorders	854,425
Recorder-Reproducers	844,093
Relays	188,407
Reproducer, Voice/code	95,230
Resistance Standards	153,340
Resistors, variable	63,371
Sensing elements	58,474
Semiconductors	861,180
Solenoids, electrical	77,799
Switches	86,010
Telegraph equipment	589,863
Telemetering equipment	4,659,995
Telephone equipment	577,125
Test consoles	273,570
Transducers	37,125
Transformers	29,725
Tubes, electron	1,251,069
TV scanning equipment	42,000
Vacuum equipment	84,510
X-Y Electroplotter system	57,200

Comparison of U.S./Canadian Engineering Salaries

	Starting Salaries			Median P. E. Salaries		
Year	U. S.	Can.	% Difference	U. S.	Can.	% Difference
1953	4050	3534	15	—	—	—
1954	—	—	—	8460	6100	39
1956	5000	4266	17	9490	7200	32
1958	5850	4776	22	10000	7900	27
1960	6500	4950	31	10660	8544	25

Source: Canadian Dept. of Labour, Ottawa.

U. S. Exports of Scientific & Process Control Instruments, First Half 1962 vs. First Half 1961

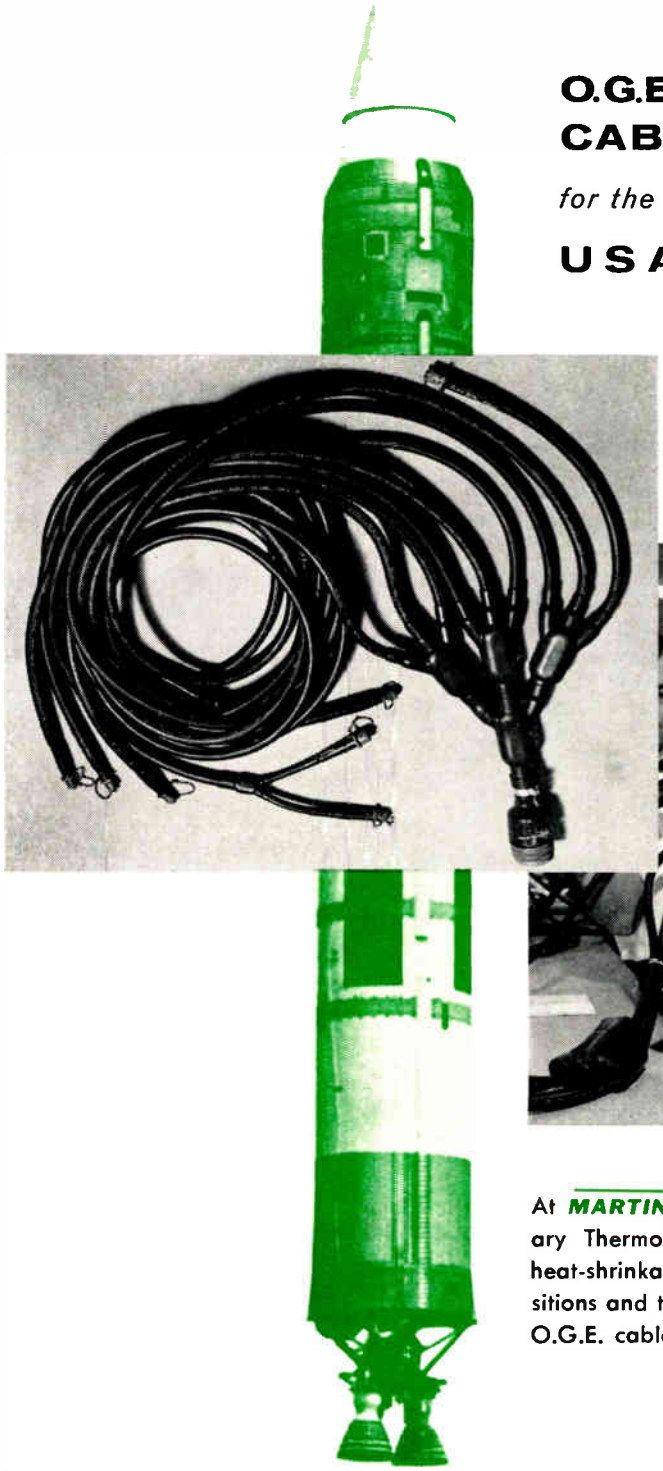
	First Half 1962	First Half 1961	% Change First Half 1962/1961
All Classes, Total	$295,795,190	$190,858,876	+ 55.0
I. Scientific and laboratory instruments and equipment	172,910,030	83,871,105	+106.2
1. Surveying and engineering	1,387,422	1,386,046	+ .9
2. Optical	9,815,585	8,440,075	+ 10.0
3. Flight, navigational, and meteorological	140,076,434	58,773,378	+138.3
4. Laboratory apparatus	21,630,589	15,271,606	+ 41.6
II. Industrial and process instruments and equipment	122,885,160	106,987,771	+ 14.8
1. Electrical measuring	30,035,496	25,317,545	+ 18.6
2. Mechanical measuring	26,670,654	24,134,010	+ 10.5
3. Automatic control devices	66,179,010	57,536,216	+ 15.0

Source: U. S. Dept. of Commerce.

O.G.E.
CABLE ASSEMBLY

for the

USAF TITAN II



At **MARTIN** Denver the revolutionary Thermofit harness system of heat-shrinkable, slip-on boots, transitions and tubing form a complete O.G.E. cable assembly.

THERMOFIT

HARNESSING SYSTEMS

RAYCLAD TUBES
INCORPORATED
REDWOOD CITY, CALIFORNIA

NEWS BRIEFS

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

PHILCO CORP.'s COMMUNICATIONS AND ELECTRONICS DIV., Philadelphia, Pa. has been awarded a $5,881,478 contract by the U.S. Navy for production of guidance and control systems for Sidewinder I-A missiles.

DOUGLAS RESEARCH DIV., DOUGLAS MICROWAVE CO., Mt. Vernon, N. Y., has received a contract in excess of $100,000 from **LEAR SIEGLER, INC.**, Santa Monica, Calif., to design and manufacture the complete microwave transmitter and receiver system for the Cloud Detecting Radar AN/CPQ-11.

ADLER ELECTRONICS, INC., New Rochelle, N.Y., received a $600,000 contract from the U.S. Air Force to engineer, furnish and install communications control systems for the Atlantic Missile Range. The project includes installations at Cape Canaveral, Antiqua and Ascension Islands, and training of government personnel to maintain and operate the facilities. Major components and assemblies will be manufactured at the firm's Pelham Manor, N.Y. plants. The Rome Air Material Command, (ROAMA), Rome, N.Y., was the awarding agency.

ELECTRONIC COMMUNICATIONS, INC., St. Petersburg, Fla., has received 4 contracts totaling over $1,122,930 for communication equipment and services. Contracting agencies and the amounts are: Oklahoma City, Okla., Air Material Area, $432,000; Western Electric Co., $245,000; Warner Robins, Ga., Air Material Area, $307,930; and Middletown, Pa., Air Material Area, $138,000.

ADAMS-RUSSELL CO., INC., formerly of Cambridge, Mass., has completed its move to a new plant in the Bear Hill Industrial Park, off Route 128, in Waltham, Mass. The new 20,000 sq. ft. plant will enable the company to triple its present production capacity.

KULICKE AND SOFFA MFG. CO., Industrial Park, Ft. Washington, Pa., has announced the formation of **THE DIAMOND BRAZER CO. OF AMERICA**, to manufacturer multi-point diamond truers for abrasive grinding wheels. Diamand Brazer will operate as a division of Kulicke and Soffa.

HAZELTINE CORP., Little Neck, N.Y., has received a letter contract from the U.S. Air Force for additional quantities of the AN/APS-95 airborne early warning (AEW) radar system. According to a company spokesman, cost of the new system will total over $1 million.

AEROSPACE GROUP, consisting of the **AEROSPACE SYSTEMS DIV., KEARFOTT DIV.**, and **AEROSPACE RESEARCH CENTER**, of **GENERAL PRECISION, INC.**, Little Falls, N.J., has announced plans for a construction of a new 100,000 sq. ft. research and development building in Wayne Township, N.J. The building, to cost more than $1 million, will be situated on a 113-ocre tract recently purchased by General Precision for its Aerospace Group.

BARNES ENGINEERING CO., Stamford, Conn., has acquired, far an undisclosed sum, the assets of the **VERSATRONICS CORP.**, Ft. Walton Beach, Fla. Plans are under way to combine the former Versatronics and Barnes Florida groups at a single location near Cape Canaveral. The resulting organization will be known as the Barnes Engineering Co., **RANGE SYSTEMS DIV.**

GENERAL TELEPHONE & ELECTRONICS CORP., New York, N.Y. has announced receipt of a $13.7 million contract from the Dept, of the Army, for the production of electronic equipment. The work will be performed by **SYLVANIA ELECTRONIC SYSTEMS**, Div. of **SYLVANIA ELECTRIC PRODUCTS, INC.**, a subsidiary of GT&E.

PHOTOCIRCUITS CORP., Glen Cove, N.Y., has announced their 10th addition in 10 years which is scheduled for completion in early '63. The latest addition will be 41,000 sq. ft. in size, and will be used for the manufacture of printed motors, photoelectric tape readers and precision printed circuits.

TELEPLEX CORP., Princeton, N.J., has officially changed its name to **DYNAPLEX CORP.** by recent action of the company's stockholders and Board of Directors. It wos stated that the change had been made to eliminate possible confusion with the name of another company.

POWERTRON ULTRASONICS CORP., Plainview, L.I., N.Y., has been acquired (both business and assets) by **GIANNINI CONTROLS CORP.**, Duarte, Calif., for stock of Giannini. Subject to approval by Powertron stackholders, Giannini will issue 1 share of common stock and 1 share of convertible preferred stock for each 12 shares of Powertron. Giannini will operate Powertron as a wholly owned subsidiary.

RADIATION INC., Melbourne, Fla., has announced receipt of follow-on contracts totaling over $600,000 from **BELL TELEPHONE LABORATORIES.** The contracts are for additional data handling equipment for the U.S. Army's Nike-Zeus anti-missile missile system, now under development.

POWER DESIGNS INC., Westbury, N.Y., has been awarded a $100,000 contract by **ITT FEDERAL LABORATORIES**, Nutley, N.J., to provide highly reliable power supplies for use in an overseas communications network.

MID-WEST

MINNEAPOLIS-HONEYWELL REGULATOR CO., will transfer its Philadelphia-based **RUBICON DIV.** to the Heiland Div. in Denver, Colo. The 3 other Honeywell divisions, Brown Instruments, Valve and Special Systems will remain in the Philadelphia area.

CONTROL DATA CORP., Minneapolis, Minn., has been awarded a $4½ million contract to manufacture classified electronic equipment for the U.S. Army Electronic Command, Fort Mead, Md. Contract work will be performed at CDC's **COMPUTER DIV.** at Minneapolis and the company's **SYSTEMS SCIENCES DIV.**, Beverly Hills, Calif.

RADIO CORP. OF AMERICA has placed in operation, on an around-the-clock basis, its second color television tube manufacturing facility. The facility in RCA's Marion, Ind. plant is the second major addition within the year to RCA's color tube production. It represents a $1.7 million expansion in facilities.

OAK MFG. CO., Crystal Lake, Ill., has moved all operations of **DELTA-F, INC.**, Geneva, Ill., to Oak's main plant in Crystal Lake. Delta-f, acauired by Oak in February of '62, will still maintain its separate identity and have its own production facilities.

WEST

ELECTRADA CORP.'s DATA PRODUCTS DIV., Los Angeles, Calif., has received a contract, from the Electronics Systems Div. of the U.S. Air Force Systems Command, amounting to over $140,000 for Electrada's DATACOM systems for integration in an intelligence data handling system.

ELECTRALAB PRINTED ELECTRONICS CORP., Encinitas, Calif., has been purchased from the **FARRINGTON MFG. CO.**, Boston, Mass. by former employees of the previously wholly owned subsidiary of Farrington. Electrolab will continue development and production of printed circuits, under their new name of **ELECTRALAB ELECTRONICS CORP.**

THE GEOTECHNICAL CORP., Garland, Tex., has begun construction on a 14,000 sq. ft. addition to its main plant, to provide additional engineering and manufacturing work space. The addition will increase Geotechnical's floor space to 95,000 sq. ft.

R S ELECTRONICS CORP., sub. of **PACIFIC INDUSTRIES, INC.**, Palo Alto, Calif., has been awarded a contract by **NORTHROP CORP., VENTURA DIV.**, amounting to over $500,000. The contract calls for quantity production of command receivers and autopilots for the KD2R-5 Target Drone being supplied to the U.S. Navy by Northrop-Ventura.

ESPEY MFG. & ELECTRONICS CORP., Saratoga Springs, N.Y., has announced the formation of the **SARATOGA PACIFIC CORP.**, Anaheim, Calif. Saratoga Pacific will operate as a wholly owned subsidiary of Espey, and will operate in a 5,000 sq. ft. plant in the Anaheim industrial complex, designing and manufacturing r-f filters and delay lines.

AMELCO, INC., Mountain View, Calif., has announced the beginning of construction of a 55,000 sq. ft. manufacturing and research facility in the Mountain View Industriol Park, Stierlin Rd. and Bayshore Freeway. Cost is expected to be in excess of $1 million.

HYCON MFG. CO., Monrovia, Calif., has announced receipt of awards totaling approximately $4.4 million for development and production of aerial reconnaissance systems and missile test equipment.

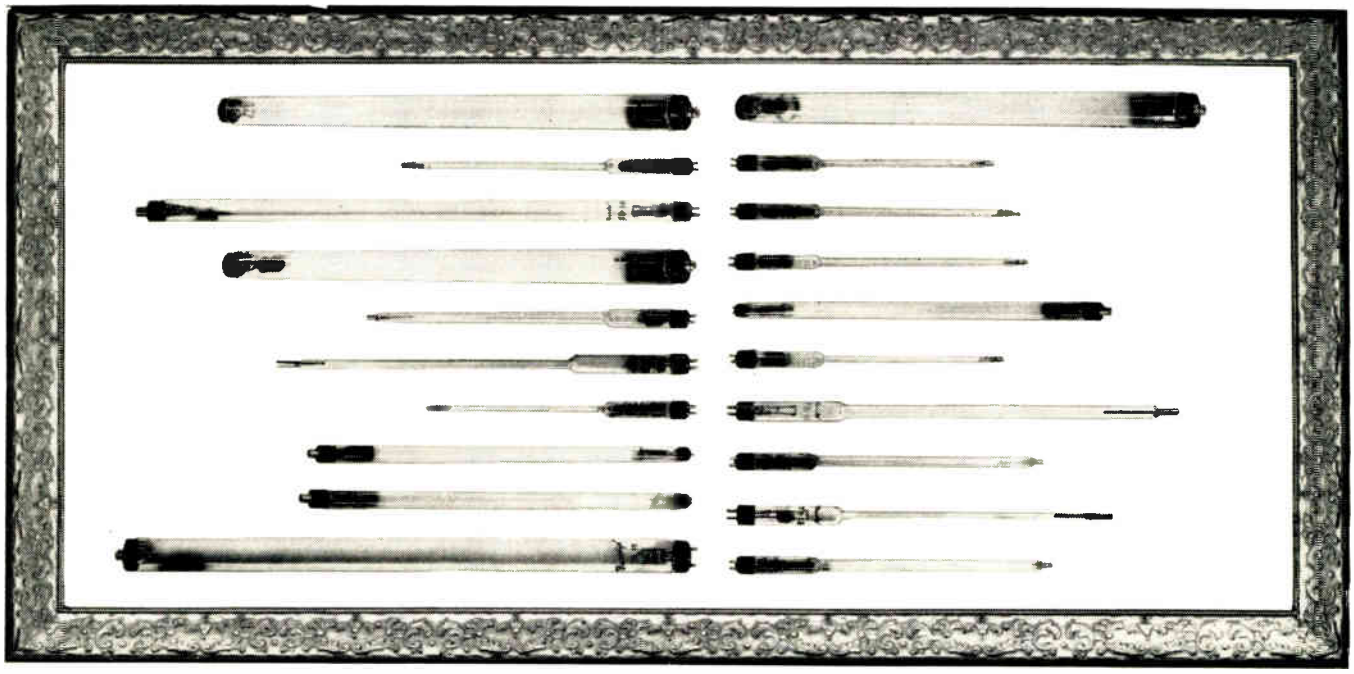
BECKMAN INSTRUMENTS, INC., Richmond, Calif., has announced the acquisition of **STEVENS-EVANS, INC.**, San Diego, Calif., manufacturer of specialized electronic test and control instruments. The transaction was completed for an undisclosed amount of cash. Stevens-Evans will operate as a subsidiary of Beckman.

ALLIED CHEMICAL CORP., New York, N.Y., has announced a new multi-million dollar plant at El Segundo, Los Angeles, Calif., for production of its "Genetron" fluorinated hydrocarbon refrigerants, aerosal propellants, solvents and urethan foam blowing agents. The plant will be built and operated by the company's **GENERAL CHEMICAL DIV.**

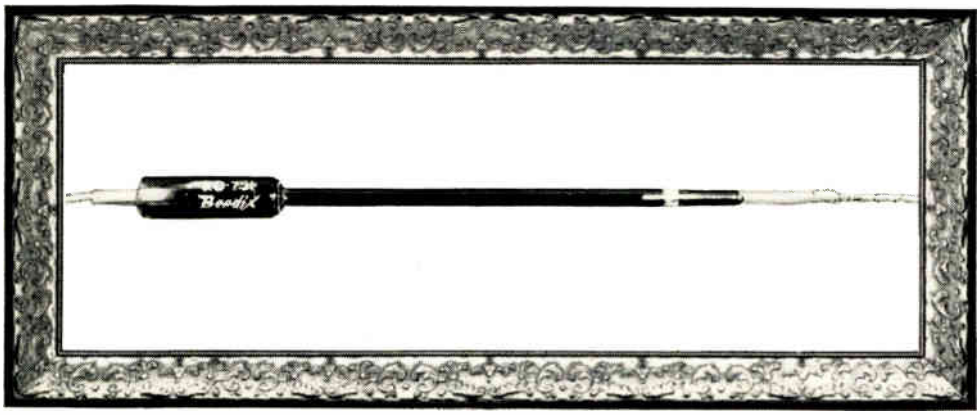
HEWLETT-PACKARD CO., Palo Alto, Calif., has announced plans to convert two of its wholly-owned subsidiaries, **BOONTON RADIO CORP.**, Rockaway Township, N.J. and **PALO ALTO ENGINEERING CO.**, Palo Alto, Calif. into divisions of the company. The establishment of Boonton Radio and PAECO as HP divisions is part of the parent company's program of gradually divisionalizing its corporate structure.

LING-TEMCO-VOUGHT, INC., Dallas, Tex., has received a follow-on contract amounting to $442,000 from **WESTINGHOUSE ELECTRIC CORP., ELECTRONICS DIV.**, Baltimore, Md., for additional production of a number of large AN/FPS-27 radar antenna mount assemblies for the USAF.

ELDORADO ELECTRONICS, Concord, Calif., has begun construction of a 22,000 sq. ft. building in Concord to provide for expansion of the company.



Our gas-noise tubes are free from ambient temperature variations, are durable and dependable, and can be matched to your applications. One of our family is missing from this picture.



He left for Venus with Mariner II.

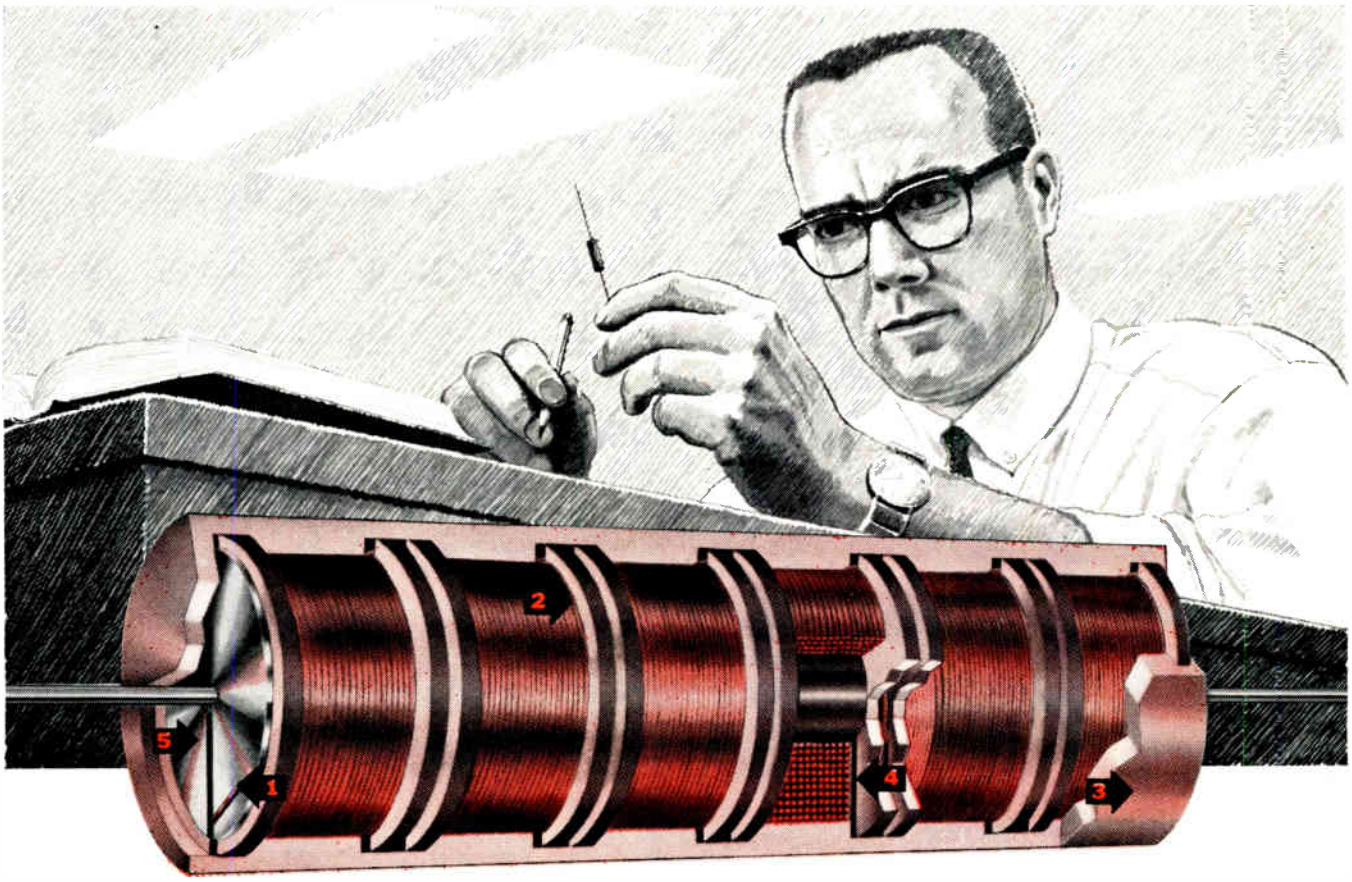
FOR ADDITIONAL INFORMATION, WRITE US IN EATONTOWN, NEW JERSEY.

Red Bank Division

THE Bendix CORPORATION

DALE RELIABILITY...

design it into your circuit with WW Bobbin Type Resistors



IN designing a circuit to include Dale WW Resistors, you get exclusive reliability features available in no other bobbin type resistors. Both the termination and winding method in the WW Resistor are covered by U.S. Patent No. 2,993,186. WW's are precision non-inductive resistors encapsulated in epoxy to completely protect them against tough environments. An additional benefit is the assurance of INHERENT STABILITY which has resulted from Dale's long experience in the technology of winding fine resistance wire. This experience, linked with Dale's participation in the **MINUTEMAN** High Reliability Component Development Program, has provided new levels of achievement in design and processing of resistors. Add reliability to your circuit by specifying Dale WW Bobbin Type Resistors. Available with weldable leads.

SPECIFICATIONS

• Meet requirements of MIL-R-93C. characteristic C. • Eight physical sizes rated at 0.1, 0.15, 0.2, 0.25, 0.3, 0.5 watt. • Resistance range from 10 ohms to 1.5 megohms. • Tolerance 1% standard. • Operating temperature range -55° C. to 145° C.

HERE'S HOW DALE "BUILDS IN" RELIABILITY

VALUES WON'T SHIFT due to outside mechanical forces. New terminal disc prevents breakage of terminating wire and changes in resistance due to bending of leads or other outside mechanical force. Terminal disc welded to lead and firmly bonded to the end of the bobbin. Termination of the last pi winding can be made at any point on the periphery of the terminal disc, allowing precise calibration and more room for dependable welds.

COMPLETE SEPARATION of pi windings by patented twin-disc separators eliminates need for insulating tape to prevent shorting.

TOTAL PROTECTION against environmental or mechanical damage is given by encapsulation in an epoxy material with a very high dielectric strength.

RESISTANCE WIRE is procured to rigid specifications (analysis of each melt required).

COMPLETE WELDED CONSTRUCTION. Welds tested on sample basis to destruction. Available with weldable leads.

COMPLETE TESTING PROGRAM: Resistance check: 100% final; complete military specification environmental test on sampling basis.

Write for Dale Resistor Catalog A

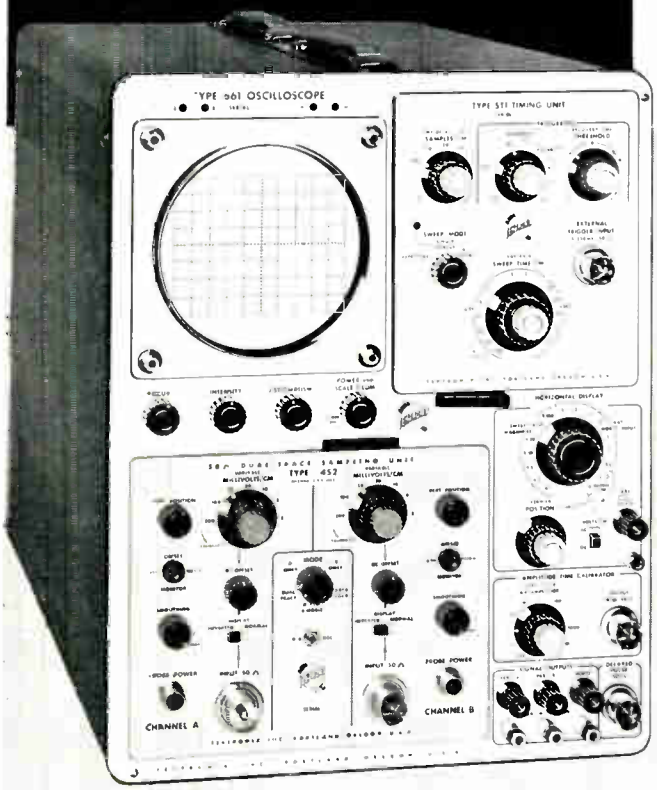
DALE ELECTRONICS, INC.
1304 28th Avenue, Columbus, Nebraska
A subsidiary of THE LIONEL CORPORATION
Also Made and Sold by Dale Electronics Canada, Ltd., Toronto, Ontario, Canada

SEE OUR SPECIFICATIONS IN V·S·M·F THE MICROFILM CATALOG FILE

HIGH RESOLUTION

0.1-nsec Risetime

with the new Tektronix Type 4S2— vertical plug-in unit for the Type 661 Sampling Oscilloscope



RESOLVES fastest present switching transistor risetimes, including commercially available avalanche types (usually limited by the transistor or the transistor case).

RESOLVES most tunnel diode switching times. (Only diodes with better than 3 ma/pf are faster.)

RESOLVES stored charge in switching diodes to the 0.01 picocoulomb/milliampere region (generally limited by diode capacity and turn-on capability).

RESOLVES 0.1% system discontinuities as reflectometer with centimeter separation capability (limited by external pulse generators, delay lines, attenuators).

RESOLVES fractions of a degree of relative phase shift to over 1 gigacycle frequency with lissajous-mode operation (usually limited by harmonic content or residual reflections to a few degrees absolute).

RESOLVES millivolts of information on top of signals hundreds of millivolts in amplitude (*not* limited by the usual amplifier overload problem).

Additional Ways You Can Use the 661

. . . display repetitive signals on 16 calibrated equivalent sweep rates from 1 nsec/cm to 100 μsec/cm, accurate within 3%. Magnifier provides display expansion from 2 to 100 times . . . time per dot remains the same for digital readout.

. . . change the probes' signal source without affecting the dot transient response.

. . . reduce time jitter and amplitude noise, if needed, on the more sensitive vertical ranges and faster sweep rates by means of a smoothing control.

. . . calibrate with amplitude and timing signals available at the front panel.

. . . show lissajous patterns in addition to single and dual-trace displays and signals added algebraically.

. . . drive X-Y plotters or similar readout accessories.

. . . drive external equipment, with fast delayed-pulse output.

. . . add plug-in units as they come along.

Type 661 Oscilloscope (without plug-ins)	$1150
Type 5T1 Timing Unit (required to provide time base)	$ 750
50Ω Dual-Trace Sampling Units (at least 1 required):	
Type 4S2 (0.1-nsec risetime)	$1600
Type 4S1 (0.35-nsec risetime)	$1430

Currently available, the general-purpose Type 4S1 Unit, with delay lines and internal triggering, permits 661 operation much like a conventional oscilloscope.

Probes:

Type P6032 Cathode-Follower Probe	$ 160
Type P6034 Miniature Passive Probe (10X attenuation)	$ 35
Type P6035 Miniature Passive Probe (100X attenuation)	$ 35

Both miniature passive probes have input capacitance of 0.7 pf ±0.1 pf from 1 to 1000 Mc. U.S. Sales Prices f.o.b. Beaverton, Oregon

Type 4S2 Dual-Trace Sampling Unit—used with a Type 5T1 Timing Unit in a Tektronix 661 Oscilloscope—makes possible a new degree of time resolution. This new vertical plug-in unit retains most features of the general-purpose Type 4S1, except for delay lines and internal triggering.

Type 4S2 is expected to be available during first quarter 1963. Keep in touch with your Tektronix Field Engineer for latest availability information.

Tektronix, Inc. / P. O. BOX 500 · BEAVERTON, OREGON / Mitchell 4-0161 · TWX—503-291-6805 · Cable: TEKTRONIX. OVERSEAS DISTRIBUTORS IN 27 COUNTRIES AND HONOLULU, HAWAII.

Tektronix Field Offices are located in principal cities throughout the United States. Please consult your Telephone Directory.

Tektronix Canada Ltd: Montreal, Quebec • Toronto (Willowdale) Ontario • Tektronix International A. G., Terrassenweg 1A, Zug, Switzerland.

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A COMPLETE FAMILY OF SOUND

CTS Loudspeakers—from 3″ to 15″—capture the full range of Clear True Sound. Thousands of custom variations in all standard E.I.A. and special sizes and types constitute the industry's most complete line of loudspeakers. Available in Alnico or Ferrites. Competitively priced. Made from all U.S. parts.

CTS will mass produce loudspeakers to your exact requirements—with the well-known built-in CTS quality. Its new, highly efficient automated manufacturing facility (106,000 sq. ft.) is entirely devoted to loudspeaker production. The CTS loudspeaker engineering staff will gladly help you solve unusual application problems.

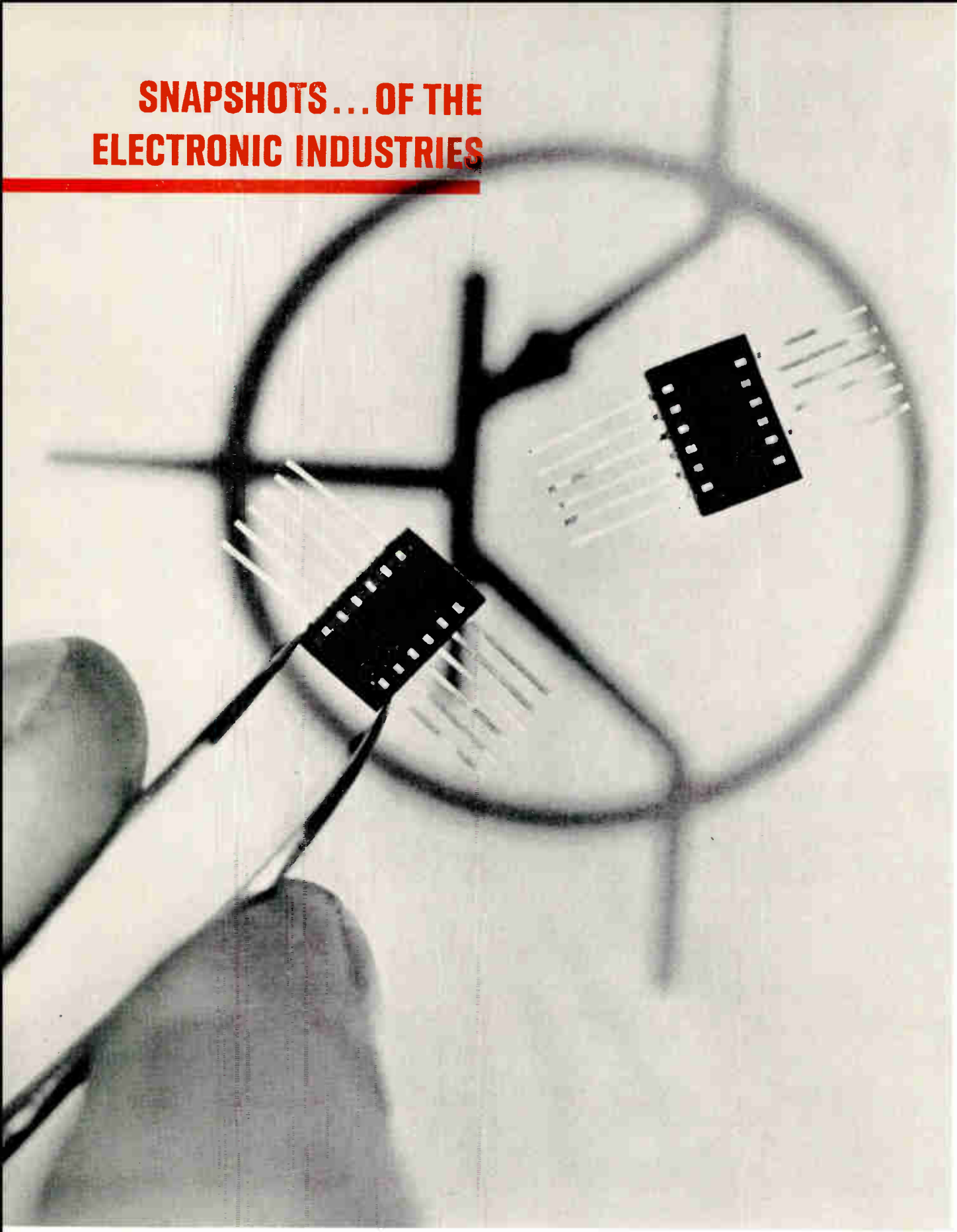
For detailed information, write for Catalog P-102.

Founded 1896

CTS OF PADUCAH, INC.
1500 No. 8th Street, Paducah, Kentucky

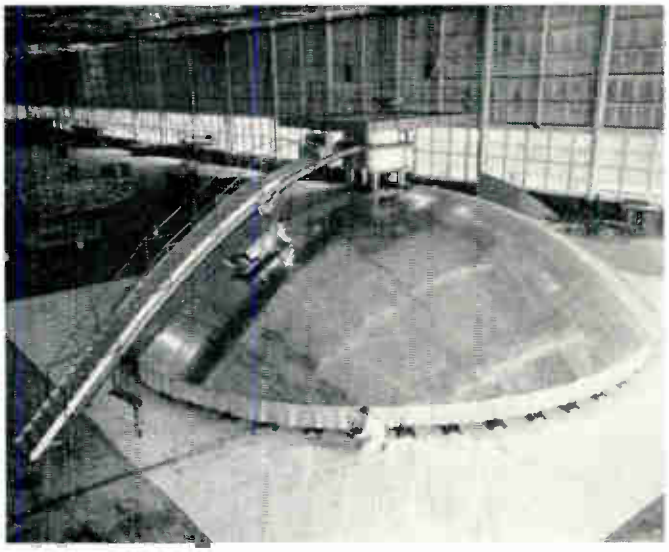
a subsidiary of
CTS CORPORATION
Elkhart, Indiana
Manufacturer of Electronic Components

SNAPSHOTS...OF THE ELECTRONIC INDUSTRIES



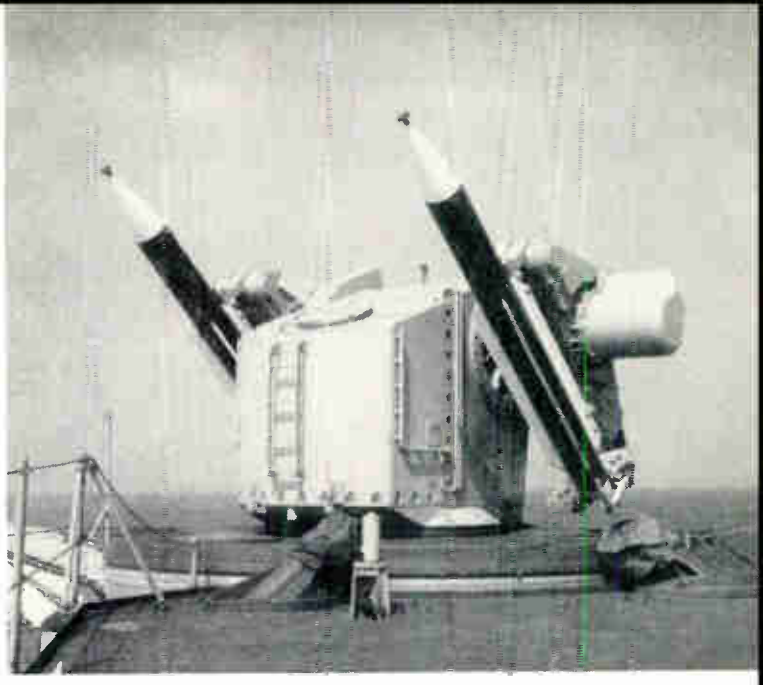
GLASS PACKAGE

This 12-lead black-glass enclosure is one of a variety of new configurations for integrated circuits and semiconductors. It is opaque to visible and infrared radiation. The manufacturer, Corning Glass Works, Corning, N. Y., reports configurations that are now possible include round, square and rectangular shapes, with many leads and almost any lead placement.



INFLATABLE COLLECTOR

Reflector for solar energy collection to power future space craft is under construction at Goodyear Aircraft Corp.'s Arizona Div. Ground tests for the unit are set for early this year.



"DESK SET"

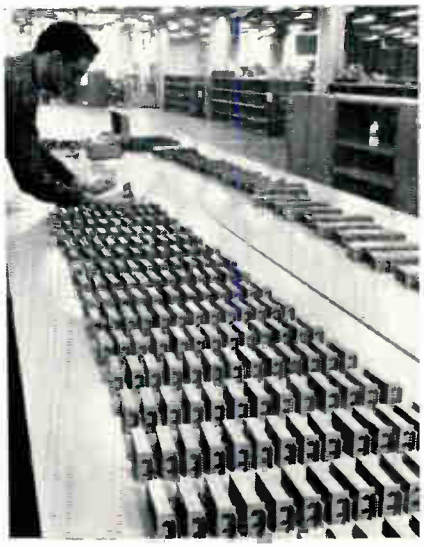
U.S. Navy Tartar solid-fuel guided missile is shown aboard the destroyer USS Robicon. Prime contractor for supersonic surface-to-air missile is General Dynamics/Pomona in Pomona, Calif.

ANECHOIC TEST RANGE

Precision range is used for antenna measurements in a range from 1 to 40 GC. Range is located at Budd-Stanley Co., Inc , Syosset, N.Y.

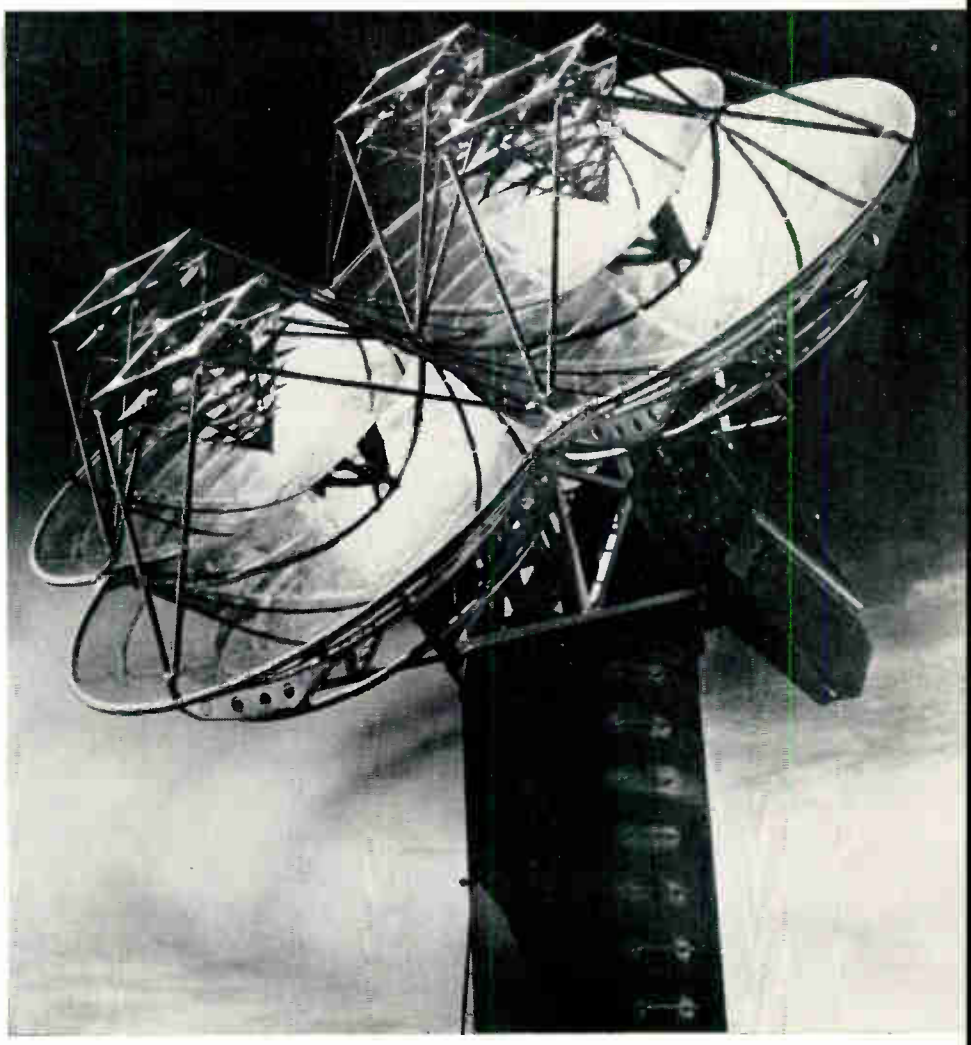
RELIABILITY CHECK

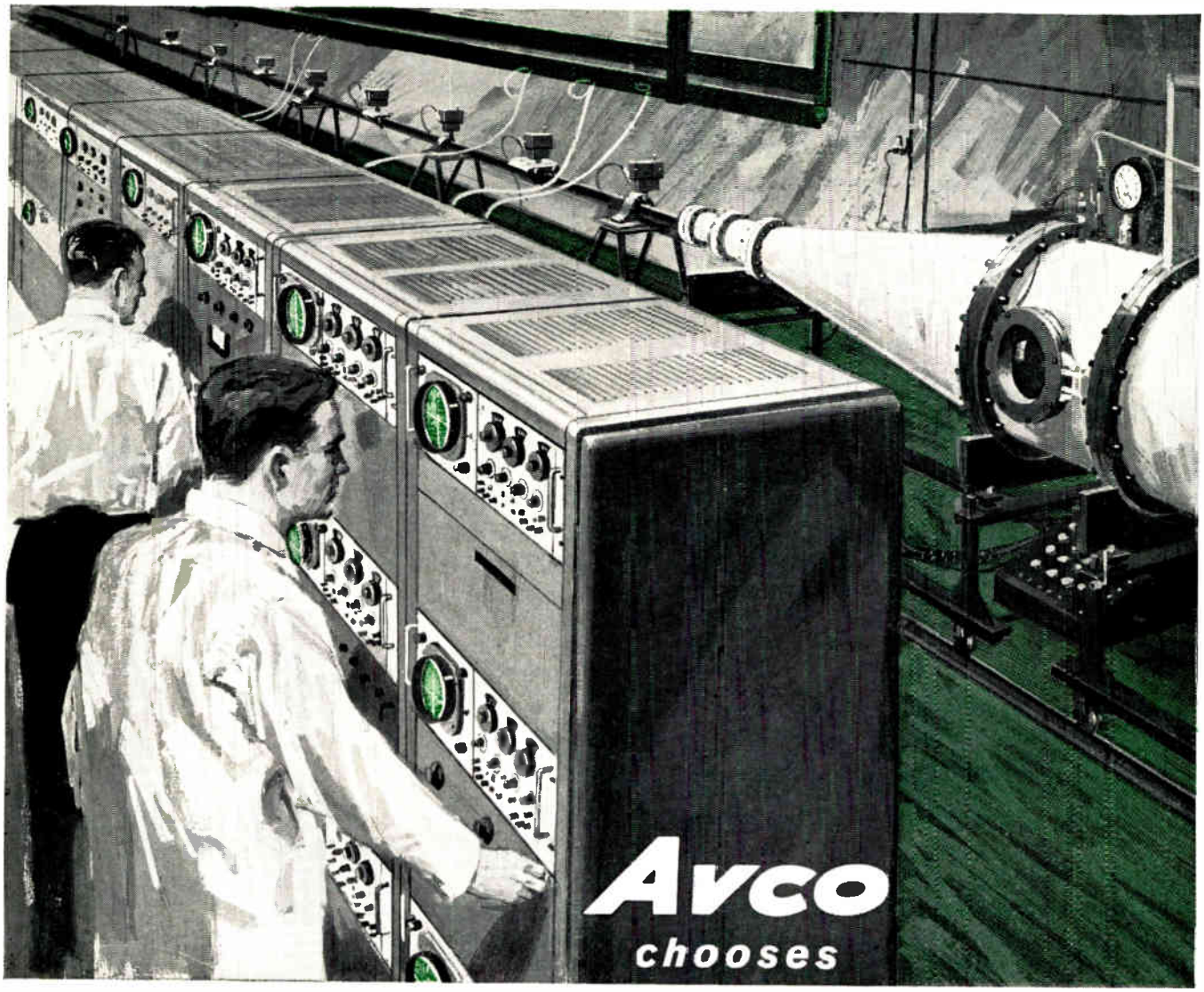
Dual light modules are checked for reliability before packaging for shipment. They are used in an electronic monitoring system developed by Martin Co., Baltimore, Md.



MULTI-PURPOSE

Multi-purpose phase monopulse antenna system has a bandwidth of 200 to 2300 MC. Named Telscom, the new antenna handles telemetry, surveillance and communications functions. Aluminum reflector is about 20 ft. in diameter. Antenna was developed by Radiation Inc.





Analab DUAL-TRACE OSCILLOSCOPES

for shock-tunnel tests on advanced ICBM re-entry systems

At Avco Corporation's Research and Advanced Development Division in Wilmington, Mass., re-entry conditions are simulated on nose cones for ballistic missiles and other aerospace projects.

In 4-millisecond test time, 24 channels of extremely low-output temperature and pressure data are transmitted from a model in the Mach 15 flow to a bank of Analab dual-trace oscilloscopes triggered simultaneously.

Simplicity of set-up (aided by Analab scopes' trace-tagging beam finder), plus identical high amplifier and triggering stability and sensitivity, permit all the scopes to be made ready in a small fraction of the time required by other scopes. Minimum calibration time and minimum d-c drift also helped Avco's choice of Analab for this demanding service.

Analab, maker of the world's finest oscilloscopes, offers a range of main frames and plug-ins (including storage and sampling) to meet your most exacting requirements. Call, wire, or write for complete technical data.

One of 46 Analab Type 1120R/700 scopes being used at Avco. 100 μv/cm sensitivity and direct-reading null-readout dials permit measurements of amplitude, time, and phase to ±2% accuracy.

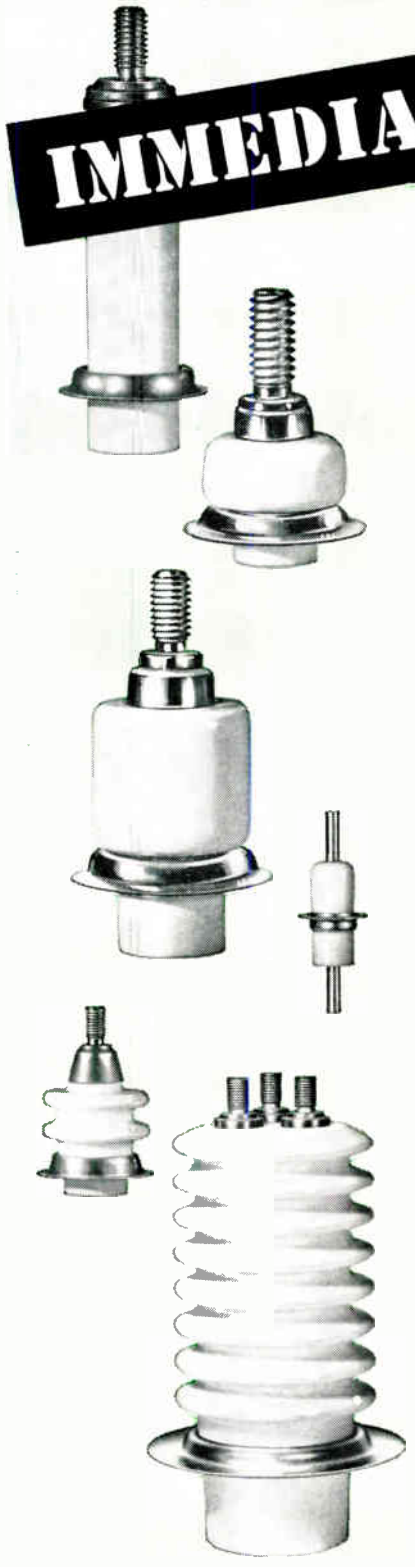
Analab INSTRUMENT CORPORATION
A subsidiary of THE JERROLD CORPORATION
Cedar Grove, New Jersey

IMMEDIATE DELIVERY

of ALITE®

STANDARD HIGH ALUMINA BUSHINGS

In Over 100 Types and Sizes



More than 100 sizes of standard Alite high voltage terminals, feed-throughs, cable end seals and high amperage bushings are stocked for immediate, "off-the-shelf" delivery to simplify design problems, save time and help reduce costs.

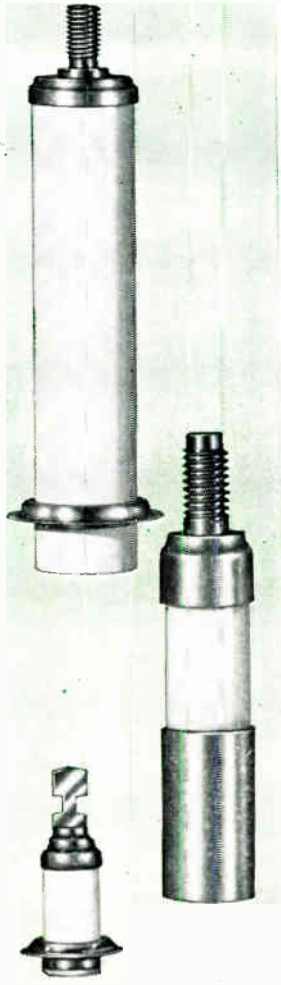
One of these standard Alite high alumina ceramic-to-metal hermetic seals may be just the answer to your problems of reliability and maintenance where service conditions are extremely severe or critical.

- Alite hermetic seals — tested for vacuum-tightness with a high sensitivity helium mass spectrometer — are adaptable to virtually any assembly procedure, such as welding, brazing or soldering.
- Alite's mechanical strength and thermal-shock properties far exceed those of glass or porcelain.
- Alite retains its dielectric properties at elevated operating temperatures.
- Alite's smooth, white glaze resists build-up of contaminants on surfaces — easy to see, easy to clean.

From ceramic formulation to finished part, every manufacturing step is handled within our own plant. Strict quality control assures absolute adherence to specifications, utmost uniformity and reliability.

* * * *

When special bushings are called for, it is often possible to save time and money by modifying one of the standard units. However, when necessary a team of Alite engineers stands ready to help you by designing new bushings.



Write for these free helpful brochures. Bulletin A-40R illustrates, describes and gives complete specifications of standard Alite bushings, both high voltage and high amperage. Bulletin A-8 provides detailed descriptions of Alite formulations. 235-H

ALITE DIVISION

U. S. STONEWARE

BOX 119 ORRVILLE, OHIO

PACKAGE DENSITY:
432,000 PARTS PER CUBIC FOOT

There are 101 "VK" Capacitors (count them) in our 5" model of the U.S. — and there's plenty of room for more. On a circuit board, this saving in space could be critical.

VK®

Micro-miniature

CERAMIC CAPACITORS

conform to MIL-C-11015C/18A/19A
CK05 and CK06

VK 30
case size:
.3 x .3 x .1
thru 10,000 mmf

VK 20
case size:
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thru 1000 mmf

- **10–10,000 mmf**
- **–55° C to 150° C**
- **200 VDC rating**

There's no room for space-robbing components in today's modules and circuit boards . . . and every part has to "pay its own way." "VK" Capacitors not only leave plenty of room for other components, but offer a high level of reliability to operate compatibly with all components in the circuit.

Designed as general purpose capacitors, they are ideally suited for coupling and by-pass applications, and exhibit exceptional performance characteristics. Dissipation Factor is less than 1.5% for values through 680 mmf. and less than 2.5% for values from 820 mmf. through 10,000 mmf. Temperature coefficient is ±10% for values through 680 mmf. and ±15% for values from 820 mmf. to 10,000 mmf.

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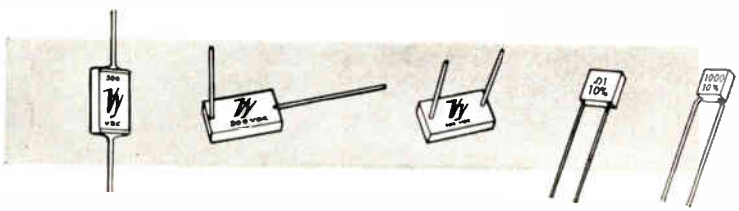

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WASHINGTON TRENDS

PLANS FOR SPENDING CUTS DROPPED— Defense Dept. plans for budget-cutting have gone out the window. Pentagon officials now foresee a $2 billion increase in defense spending during the new fiscal year. This would mean a defense budget of at least $52 billion for the 12-month period starting July 1. Pentagon budget sources now see no end to increased defense spending, no matter what economy moves are made. There will be new crises, new weapons, and new programs which will cost more money, they predict.

MORE RADAR BUYING — The Federal Aviation Agency is getting ready to ask Congress for what may be the fattest civilian radar procurement program in years. The FAA says it agrees with an outspoken report from the Air Traffic Control Association, laying the blame for unsafe air travel on obsolete radar and radio systems. The report, based on suggestions from hundreds of air traffic controllers, urges more emphasis on procuring radar and radio equipment of proven design; less on research for newer "ultimate" systems. The ATCA calls for a network of new ASR-4 terminal radars ("our best bet in the next decade"). FAA points out, however, that Congress holds the purse strings and that in recent years, the agency's "future requirements were not adequately provided for."

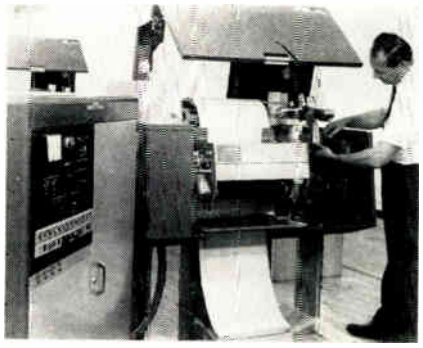
MERGERS WORRY CONGRESS — Changes wrought by defense buying and space-age techniques are being blamed by anti-merger forces as major reasons for the present "trend toward superconcentration." These Congressional forces say present antitrust laws "have had no visible deterrent effect on the (total) merger movement." Congressional reports point out the merger effects of defense and space changes. They say: 1. "The changing pattern of defense procurement, subordinating aircraft to missiles, has, in effect, brought an inter-industry merger between aircraft and electronics." 2. "The revolution in industrial techniques, marking the advent of the Space Age, has influenced the swashbuckling rise—through massive mergers—of some new factors in ranks of the top industrial corporations. But the older dominant firms have not been idle, themselves making significant, selective, and huge mergers. "The ranks of large business, as well as small business, are under pressure of the unabated trend toward superconcentration," the reports conclude. Moves are now being planned on ways to lessen this pressure.

GOVT. TO EXAMINE PROFITS — The Kennedy Administration is serving notice that an industry's profit picture will play an important part in deciding if it is eligible for relief from excessive volume of imported goods. Commerce Secretary Hodges made this clear recently in disclosing that the Government is investigating profits in the textile industry in connection with that industry's request for government help in its continuing struggle against imports. Just what constitutes "reasonable profits" has not been defined anywhere in Washington, so the agencies concerned (Commerce Dept., Tariff Comm.) are free to make arbitrary decisions concerning financial health of any given industry.

EXPORT TRADE BOOSTED — Government activities in the export field could mean a number of unique incentives to help U.S. firms sell more products abroad. Over and above the new freer-trade bill and other announced programs, the Administration is considering special tax, depreciation, financing, and service incentives for U.S. exporters. Tax incentives would be in addition to the present investment tax credit and the planned income tax cut. Depreciation aid would go beyond the recent lengthening of useful lives. Financing would go further than the Export-Import Bank now goes, and government services to exporters would be widely expanded. All of these possible incentives would be directed toward exports, and not manufacturing in general. But their purpose would be to aid the U.S. economy by making us more competitive in the world market.

INDUSTRY FACES $1.52 MINIMUM WAGE— Labor Dept. is expected to put into effect a new $1.52 an hour minimum wage for the electronic equipment industry early this year. Under the Walsh-Healey Act the Dept. sets minimum wages to be paid on work done under government contracts. Unions had asked for $1.72 an hour; manufacturers, through EIA, had proposed lower regional minimums. Dept. in late November settled on $1.52 national minimum. This was subject to further comments from management and labor within 30 days, but it was expected to be put into effect despite any protests.

DEVICE SIMULATES COMPUTER INSTRUCTIONS



IBM technician John Pollak gets ready for automatic testing of IBM 1403 printer. He's shown adjusting program tape on the printer. Unit at left will automatically direct testing procedure. It simulates instructions a computer would normally give the printer.

AUTOMATIC SYSTEM TO ANALYZE JET ENGINES

The Air Force has ordered a quantity of airborne instrument systems from Howell Instruments, Inc., Fort Worth, Tex.

This is the first order for Howell's new Aero-Jetcal—an automatic system to analye jet engines in flight. The Air Force will place the systems on first-line combat aircraft.

The system is a "monitor" of jet engine condition. It continuously checks the average temperature and spread of temperature in each jet engine, and records damage to the engine due to excessive temperature. It continuously indicates a number called a "hot section factor" for each engine. A quick look at this reading tells the flight or ground crewman how much longer the engine may be operated.

COMPUTER FOR MANNED SPACE FLIGHT TO IBM

NASA has selected IBM for negotiations to provide the groundbased computer "brains" for manned space flight missions. The complex will be part of the Integrated Mission Control Center at NASA's Manned Spacecraft Center, Houston, Tex.

The IMCC will control Gemini and Apollo flight operations just as the Mercury Control Center, Cape Canaveral, Fla., is the control center for Project Mercury flights.

The IMCC computer complex is planned to be operational in 1964 for Gemini rendezvous flights. Initial tasks under this contract, which include planning and program preparation, will cost about $1 million.

More News On Page 37

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."

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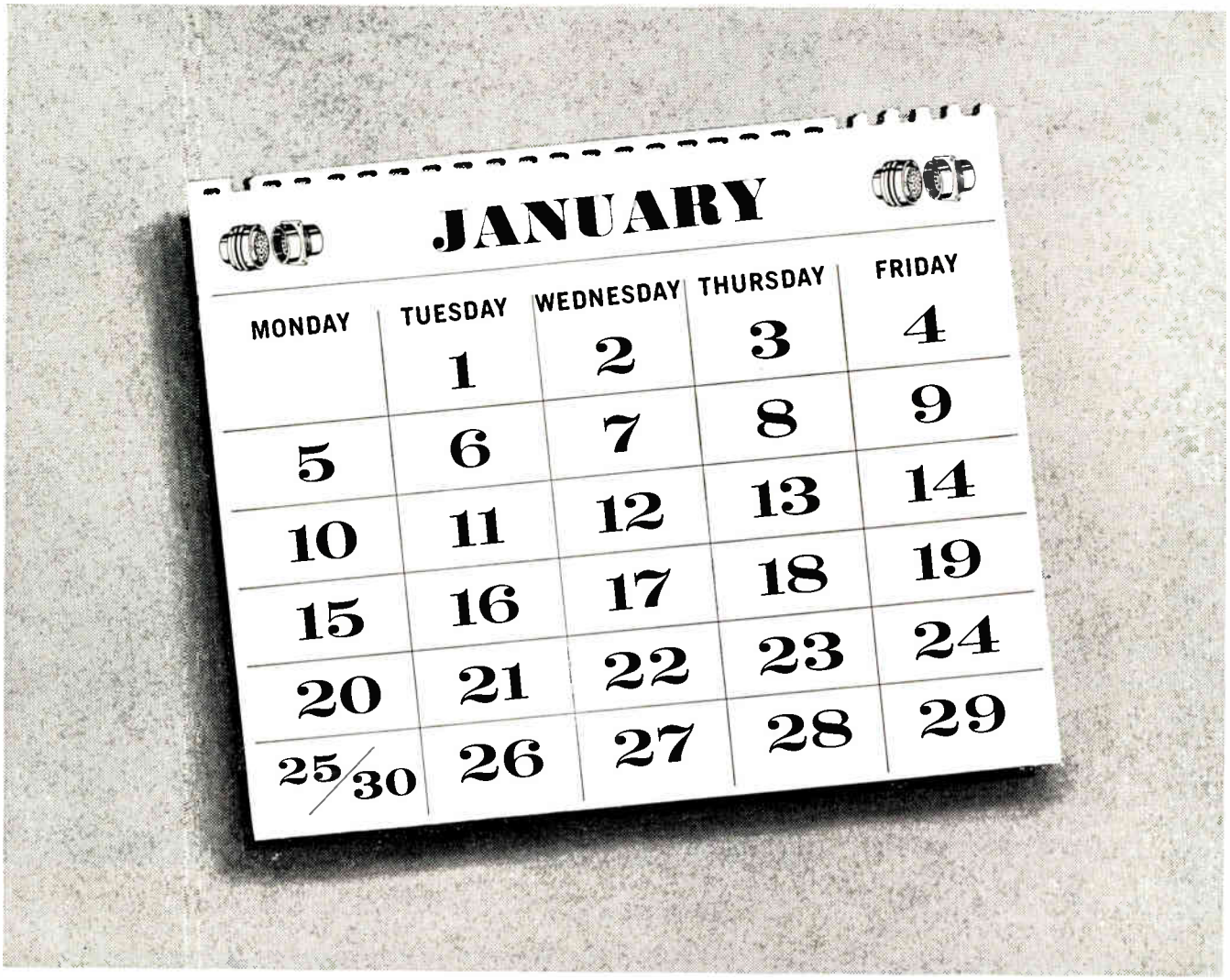


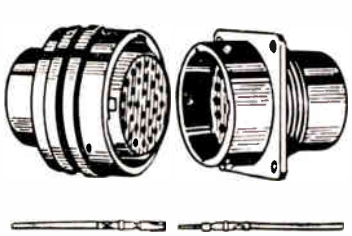
There are no "weak-ends" in Avnet's delivery of Bendix Connectors.

Your local Avnet headquarters supplements Bendix Scintilla by serving your emergency and prototype Connector requirements quickly and flexibly. Take advantage of Avnet's on-time delivery for your needs of Bendix Pygmy types PT and SP and other special types; Pygmy crimp types PTCE and PTSE; MS, MS-E, MS-R, QWLD, SR rack & panel.

A call to your local Avnet stocking facility will prove that you needn't have "weak-ends" in your delivery of Bendix Connectors.

BENDIX

AVNET



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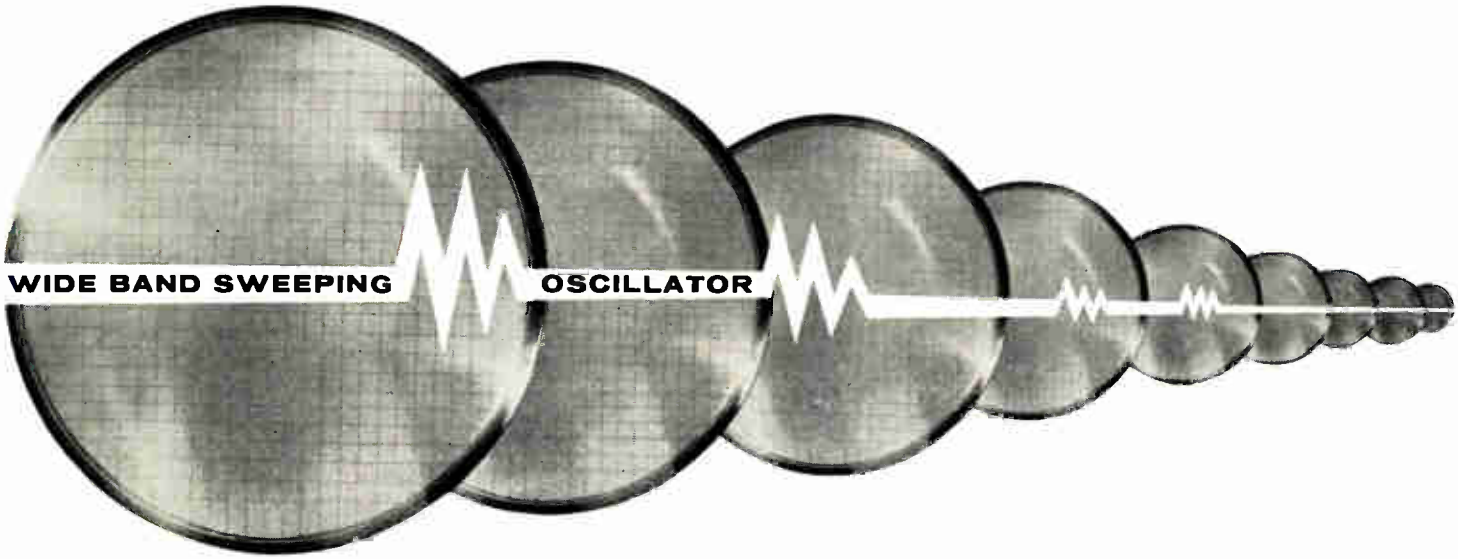
frequency sweeps more than

300 MC WIDE

KAY *Multi-Sweep* 121-A, VIDEO-UHF



ALL ELECTRONIC

SPECIFICATIONS

UHF Frequency Range: 180 to 1100 mc
Typical Sweep Width: 700 to 1100 mc, 500 to 750 mc, 180 to 220 mc
Output: .5 V rms terminated
Impedance: 50 ohms
Flatness: ± .25 db
Harmonic Distortion: better than 30 db down

VHF Frequency Range: 500 kc to 300 mc
Sweep Width: 500 kc to 300 mc
Output: .5 V rms terminated
Harmonic Distortion: better than 30 db down
Spurious: better than 30 db down
Impedance: 50 ohms
Flatness: ± .25 db
Dimensions: 19⅜" wide x 10⅞" high x 16⅛" deep
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- Same high RF level at all frequencies
- Clean VHF output
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- Provision for external frequency markers

Multi-Sweep 121-A is a wide band sweeping oscillator using all electronic circuits to achieve stable swept frequency outputs. It makes use of fundamental and beat frequency oscillator techniques to provide effective frequency coverage in a 300 megacycle wide display. Both center frequency and sweep width are continuously variable. To eliminate phasing adjustment a sawtooth voltage, synchronized with the swept output is available to drive the x-axis amplifiers in the oscilloscope.

The 121-A generates a high level of output over its entire frequency range with a fast acting AGC circuit holding the output constant under all conditions.

The use of all electronic sweep driving and sweep modulating signals provides for maximum reliability and stability of operation at both wide and narrow frequency sweeps.

Write for complete catalog information

KAY ELECTRIC COMPANY

DEPT. EI-1 MAPLE AVENUE • PINE BROOK, MORRIS COUNTY, N. J. CApital 6-4000

0.5 TO 1100 MC RANGE

Circle 29 on Inquiry Card

TELE-TIPS

CITIZENS BAND RADIO has grown from slightly over 40,000 station licensees to approximately 350,000. The FCC is concerned over rule violations, and is proposing to make some changes in the regulations. Of the 23 frequencies now available to class D stations, only five would be available for inter-station communications. The FCC also wants to obtain a clearer picture of the relationship or responsibility between the station licensee and the operator of the equipment. Each person operating the equipment would be required to have his own station license unless an exception is clearly warranted. This would apply to employees of the licensee or members of his immediate household.

AUTOMATED MARTINIS at a press of a button now come in both 110 volt and 200 volt models. Autobar Systems, a division of Ametek, Inc., manufactures the electromechanical "cocktailmatic" in two models for European or U.S. use. Company spokesman said, however, "The jolt-age in an automated dry martini is the same the world over."

THE ROLE OF MAN in the United States "Aerospace force of the future" is being studied by Ford's Aeronutronic Div., under a contract from USAF. A one-year study will define the tasks and skills to be required by members of tomorrow's aerospace crews. It is being mentioned in the industry that future spacecraft operation will demand highly technical skill, rather than flying ability. Early studies in the Ford program will be devoted to tasks and skills which individual space crew members and some members of ground operated teams will have to perform.

MINIATURE ELECTROCARDIOGRAPHS are being developed for the Air Force to check out space pilots while in flight. The units measure only 8 in. x 3 in. x 1 in. and weigh but 14 oz. They combine a signal conditioning unit and a transmitter. The package is easily worn inside the pressure suit and is free of outside connections. However, an amplifier in the cockpit relays the information to the receivers on the ground. The unit was developed by Hughes Aircraft Co. In actual use, the heart beat is picked up by a tiny sensor, and the beat is sent to a conditioning unit. There it is translated into FM frequency. Transmitted to the ground, the signal is changed back into a heart beat and recorded as a jagged line on the electrocardiogram tape.

TELE-TIPS

ANSWERING THE QUESTION why the lion's share of government R&D contracts are going to California, New York, and Massachusetts, Secretary of Defense MacNamara pointed out, "Of the 43 American Nobel prize winners in the sciences, 17 live in California, 11 in New York, and 5 in Massachusetts. That makes 33. The other 47 states, put together, have 10.

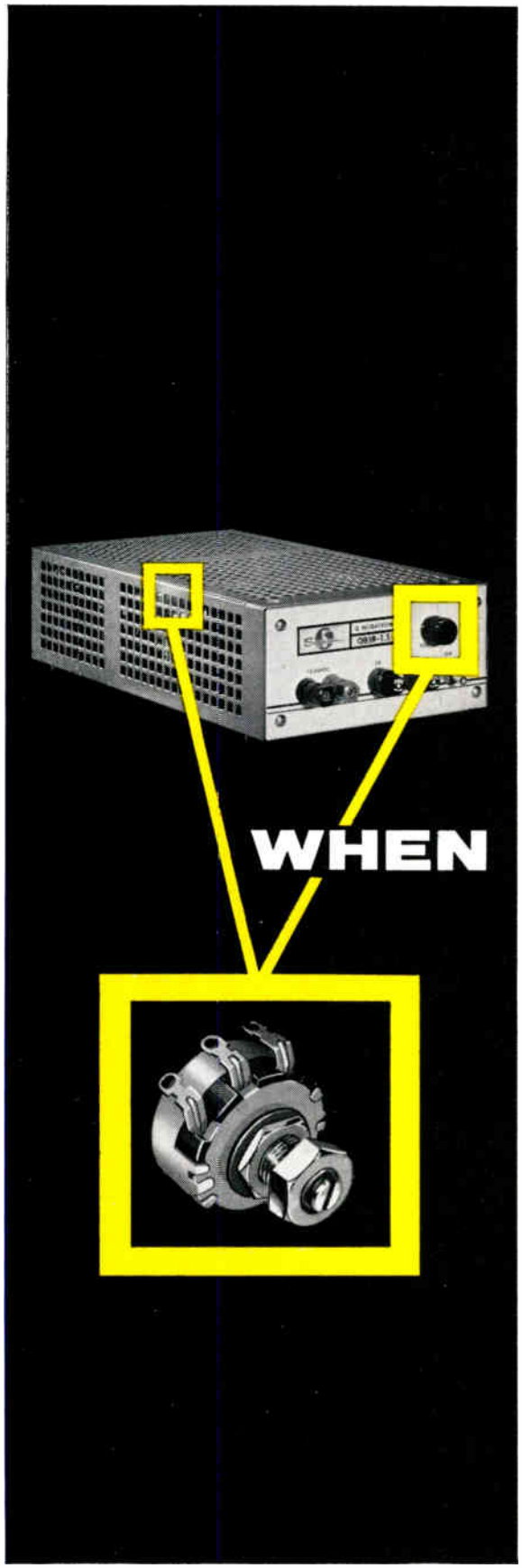
DOES LIFE EXIST on other planets? In the absence of any tangible proof, the mathematicians are now coming up with the answer "probably." Dr. M. L. Stehsel, of the Advanced Research Dept. of Aerojet General points out that our solar system—the sun, earth and eight known planets—is just one of perhaps a billion such solar systems in our galaxy. But beyond that are billions of other galaxies, each with its billions of solar systems. Astronomers and mathematicians now estimate that 6% of the planets in these multi-billions could accommodate intelligent life such as ours.

AN INFRARED OPTOMETER has been developed under Air Force contract which is reportedly "superior in performance to any known similar apparatus in stability, linearity, speed of response, sensitivity, and ease of alignment." The optometer was developed out of a study of accommodation and convergence in the human eye, another of the many studies being undertaken in the field of bionics.

AGAIN—ON SMOKING. Scientists have found that the body fluids of smokers contain a substance which is nearly absent in the body fluids of non-smokers. Trace amounts of acetonitrile (methyl cyanide) appeared consistently in concentrations proportional to the number of cigarettes smoked.

MAMMOTH MICROFILMING project for NASA has been undertaken by Recordak Corp., a subsidiary of the Eastman Kodak Co. The project involves the microfilming of more than a million and a half NASA library index cards at the rate of 200 per minute. The cards were filmed in about four weeks.

ELECTRONIC PRODUCTS that were shown at the Pakistan International Fair, Karachi included displays of microwave equipment, gyroscopes, and induction heating equipment.



WHEN GREAT NAMES GET TOGETHER...

. . . something good is bound to happen . . . like the introduction of Sorensen's QB Series transistorized low-voltage dc power supplies.

This great-name firm wanted to deliver the best. They used the best: Clarostat Series 43 2-watt wire-wound potentiometers.

Clarostat Series 43 pot was a natural selection. Long a favorite of industrial equipment manufacturers, the Series 43 offers a wide variety of mounts, terminals and shaft configurations. Available in resistance tolerances of ± 10% or closer from 1 to 50K ohms, the Series 43 is designed to do its job . . . and then some! It is an obvious choice of great-name manufacturers who **will not compromise with quality.**

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  Typical I_{CBO} 0.1 nA @ 80 volts
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  Typical BV_{CEO} 100 volts
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Plus

LOW LEVEL COMPLEMENTARY TYPES FEATURING:

- **LOW CURRENT BETA**
  Typical 50 @ 1μA
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2N929A	2N2523	2N2604
2N930A	2N2524	2N2605
2N739A	2N2518	2N2599
2N740A	2N2519	2N2600
2N735A	2N2515	2N2596
2N736B	2N2516	2N2597
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INTERNATIONAL NEWS

Japan Soon May Make All Computers It Needs

Japan, which has received all of its computer imports from the U. S. in the past, will soon be supplying all it needs and exporting some besides, states the Japanese Machinery Exporters Association.

The Japanese Government and Industry are combining in research programs to improve the quantity and quality of Japanese computers.

Example: A $278,000 Government subsidy program to develop large-size, domestically manufactured computers. The program is being jointly conducted by Nippon Electric, Fuji Tsushinki and Oki Denki.

Example: The Japanese Electronic Industry Development Association is conducting a Government-sponsored study on business applications of domestic computers.

Up to now, 188 computers, all made in the U. S., have been imported into Japan. Western Europe supplied none. The U. S. suppliers and amounts supplied were: IBM, 104; Remington Rand, 42; Burroughs, 13; National Cash Register, 10, and other U. S. companies, 19.

But the emphasis is shifting. Seven Japanese electronic firms already pro-

(*continued on page 46*)

EUROPE

London—Closed-circuit system of 16 27-in. TV receivers and 4 cameras supplied by Pye Telecommunications, Ltd., of Cambridge, helps passengers at recently completed Manchester England, air terminal obtain latest flight information.

Bern—Epoxy Products Div., Joseph Waldman & Sons, Irvington, N. J., has signed a 10-year manufacturing and marketing agreement with CIBA, Ltd., Basle, Switzerland. Under it CIBA will make and sell in Europe Epoxy Products lines of encapsulating systems, cups and pellets for electronic components.

Dublin — An electronic components plant has been opened by Raytheon Co. in the duty-free industrial complex near Shannon International Airport. The plant will eventually occupy 50,000 sq. ft. of space, employ 500. It will make components for free-world markets.

The Hague—N. V. Emba Agencies, of Rotterdam, has signed an agreement with Lockheed Electronics Co., Plainfield, N. J., to distribute the Lockheed computing oil register in Europe. This mechanical computer-register, mounted on a fuel truck meter, automatically prints a complete invoice when a fuel oil delivery is completed.

London—Dr. Alfred N. Goldsmith, noted scientist, engineer and inventor and Honorary Vice President of RCA, has been elected a Benjamin Franklin Fellow of the Royal Society of Arts, of England. The fellowship commemorates the fact that Franklin was one of the society's most active early members.

Paris—S. E. V. Motorola, S. A., a company to make electronic alternators for European cars and trucks, has been formed by Motorola, Inc., and Societie Anonyme Pour L'Equipment Electrique Des Vehicules, of France. Alternators and regulators are already being produced at the newly constructed Blois facilities.

Rome—Carrier Corp., Syracuse, N. Y., and Pirelli s. p. a., Milano, Italy, have agreed to form an Italian company, S. P. Elettronica S. p. A. The firm will manufacture linear precision potentiometers and trimming potentiometers under the trademark "Spectrol," owned by Spectrol Electronics Corp., a Carrier subsidiary.

ASIA

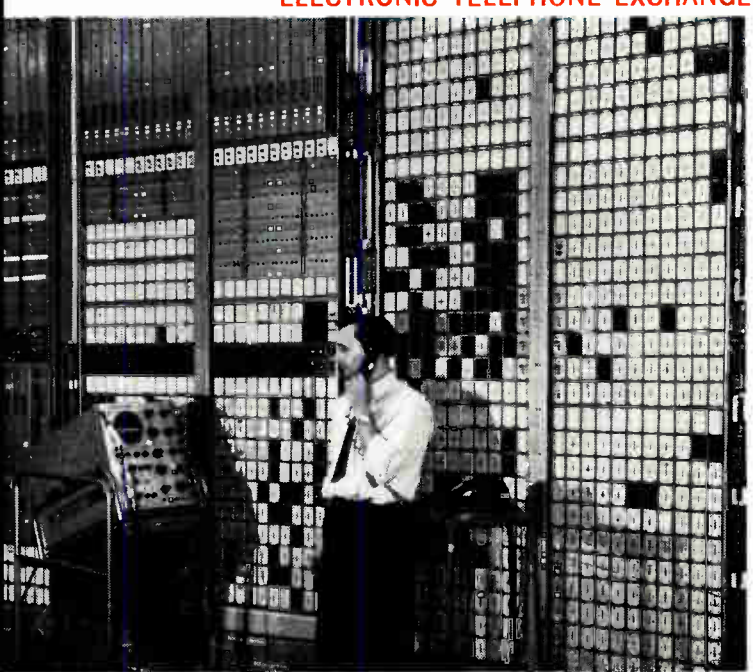
Tokyo—Fujikura Cable Works, Ltd., has been licensed by Resources & Facilities Corp., New York City, to use its process for die-stamping electrical circuits. Fujikura is one of the largest producers of cable and electrical components in the Far East.

(*continued on page 46*)

JAPANESE F-104J TRAINER

Lt. Col. E. Murai, of Japan Self Defense AF (l), and Mr. Susumo Sato, of Mitsubishi Mfg. Co., try out Link F-104J Flight Simulator during acceptance tests at General Precision Link Div. plant at Binghamton, N. Y. F-104J Simulator is first of two to be delivered to Japan Defense Agency to train jet pilots.

ELECTRONIC TELEPHONE EXCHANGE



All-electronic telephone exchange being tested here is now in operation in Highgate Wood, London. Five companies cooperated with British P. O. in six-year development of exchange. They are: Associated Electrical Industries, Ltd.; Automatic Telephone & Electric Co., Ltd.; Ericsson Telephones, Ltd.; The General Electric Co., and Standard Telephones & Cables, Ltd.

INTERNATIONAL NEWS

Tokyo—Japan's Ministry of Posts and Telecommunications and NASA will cooperate in testing NASA-launched communications satellites under a recently signed agreement. Japan, a U. S. partner in several recent space explorations, will supply a ground satellite communications station. Japan will be able to use the satellites for local and joint experiments.

Tokyo—Education using tape recorders has become more and more popular in Japan. The Ministry of Education reports that 74.7% of public primary schools and 78.8% of public junior high schools now own tape recorders.

NORTH AMERICA

Washington—Otto Poeschl and his firm, Arga Warenhandelsgesellschaft, of Vienna, Austria, have temporarily been denied U. S. export privileges. The Dept. of Commerce is investigating reports the firm unlawfully disposed of strategic U. S. electronic equipment to Soviet bloc countries.

Washington—Isaac L. Auerbach, American Federation of Information Processing Societies representative to IFIP, has been re-elected to a second three-year term as President of the International Federation for Information Processing (IFIP).

Ottawa—Canadian Aviation Electronics, Ltd., Montreal, Que., has bought a majority interest in Northwest Industries, Ltd., Edmonton, Alb. Northwest Industries is one of Canada's largest aircraft maintenance firms. It also owns B. C. Airlines, Ltd.

Japanese Computers

(*continued from page 45*)

duce several computer models each. These are: Fuji Tsushinki, Oki Denki, Hitachi, Tokyo Shibaura, Matsushita, Mitsubishi Electric and Nippon Electric.

These firms are conducting most of Japan's current computer research programs. They are trying to improve input and output devices, accelerate calculation rates and improve accuracy.

JMEA officials believe Japan will soon be able to meet its own needs for medium-sized computers. Then, they predict, Japan will forge ahead into the export market.

Circle 34 on Inquiry Card →

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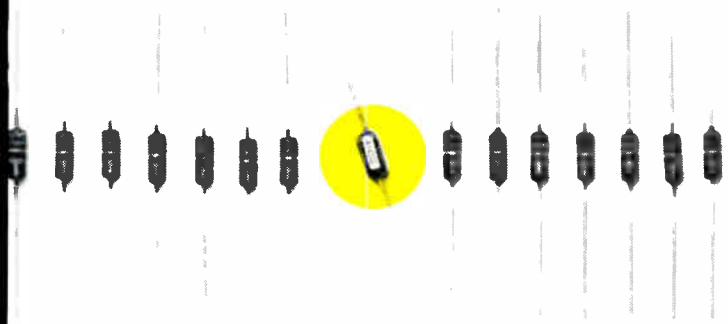
TRANSITRON'S BROAD LINE OF STANDARD SUBMINIATURE GLASS ZENER DIODES GIVES YOU THE COMPLETE RELIABILITY THAT 99 CIRCUITS IN 100 DEMAND.
TRANSITRON'S ULTRA-RELIABLE DIODE — THE CERTIFIED VOLTAGE REFERENCE — DELIVERS THE GUARANTEED STABILITY THAT ONLY 1 CIRCUIT IN 100 DEMANDS.

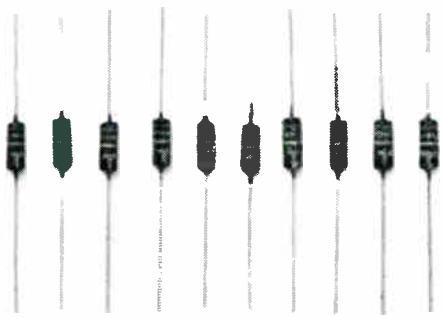


PROVED

The CVR demonstrates a high level of manufacturing competence. It is individually power-aged, temperature-cycled and documented for more than 1,000 hours, demonstrated to provide voltage stability to within ±0.000124 volts; serially registered; and currently available in production quantities.

The CVR is but one example of Transitron's capacity to satisfy a wide range of diode requirements. Made on the same production line that makes all Transitron voltage references, it reflects a research-to-production experience that further improves hundreds of other high-quality Transitron subminiature glass zener diodes.

IMPROVED



Transitron's standard line of regulators and references spans a wide range of voltage, tolerance, power and package requirements. Subminiature glass, micro-miniature glass with an hermetic seal, and high power dissipation types, up to 10 watts, in appropriate standard packages, are all in continuous volume production. All types — including military — are tested and rated in accordance with appropriate MIL specifications.

Popular subminiature glass series available through your Transitron Distributor include 1N761-1N769, 1N702(A)-1N725(A), 1N821-1N829 and 1N3501-1N3504 (CVR), all with power ratings of 250 mW. Also available, 1N746(A)-1N759(A) series with a power rating of 400 mW. For complete listing, write for An Alpha-Numerical Guide to Transitron Silicon Zener Diodes.

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IR STANDARD 'KLIP-SELS' NOW AVAILABLE OFF-THE-SHELF. SPECIAL ASSEMBLIES DESIGNED FOR PARTICULAR NEEDS.

CARTRIDGE TYPES

IR TYPE NUMBER	MAX. RMS OPERATING VOLTAGE	TYPICAL CLAMPING VOLTAGE*	CURRENT AT CLAMP. VOLTAGE (AMP. PEAK)
KY1DPF	26	63	0.25
KY2DPF	52	125	0.25
KY5DPF	130	310	0.25
KY6DPF	156	375	0.25
KY10DPF	260	625	0.25
KZ1DPF	26	63	1.0
KZ2DPF	52	125	1.0
KZ5DPF	130	310	1.0
KZ6DPF	156	375	1.0
KZ9DBF	234	565	1.0
KZ10DBF	260	625	1.0
KZ14DBF	364	890	1.0

STACK TYPES

KA1DAF	26	63	3.0
KA2DAF	52	125	3.0
KA5DAF	130	310	3.0
KA6DBF	156	375	3.0
KA8DBF	208	500	3.0
KA9DAF	234	565	3.0
KA10DBF	260	625	3.0
KA14DAF	364	890	3.0
KL1DAF	26	63	15.0
KL2DAF	52	125	15.0
KL5DAF	130	310	15.0
KL6DBF	156	375	15.0
KL8DBF	208	500	15.0
KL10DBF	260	625	15.0

*PRV rating of rectifiers being protected must be greater than the clamping voltage to obtain optimum protection.

International Rectifier Selenium 'KLIP-SEL'

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Simplify your circuit protection design... use IR's new

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This unique instrument substantially reduces engineering and specification time. Simple dialing selects the proper voltage. Values calibrated in 26 volt step-ups... 20 possible positions. Easy-to-use input and output jacks.

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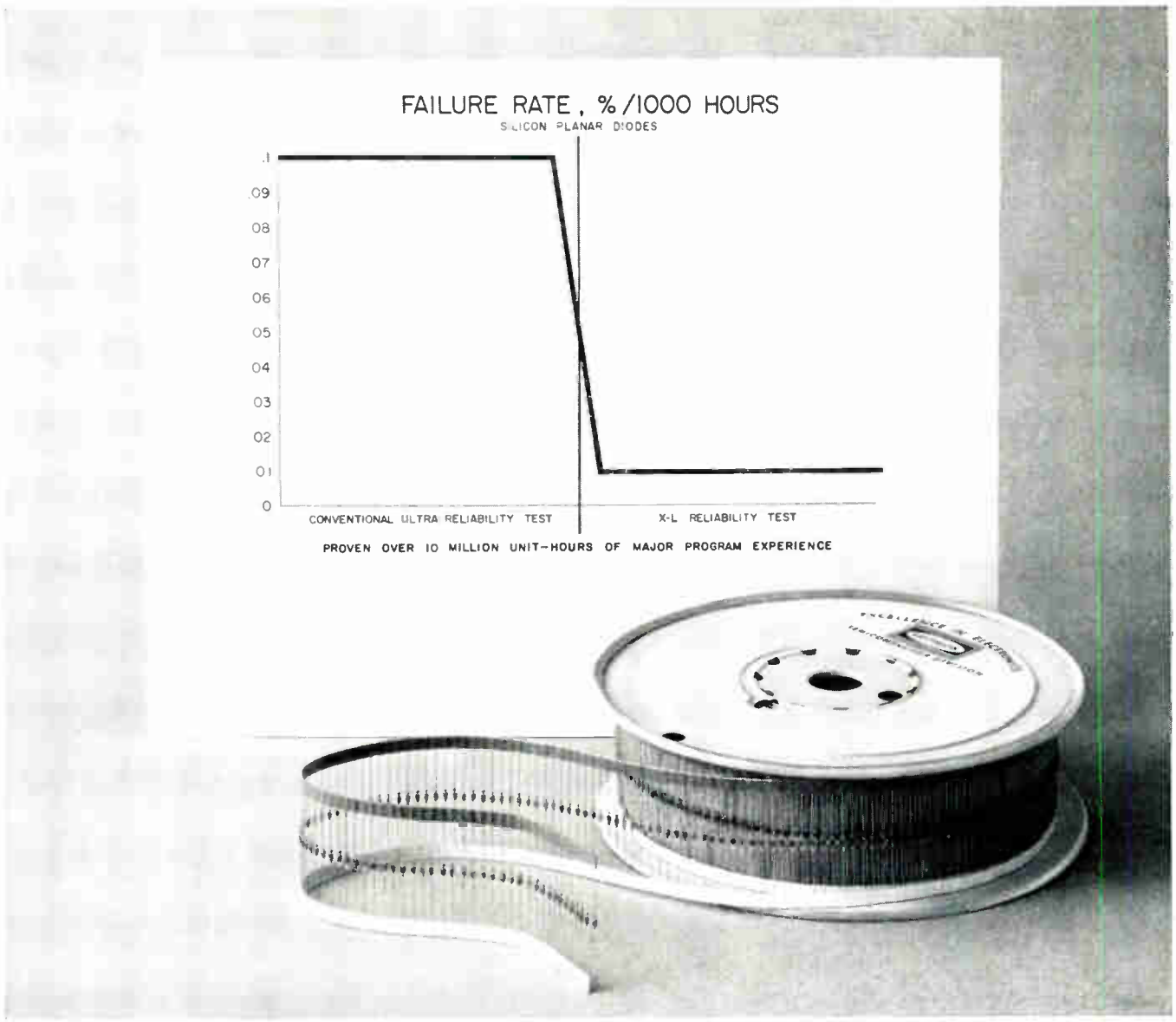

How low-cost Raytheon X-L Reliability Program cuts "hidden" semiconductor failures by 10:1

Many transistors and diodes good enough to pass today's reliability tests can still drift out of spec limits and fail tomorrow. Now, for the first time, Raytheon's X-L reliability technique can detect these future drifters before they fail — at exceptionally low cost. Result: a reduction in failure rate of as much as 10:1 over conventional ultra-reliability levels — 100:1 over Military Specifications.

To qualify for X-L certification, devices must first pass the rugged requirements of the Raytheon MARK X and MARK XII reliability programs. Then, each semiconductor is carefully measured — electrically exercised for 100 hours — and measured again for changes in characteristics. A parameter change of as little as 2 nanoamps can cause rejection — *even though the device is still within initial spec limits.* Potential failures, which would have passed conventional electrical tests, are eliminated.

These low-cost, "tight yardstick" benefits of X-L certification are a direct result of proprietary techniques and specialized equipment developed at Raytheon and proven over 10 million unit-hours of major program experience.

When your equipment or system requires this kind of semiconductor reliability — without the high cost of circuit redundancy — please contact your nearest Raytheon Field Office for full information or write Semiconductor Division, Lowell, Massachusetts.

RAYTHEON

←Circle 35 on Inquiry Card

Resistors?

STACKPOLE matches every requirement

If you have a burning yearning for improved resistor dependability coupled with on-time deliveries, here's a hot tip:

In Performance Stackpole Coldite 70+ fixed composition resistors go well beyond MIL-R-11 requirements—with added dividends in load life, moisture resistance and humidity characteristics. For extra reliability, their carbon resistance elements and outer insulating shells are cold-molded of similar materials. These are formed by a new process into a solid, homogeneous structure that remains free from catastrophic failure or erratic changes in resistance in severe environments.

In Production Stackpole Coldite 70+ Resistors remain one of the easiest components to solder either by dip or iron. They're the only resistors having leads that are solder dipped—not once, but twice—in addition to the usual tin coating. That's why leads stay smooth and tarnish free even after months in storage.

In Appearance it's hard to match their smooth, glossy finish and uniform, easily-read color codes. And this attractive appearance lasts even after scrubbing with solvents.

Stackpole Coldite 70+ Resistors are available in MIL-R-11 Type RC-20 (½-watt), Type RC-32 (1-watt), and Type RC-42 (2-watts) . . . in all standard resistance values, and at ordinary resistor prices.

Electronic Components Division
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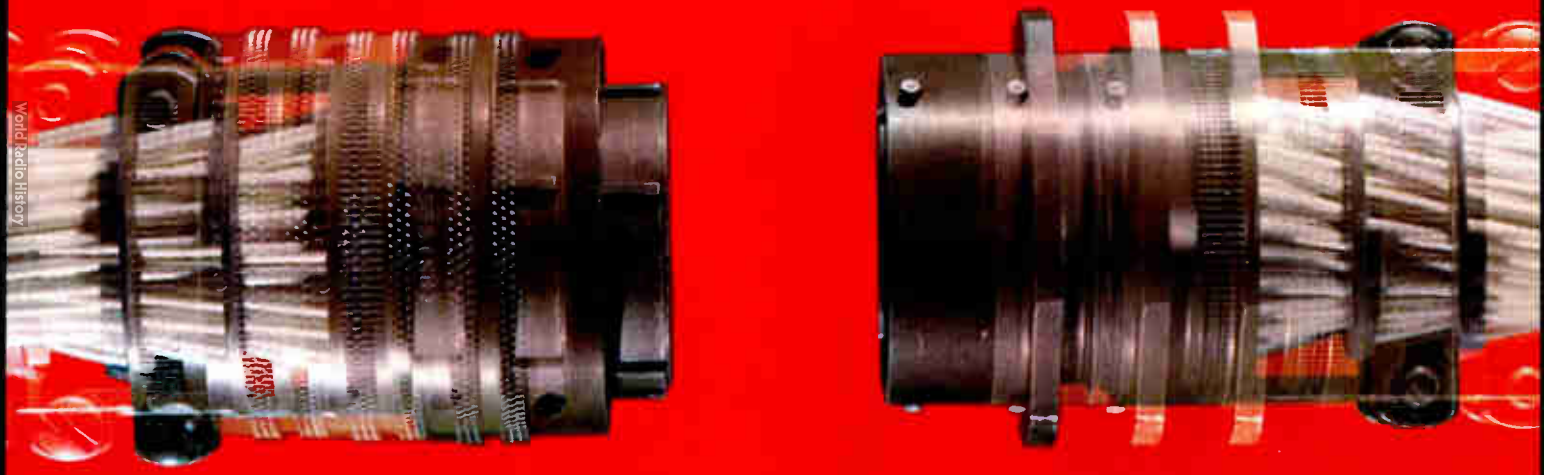
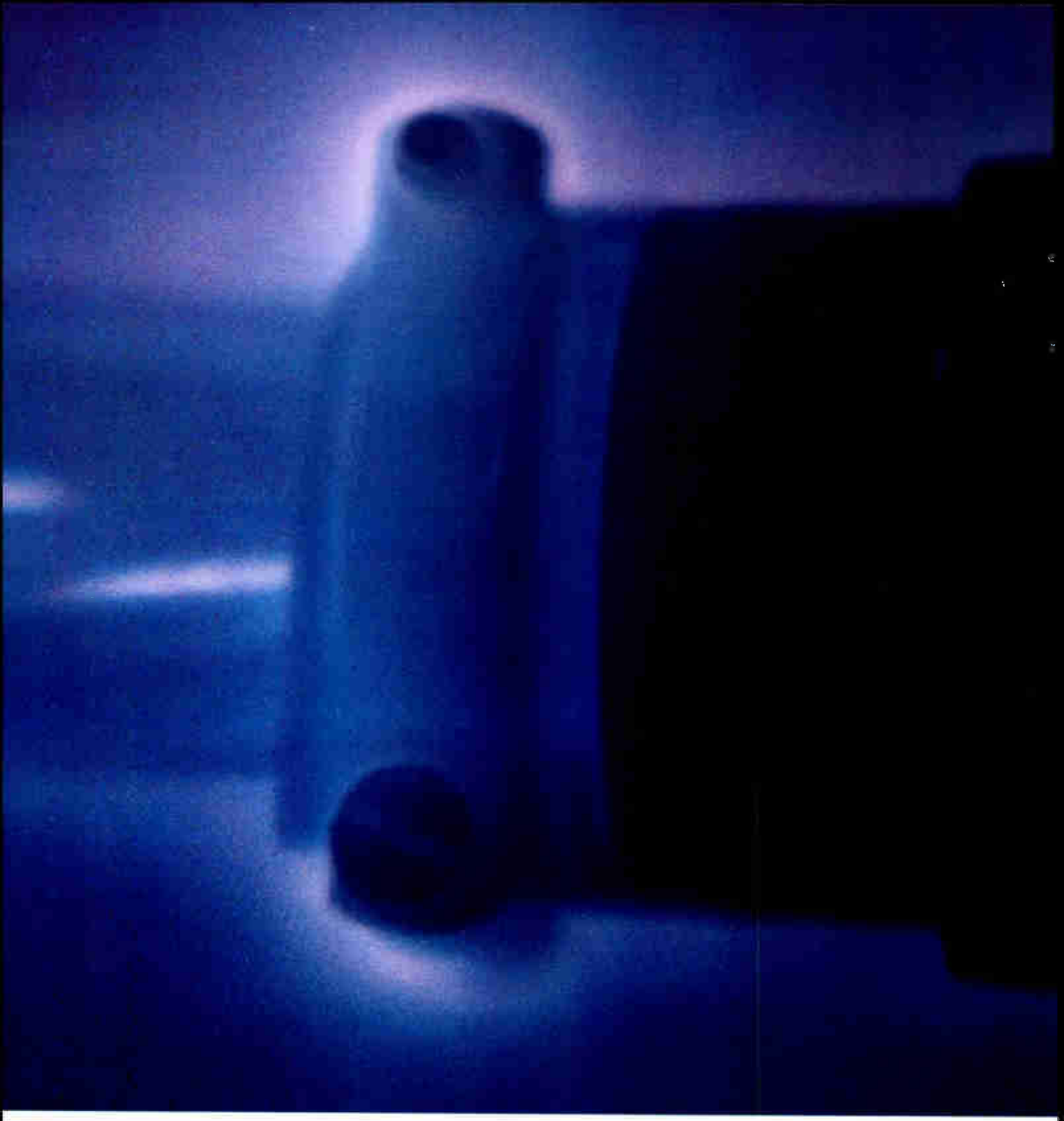


beware . . .

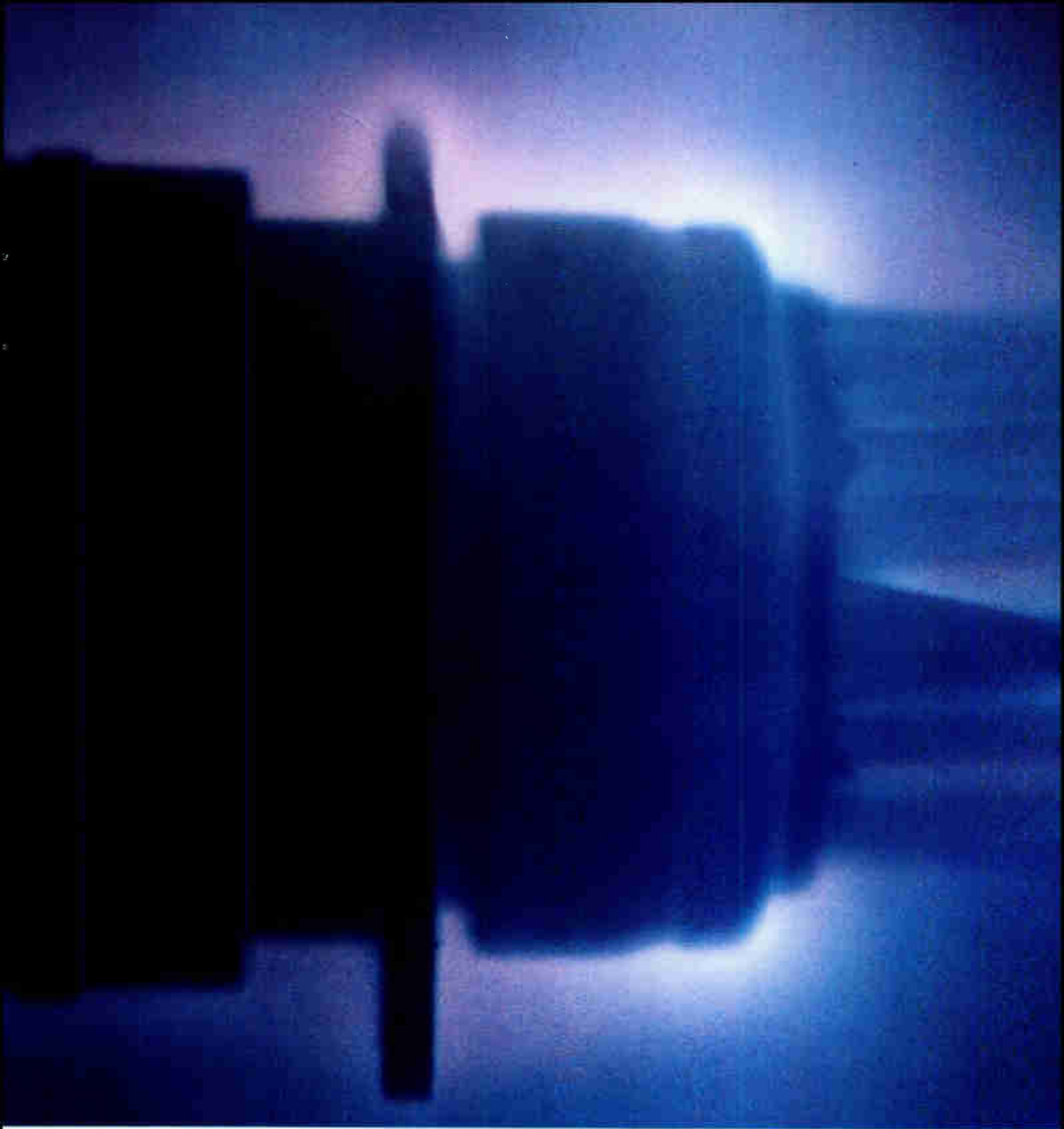


corona!

The mysterious light has returned to plague man again—this time in space applications. Ancient mariners watched its ghostly glow flicker from the masts of their storm-tossed ships. The superstitious among them warned that it portended the presence of evil spirits. Religious men called it St. Elmo's Fire after the patron saint of seamen. Centuries passed before modern man explained this harmless phenomenon as a luminous discharge resulting from ionization of the air.

A similar phenomenon occurs during the space explorations of today. It's called Corona. But unlike St. Elmo's Fire, it poses a host of knotty problems. Corona causes power loss and insulation damage, and is a source of high frequency radio interference. Working in the Engineering Test Laboratory of the Scintilla Division, Bendix engineers have done extensive work on the problem of Corona associated with electrical wiring.

Corona occurs in aircraft, missiles, and space vehicles when high-altitude breakdown in electrical circuits is avoided by interposing a solid dielectric, or insulation, in the air gap between uninsulated wires or components. The potential gradient is altered and as altitude is increased



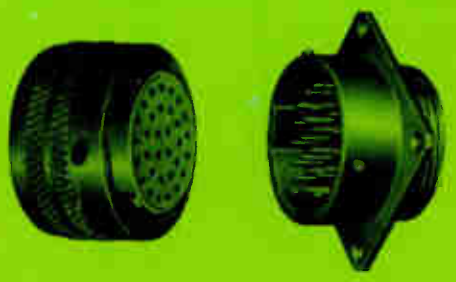
up to a certain critical level, insulation value of the air is reduced. When the dielectric strength of the air is less than the potential gradient, Corona occurs. Introducing insulation may actually cause Corona at lower applied potentials or at lower altitudes than that at which arc-over would have occurred in the free air condition.

To avoid Corona, spacing of the wires, junctions, or contacts must be increased or the voltage decreased as the critical altitudes are approached. Air gaps may also be pressurized or eliminated entirely.

We have prepared a paper called "Connector and Cable High Altitude Performance Considerations" which presents some basic information and findings on the subject of Corona. A copy is yours for the asking.

But the high-altitude problem of Corona is just one of the special application problems our people have studied. Why not take advantage of our many years of experience for help in solving all of your connector and wiring problems. Write, wire or phone us at Sidney, New York.

SCINTILLA DIVISION/THE BENDIX CORPORATION



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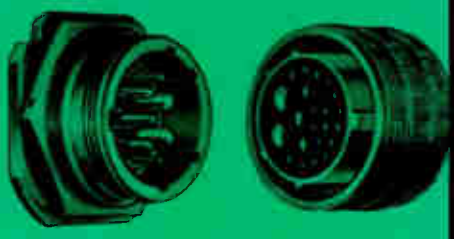

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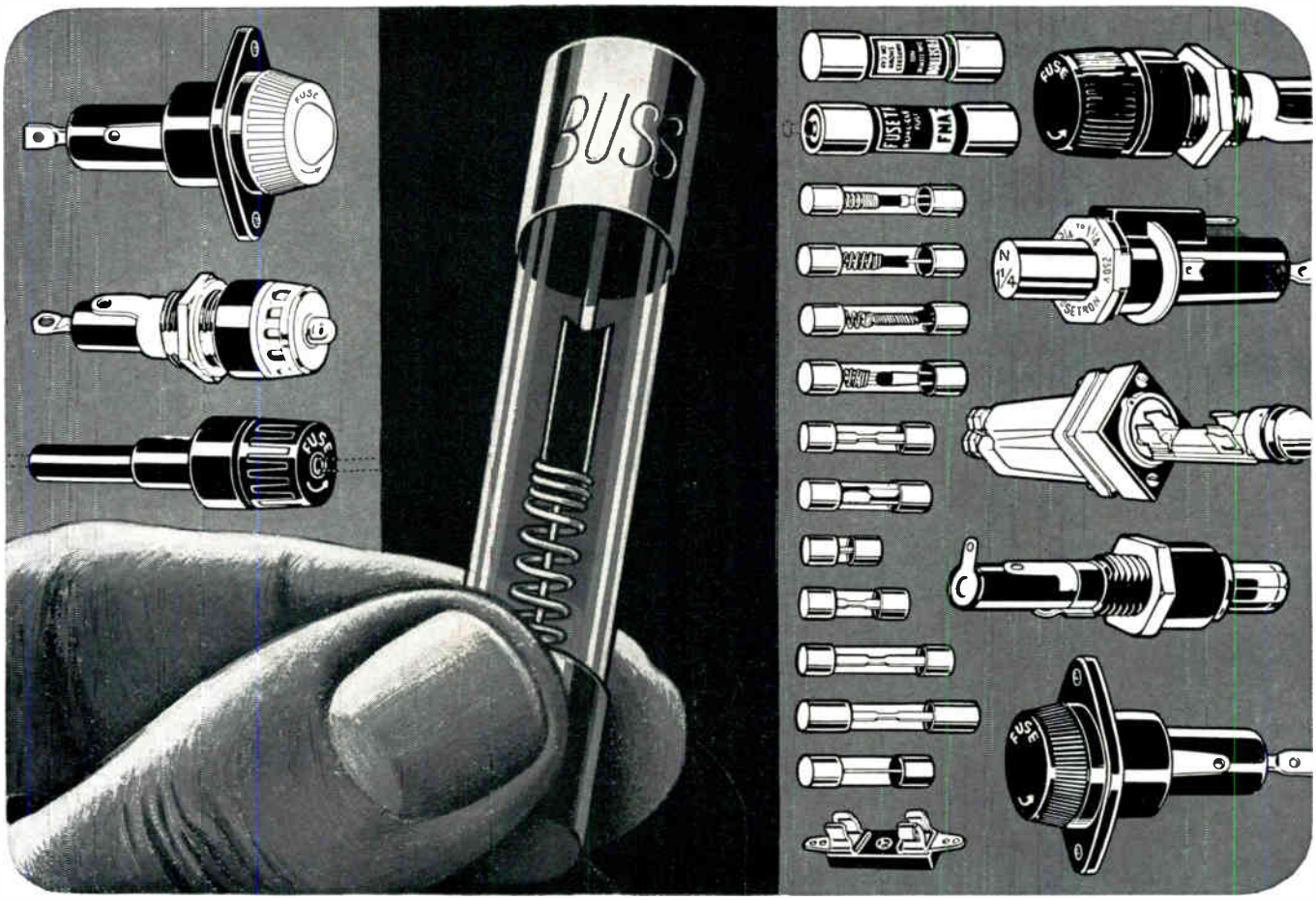
As a leading producer of electrical connectors Scintilla Division of Bendix is keenly aware of the responsibility which this position implies. Devoting much energy to research and development of new and better products, we are proud to have introduced many new design concepts and testing procedures which have been adopted as standards by the connector producing and using industry.

A few of our contributions to this industry are successful use of resilient inserts, closed entry probe proof socket design, cadmium plate over aluminum, three point bayonet lock coupling, Alumilite hard anodic coating, five key and keyway polarization, prefilled wire wells, miniature cylindrical (Pygmy®) connectors—which stimulated creation of MIL-C-26482 specification.

For your convenience we list here the many sources of supply for dependable Bendix electrical connectors.

Scintilla Division THE Bendix CORPORATION



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there's a safe and dependable BUSS or FUSETRON Fuse!

BUSS fuse engineers have consistently pioneered the development of new fuses to keep pace with the demands of the Electronic industry. Today, the complete line includes:

Single-element fuses for circuits where quick-blowing is needed;—or single-element fuses for normal circuit protection;—or dual-element, "slow-blowing" fuses for circuits where harmless current surges occur;—or indicating fuses for circuits where signals must be given when fuses open. Fuses range in sizes from 1/500 amperes up—and there's a companion line of fuse clips, blocks and holders.

If you have a special protection problem

The world's largest fuse research laboratory, plus the experience gained by solving many, many electrical protection problems is on call to you at all times. Our engineers work with yours and can help you save engineering time and trouble.

For more information, write for BUSS bulletin SFB.

BUSS: The complete line of fuses and fuse mountings of unquestioned high quality.

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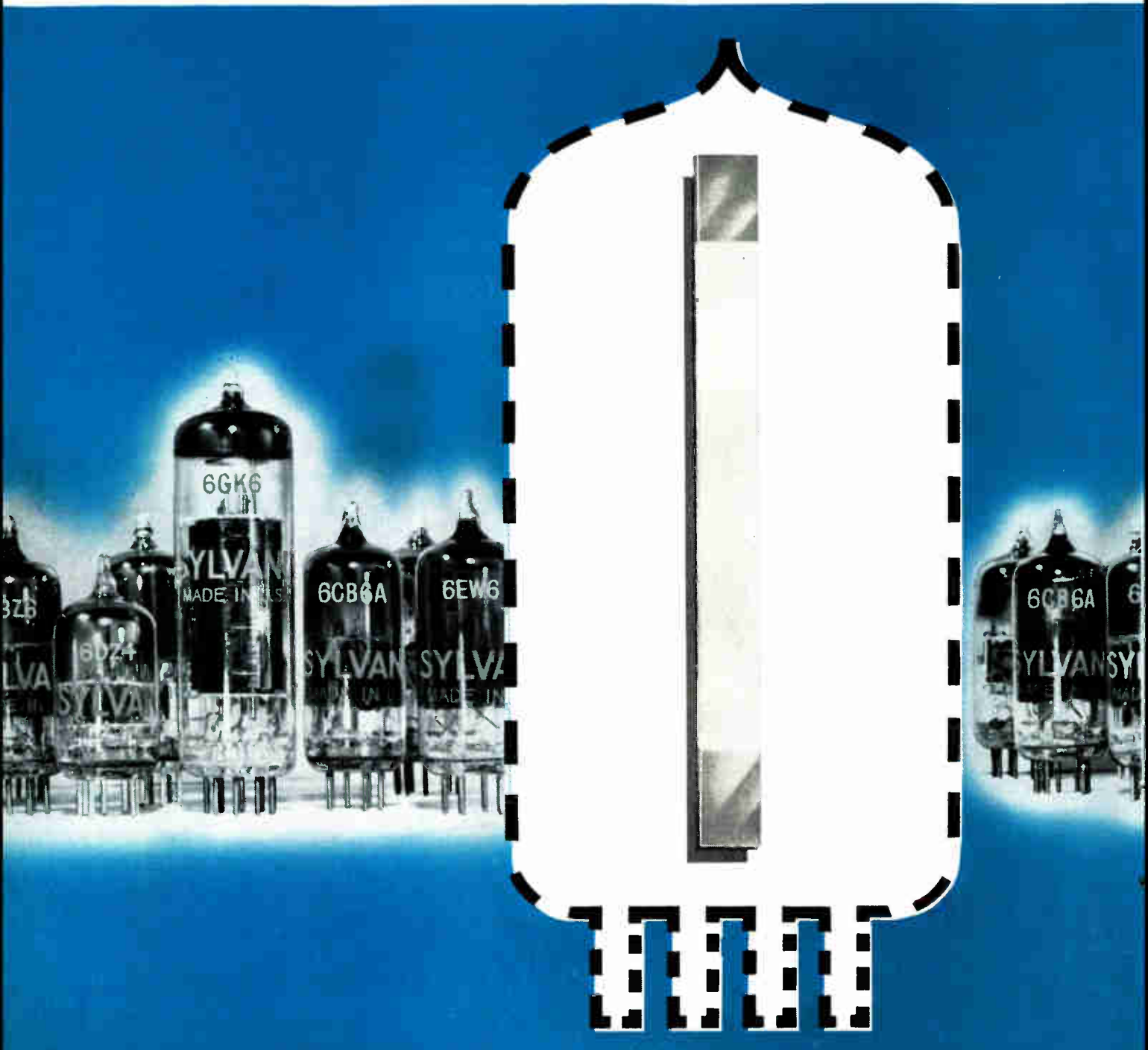
762

Sylvania—first with the Sarong and Bikini cathodes—now announces a new development that significantly increases the reliability of Sylvania tubes. "Life-Boost Cathode" is the name...the secret is an ultra-pure, uniform alloy made possible by Sylvania's leadership in powder metal technology.

Contrasted to conventional melted alloys, the Life-Boost powder-metal alloy is so pure and uniform, with performance so predictable, that it eliminates any need for the usual "melt approval." Alloy uniformity inhibits the formation of leakage paths, which extends tube life. It also means better-controlled electron emission and regulated barium release throughout life—tube performance stays within specifications. Further, the new cathodes have 25% greater mechanical strength, which significantly reduces equipment failure in the field.

Precise control of alloy composition is the key. The basic pure nickel powder plus carefully controlled powdered reducing agents are thoroughly blended and immediately rolled into thin-gauge strip. Because no critical temperatures are involved, no impurities are introduced from crucibles and con-

New LIFE-BOOST* Cathode gives increased life, stability and



tainers, forging hammers or hot-rolling equipment. And the powder process permits previously impossible or hard-to-attain combinations of wanted properties, such as electrical passivity and mechanical strength at high temperature.

A planned conversion of Sylvania tubes to the Life-Boost Cathode is under way. For information on types available now, contact your Sylvania Sales Engineer, or write: Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York.

Sylvania Tubes uniformity

MORE THAN 80 TYPES already have the LIFE-BOOST Cathode:

2AF4B; 3AF4B; 6AF4A, B; 2/3/6DZ4; 6GK6; 6BQ5; 6DQ5; 6AU8, A; 6BH8; 7060; 8ET7; 6/8GN8; 10JY8; 6BL8; 6/25CD6; 25DN6; 6/12/25BQ6GTB, A; 6V6; 12BZ6; 3/4/6CB6A; 4/6DE6; 6AH6; 6BC5; 25F5; 35C5; 6AS5; 4/6BZ6; 6CB6A; 6CF6; 3/6DE6; 5/6EW6; 6186; 7056; 5/6GM6; 32ET5A; 6/12DQ6B; 6J4WA; 12CA5; 12ED5; 50C5; 6BF5; 6CA5; 25EH5; 50B5; 6AH6WA; 6CU5; 6/12DT5; 6/12/25BK5; 6DT5; 5687WA; 6AN5; 12DB5; 6K6; 6146; 6146A; 6159A; 6883A; 6080WA; 6080WB; GB-6080; 6082; 6GR7; 12BV7; 12BY7; 6ET7; 12BY7; 12BV7; 6ET7; 6BL7GTA; 6/12AV5GA

Here's evidence of what it can do:

...In 6DZ4 UHF oscillator: No failures, greatly improved stability

Test: 40 tubes operated at 130 VAC for 1500 hours in 40 TV sets (4 models, 3 manufacturers represented).

Failures: None resulting in set failure. (Statistical estimate: 1% per 1000 hours at 130 V, or about 0.3% per 1000 hours at 117 V.) Failure rate for same tube made with conventionally prepared cathode material: 13.1%.

Oscillator Grid Current: After 1500 hours at 130 V, 90% of LIFE-BOOST Cathode tubes had grid current between 550 and 950 μA. Only about 38% of the tubes with conventional cathodes remained within these limits after period of test.

...in 6GK6, used for critical vertical output: TV set manufacturer reports improved stability

Test: More than 1000 hours at 135 VAC line.

Results: No leakage problems, no slump in characteristics; tube can be used in vertical socket as well as other sockets of customer's TV set line.

Sylvania tests show significantly reduced sublimation (formation of leakage paths), and improved plate current stability under accelerated life test and heater cycling conditions with over-voltages applied.

...in RF pentodes: Reduced grid emission, no insulation breakdown

RF pentodes BZ6, CB6, EW6 and others, when subjected to life testing, showed reduced grid emission levels after conversion to the LIFE-BOOST Cathode. Insulation levels during and at the completion of life showed little or no change—an indication of improved stability—and end-point failures due to breakdown were virtually nonexistent.

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LETTERS

to the Editor

"Power Supplies"

Editor, ELECTRONIC INDUSTRIES:

Congratulations on your October 1962 issue with the section devoted to power supplies. It is unfortunate that such a much-required review of an important subject should contain errors not only of the obvious typographical variety (fig. 6a, showing a voltage rise with a step load increase, and vice versa, in Mr. Kupferberg's terminology review, and the short circuit across the rectifiers' output in fig. 16 in Mr. Weitzel's article on "Understanding Power Supply Voltage Regulators"), but should also have factual errors.

It is true that there exists confusion in power supply terminology, and the IRE is trying, through its Subcommittee 10.6 on Regulated Power Supplies, of Technical Committee 10, Industrial Electronics, to do something about this. Work has been going on in the committee for over 3 years to establish standards of terminology and measurement. The task is a laborious one, because the committee must develop definitions that are unequivocal, and non-editorial. For example, Mr. Kupferberg refers to "COOLING, LATERAL FORCED AIR," as ". . . an efficient method of heat transfer. . . ." The IRE, or any general standard technical definition, must not use such an editorializing phrase as "efficient."

There are other unfortunate errors which represent incomplete knowledge of a broad field, due to narrow commercial experience. Thus, Mr. Lawrence Oakley in "Power Supply Regulator Notes," pg. 146, states, under "10. Switching At High Frequency," "it cannot be, of course, as reliable, due to the increased number of components." Beside the fact that this statement is in error, in that switching power supplies are *more reliable* (for reasons beyond the scope of this letter), there is an implied statement that any system which has more components is inherently less reliable than another system which has fewer components. This reflects ignorance of well known reliability techniques. Thus, two switches in parallel, operated simultaneously, are more reliable than one single switch, if a single switch can fail in an open mode. This is

(*Continued on page* 64)

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World's Largest Selling

POCKET SIZE V-O-M

FEATURES:

1. Hand size and lightweight, but with the features of a full-size V-O-M.
2. 20,000 ohms per volt DC; 5,000 AC.
3. EXCLUSIVE SINGLE SELECTOR SWITCH speeds circuit and range settings. The first miniature V-O-M with this exclusive feature for quick, fool-proof selection of all ranges.

SELF-SHIELDED Bar-Ring instrument; permits checking in strong magnetic fields • Fitting interchangeable test prod tip into top of tester makes it the common probe, thereby freeing one hand • UNBREAKABLE plastic meter window • BANANA-TYPE JACKS—positive connection and long life.

■ Price—only **$37.50**; leather case **$3.20.**

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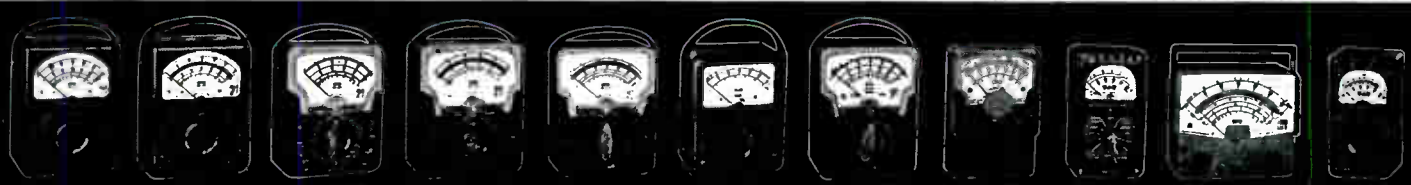
MODEL 100

The most comprehensive test set in the Triplett line is Model 100 V-O-M Clamp-On-Ammeter Kit, now available at distributors. The world's most versatile instrument—a complete accurate V-O-M plus a clamp-on-ammeter with which you can take measurements without stripping the wires. Handsome, triple-purpose carton holds and displays all the components: Model 310 miniaturized V-O-M, Model 10 Clamp-On-Ammeter, Model 101 Line Separator, No. 311 Extension leads, and a leather carrying case, which neatly accommodates all the components. Model 101 literally makes it possible to separate the two sides of the line when using Model 10. Extension leads permit use of Model 10 at a distance from the V-O-M. Complete Model 100 is only **$64.50**



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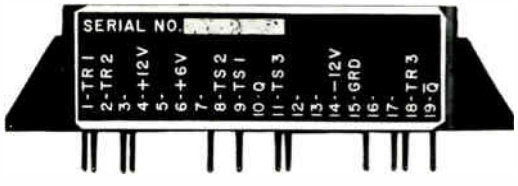

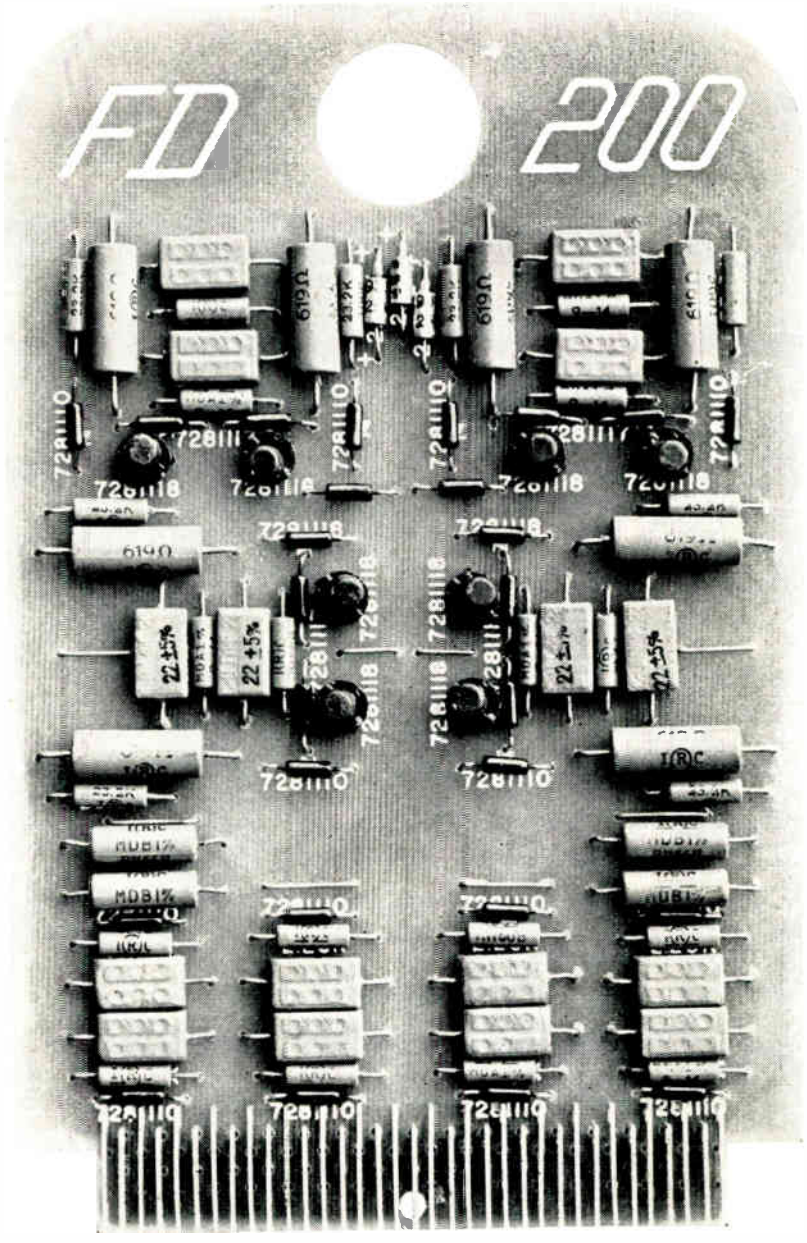

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Tested, proved, ready for work . . . Delco's new 10 mc Silicon Digital Modules are available in either building block or plug-in card. Both circuits are *exactly* the same electrically. Either way, these modules meet or exceed all MIL-E-5272D (ASG) environmental requirements. In the blockhouse, the plug-in card package offers extreme accuracy and reliability with a gate-switch speed of 40 nanoseconds. The building block package and the card offer the same high speed at temperatures of −55°C to +100°C. Ideally suited to airborne guidance and control, the building block package is environmentally

ONE FOR THE BLOCKHOUSE

proved to: *Shock*, 1,000G's in all planes; *Vibration*, 15G's at 10 to 2,000 cps.; *Humidity*, 95% at max. temp.; *Storage and Sterilization Temp.*, −65°C to +125°C; *Acceleration*, 20G's. Both building block and plug-in card modules are designed for systems using from one module to 100,000, and the module's rated performance considers the problems of interconnection. Delco Radio can offer both 10 mc module packages off-the-shelf or can supply circuits to meet your specific needs. Write Delco Radio Military Sales Department, Kokomo, Indiana.

DELCO RADIO
DEPENDABILITY

Division of General Motors • Kokomo, Indiana

DESIGN WITH ARNOLD "SQUARE PERMALLOY" TAPE CORES... YOU CAN GET THEM FROM STOCK IN THE RUGGED TYPE 6T CASE

Use Arnold Square Permalloy Tape Cores in your designs for low level mag amps, high frequency mag amps, magnetic modulators, converters, pulse transformers, etc.

They offer you a number of desirable magnetic characteristics, with the assurance of high uniformity from lot to lot that is available only from a completely integrated producer such as Arnold. These properties include low coercive force, low excitation to saturate, high gain and a hysteresis loop of good squareness —along with high maximum permeability and relatively stable performance under ambient temperatures in the broad range from −55° to +200°C.

Arnold Square Permalloy Cores are produced in all standard AIEE sizes (AIEE No. 430) in 1, 2 and 4-mil tape thicknesses. Most of these sizes are available for immediate shipment from stock in the Arnold Type 6T case (aluminum cased, oil filled, hermetically sealed and epoxy coated). Square Permalloy cores are also available in non-standard sizes in 1, 2 and 4-mil tape thicknesses. In addition, they're available in heavier gauges than 4-mil, and in ultra-thin gauges (less than 1-mil).

For guaranteed magnetic properties on Arnold Square Permalloy tape cores in standard sizes, write for Supplement 4, Bulletin TC-101A. *The Arnold Engineering Company, Marengo, Illinois.*

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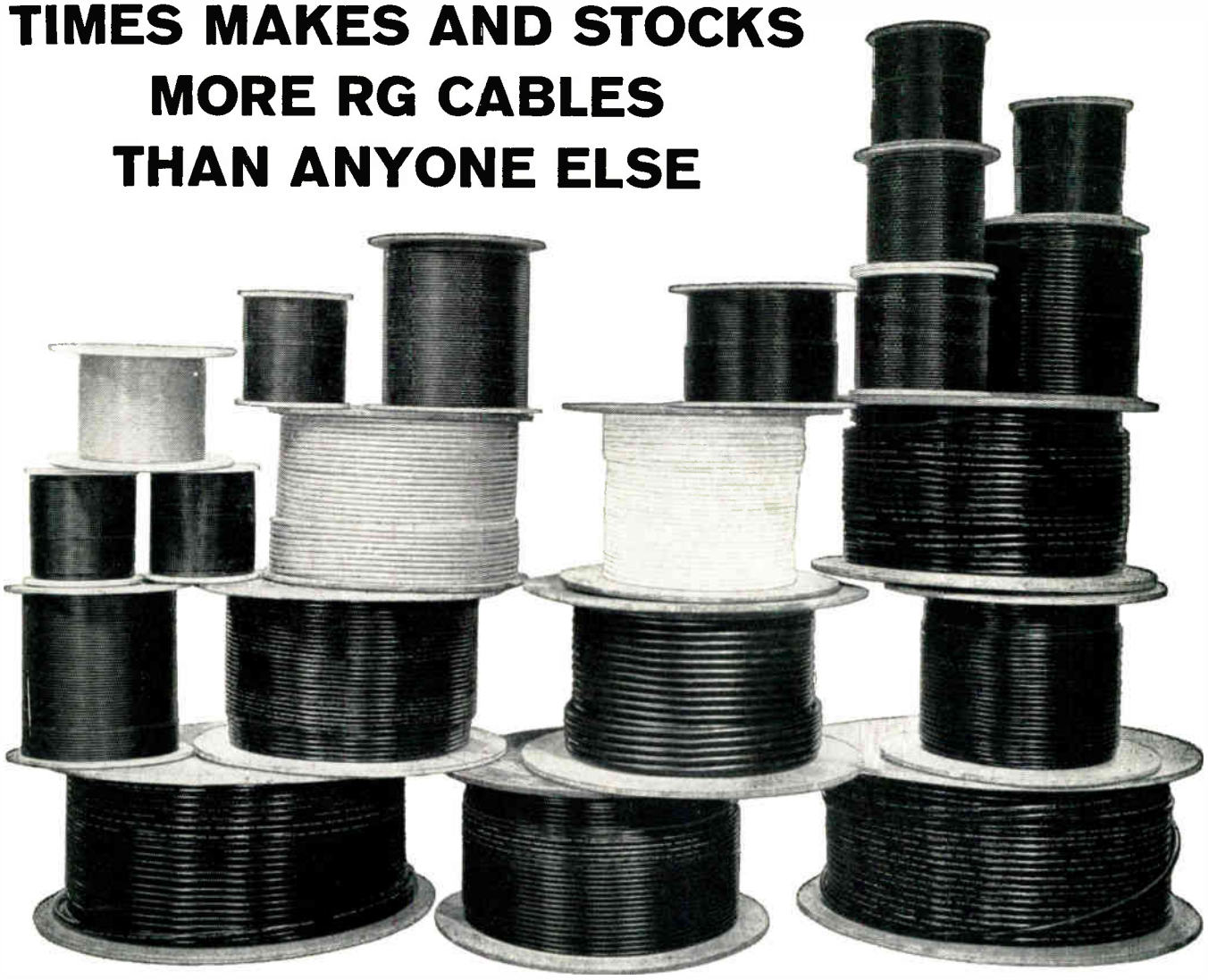


in-stock cable shipped within 24 HOURS

Times can supply you with *any* RG coaxial cable you need—*when* you need it. This exclusive customer service is possible because Times produces and stocks the world's most complete line of polyethylene and teflon RG cables . . . including special and standard cables in an extensive variety of multiconductor configurations.

Times stocks more than 125 different types of RG cables in huge quantities, including the largest supply of Mil-Spec. approved RG cables. All Times cable in stock at the factory and at Times' nationwide distributors can be shipped within 24 hours. And Times' large production facilities and high volume business make its RG cable available at the most competitive prices.

In addition to being a major supplier of RG cable, Times also produces and stocks Teflon Hook-up Wire, Mil-Spec. 16878D.

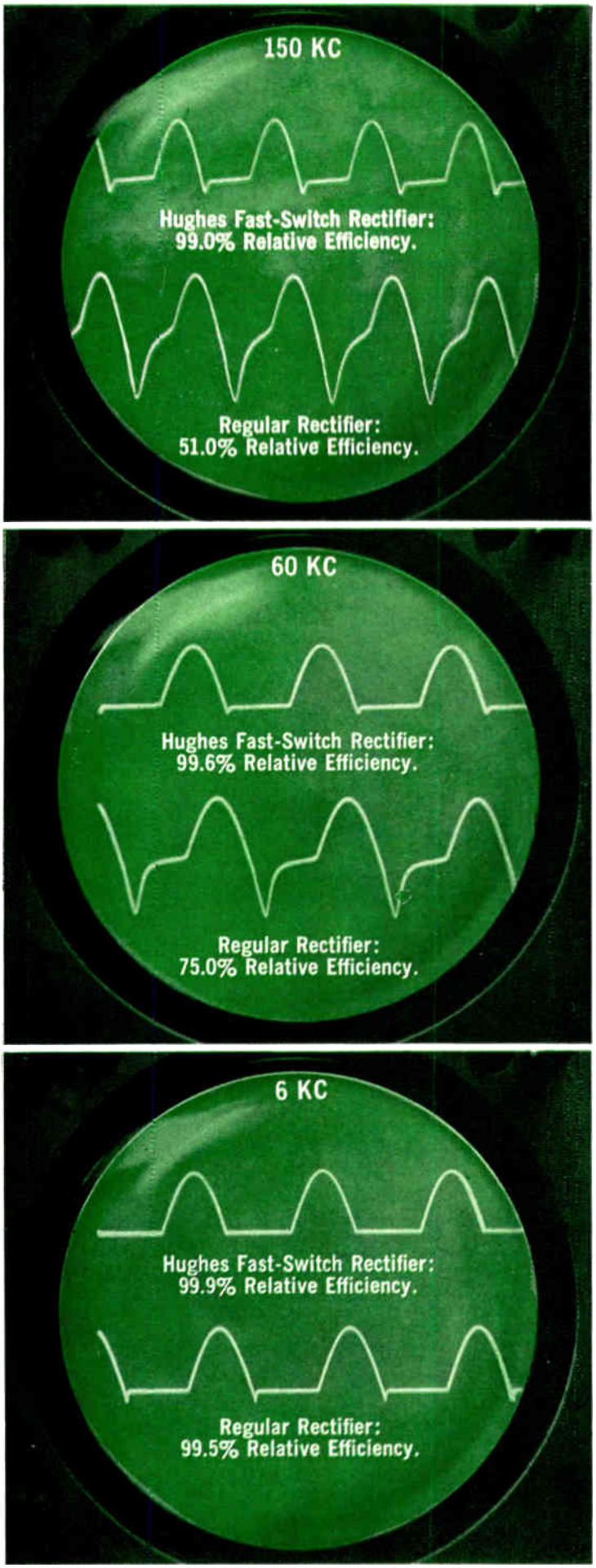
Times publishes a *weekly* stock list indicating which cables are in stock and the amount available. For further information on this service and other Times' capabilities, write on your letterhead to Sales Manager, Dept. 123.

*A DuPont Trademark

SEE OUR SPECIFICATIONS IN V·S·M·F THE MICROFILM CATALOG FILE

TIMES WIRE AND CABLE
Division of The International Silver Company
Wallingford, Connecticut

TRANSMISSION SYSTEM DESIGN AND ENGINEERING • STANDARD & SPECIAL PURPOSE COAXIAL CABLE • MULTICONDUCTOR CABLE • COMPLETE CABLE ASSEMBLIES • TEFLON* HOOK-UP WIRE



Double your efficiency with Hughes fast-switch rectifiers!

Hughes, producer of the industry's fastest-switching diode, now has available, in quantity and for immediate delivery, the industry's fastest-switching rectifier.

These actual photographs of comparative dynamic rectification tests verify the exceptional efficiency of Hughes HF Series "Golden Line" fast-switch silicon power rectifiers (1-35 amps). Such efficiency—unique in the industry—allows you to (1) increase the source frequency, which results in a decrease in the size, costs and weight of filter components and power conversion units, and (2) to decrease the source power through the elimination of high voltage drops in the filter circuit and in other circuit elements. The result: an increase of up to 50 per cent in circuit efficiency! ▪ Hughes fast-switch rectifiers have recovery times of 200 nanoseconds (max.). Typical recovery time is 80 nanoseconds. ▪ Hughes fast-switch rectifiers are available in quantity—today—in regular or insulated stud packages, and in standard or custom high-voltage, high-power stacks. (A DO-7 package—1 amp and axial leaded—is available with the same parameters.) *And here's something else to remember: Hughes fast-switch rectifiers demonstrate a high degree of immunity to the effects of space radiation.*

For additional details on local delivery or export, contact your Hughes representative; or your Hughes distributor for off-the-shelf stock. Ask for your copy of the "Golden Line" Rectifier Brochure (C-22); or write Hughes Semiconductor Division.

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SEMICONDUCTOR DIVISION
NEWPORT BEACH, CALIF.

RELIABILITY PLUS

DIODES ▪ TRANSISTORS ▪ RECTIFIERS
PACKAGED ASSEMBLIES ▪ CRYSTAL FILTERS

Circle 46 on Inquiry Card

LETTERS

to the Editor

(*Continued from page* 58)

well established concept of reliability through redundancy. Hence, Mr. Oakley's statement that the second system must of necessity be less reliable than the first system, because it has more components, is unfortunate, and reflects a serious engineering misconception.

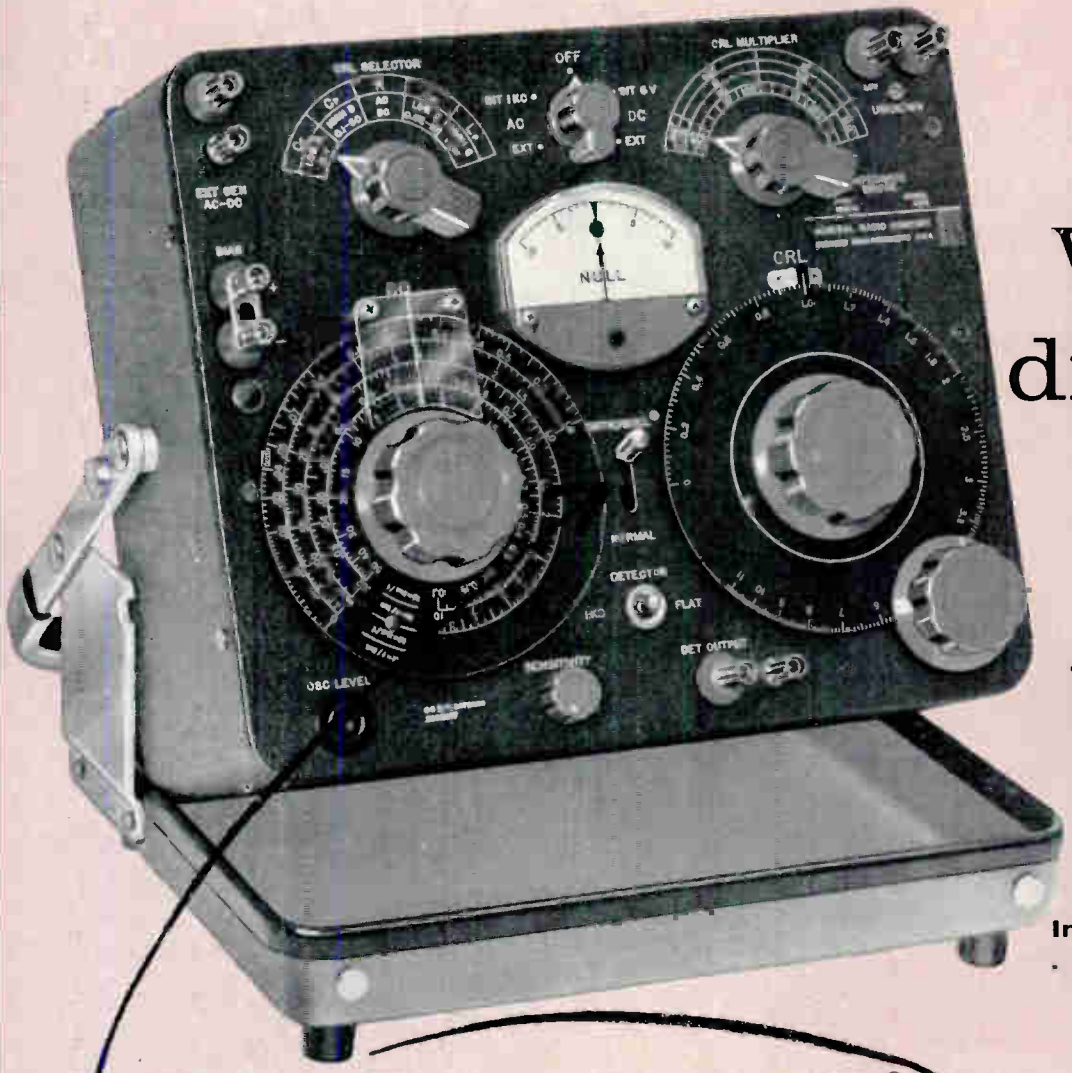
Further, Mr. Weitzel unequivocally states that there are only six types of regulating power supplies, and he omits completely the switching type, which is becoming more and more popular due to its increase in efficiency, smaller size and lighter weight and greater reliability. It is unfortunate that your editorial staff did not catch the discrepancy between Mr. Weitzel's erroneous omission of switching regulators (the SCR regulator described in fig. 16 and under item 6 cannot be considered a switching regulator) and Mr. Oakley's proper inclusion of the switching type regulator, despite his erroneous conclusions.

Another example of incomplete familiarity with the full gamut of modern power supply technology is manifested by Mr. Kupferberg when he states, in conjunction with "Current Sensing Resistor" ". . . a current regulated dc power supply regulates the current in the load by regulating the voltage across the sensing resistor." He implies that current regulators can operate only if a resistor is placed in series with the load to develop a voltage proportional to the output current. Modern techniques utilizing magnetic amplifiers and detectors actually can detect dc in a wire without any resistor, and regulate accordingly.

Even Mr. Tanner, in his excellent article on "Specifying DC Electronic Power Supplies," omitted an extremely important specification, which is often assumed, but which nevertheless should be stated—namely, the insulation rating with respect to ground. This is of particular importance in multiple output power supplies.

Since your issue will undoubtedly be used as a power supply reference for many years to come, it is the purpose of this letter to set the record

(*Continued on page* 68)



What's different about this bridge ?

Type 1650-A Impedance Bridge . . . $460
in U.S.A.

Orthonull®

PATENT NO 2 872 639

balance finder

. . . an exclusive feature found only in the GR 1650-A Impedance Bridge. Orthonull eliminates annoying sliding balances commonly associated with the measurement of components having high losses. A unique unilateral ganging mechanism, Orthonull makes the Bridge's CRL and DQ adjustments electrically independent. Once the bridge has been given an initial balance, the Orthonull clutch is engaged. Then, any adjustment of the CRL dial automatically adjusts the DQ dial, "tracking" the sliding balance. Thus, convergence of the two adjustments is rapid, balancing procedure greatly simplified, and the danger of a false balance eliminated.

OTHER FEATURES YOU GET IN THIS BRIDGE:

Wide Ranges — R: 0.001Ω to 10 M
L: 1 μh to 1000 h
C: 1 pf to 1000 μf
D: 0.001 to 50 at 1 kc
Q: 0.02 to 1000 at 1 kc

Accuracy — 1% for R, L, and C
5% for D and Q

Ready to Use — battery operated with built-in transistorized null detector and 1-kc generator. Frequency range of bridge is 20c to 20 kc with external generator.

Unique Carrying Case allows panel to be tilted to any convenient angle . . . closes for complete protection. Patent No. 2,966,257

Write for Complete Information

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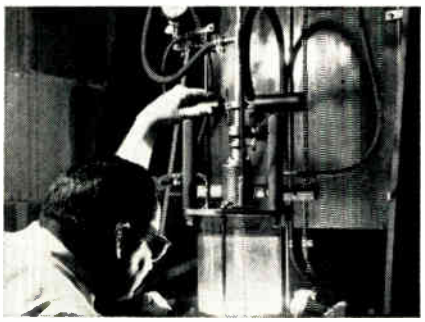
IN CANADA
(Toronto) 247-2171

Circle 48 on Inquiry Card

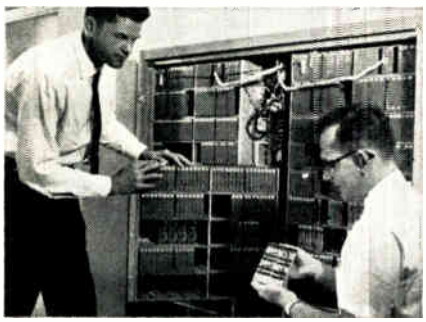
What was Bell Telephone Laboratories doing on Monday, October 1, 1962?



Murray Hill Laboratory, N. J. The search continued for new materials exhibiting superconductivity. Some of these materials have been used to produce very strong magnetic fields with the expenditure of very little electrical energy.

Allentown Laboratory, Pa. We were working with engineers of Western Electric, manufacturing unit of the Bell System, on the manufacture of long-life electron tubes for a new deep sea cable system.

Merrimack Valley Laboratory, Mass. We were increasing the capabilities of a new microwave system designed for low-cost telephone and television communications over distances up to 200 miles. This system is based on advances in solid state technology.

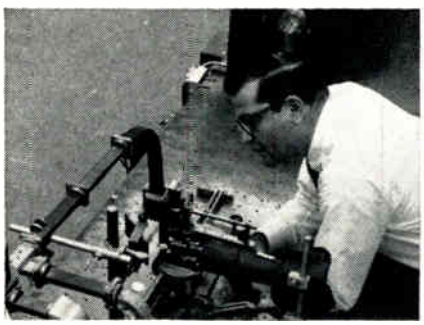


Holmdel Laboratory, N. J. We were developing an electronic switching system using new solid state devices. It will bring telephone customers a whole new range of services.

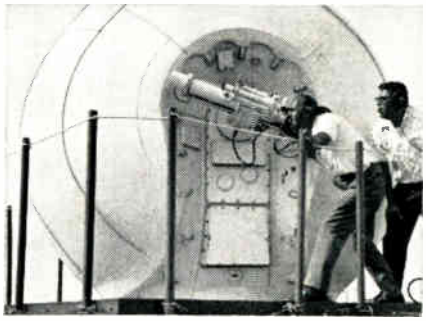
Indianapolis Laboratory, Ind. We were perfecting improved automatic dialer telephones. One model will permit the customer himself to record 50 frequently called names and numbers and then dial by simply selecting a name and pressing a button.

New York Laboratory, N. Y. We were studying the performance of a new data set which converts teletypewriter pulses into tones for transmission over regular voice circuits. Transmitting teletypewriter messages over voice circuits was introduced on August 31, 1962.

Whippany Laboratory, N. J. We were evaluating new radar technology for the NIKE-ZEUS antimissile missile system under development for the Army. Significant improvements are further tested at four other ZEUS test sites ranging halfway around the world.



Crawford Hill Laboratory, N. J. We were experimenting with the microwave modulation of light from a helium-neon gaseous optical maser. Modulated light may someday be used to carry large volumes of information.



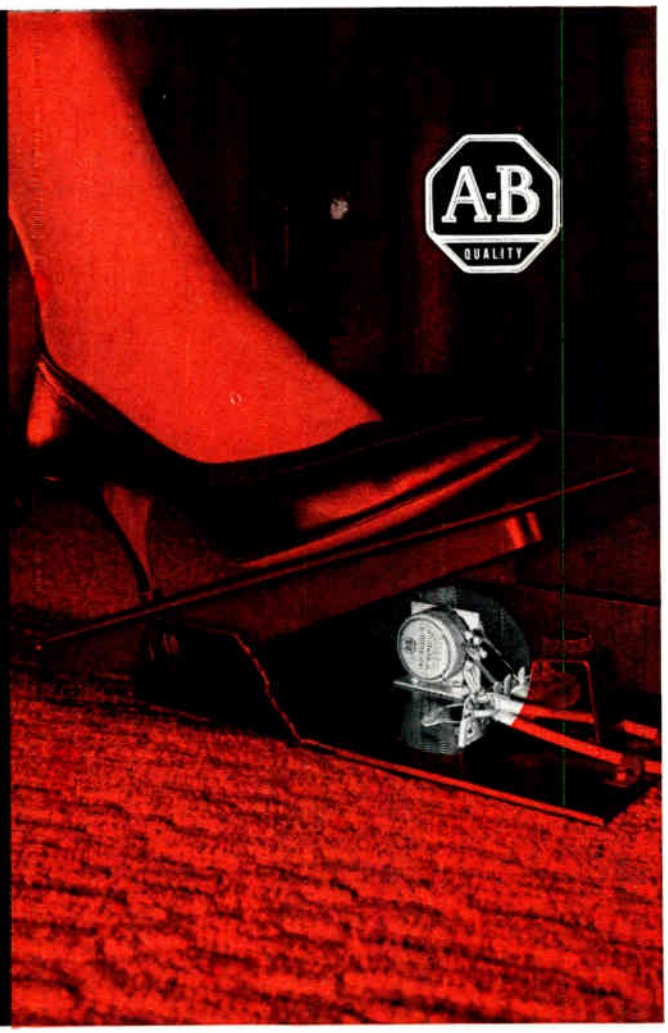
Cape Canaveral, Fla. We were preparing for the 102nd successful use of Bell Laboratories-developed Radio Command Guidance System. On July 10, it was used in the NASA launching of the Bell System's Telstar. This guidance system was originally developed for the Air Force and is operational on the Titan I ICBM.

These were some of the highlights of one day. Engineers and scientists at Bell Laboratories work in every field that can benefit communications and further improve Bell System services. Their inquiries range from atomic physics to new telephone sets, from the tiny transistor to transcontinental radio systems, from the ocean floor to outer space.

BELL TELEPHONE LABORATORIES

World center of communications research and development

HAMMOND ORGAN COMPANY USES THE POPULAR TYPE J TO INSURE LONG LIFE AND LOW NOISE IN THE SWELL PEDAL CONTROL OF THEIR NEW SPINET ORGAN.



SWELL CONTROL PEDAL FOR L-100 SERIES ORGAN SHOWING WHERE ALLEN-BRADLEY TYPE J VARIABLE RESISTOR IS USED.

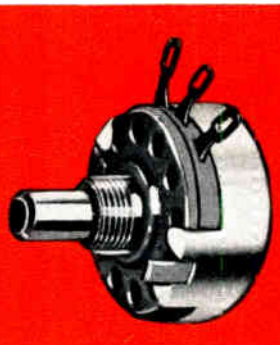
Hammond engineers — through tough tests — sold themselves on **A-B Hot Molded Variable Resistors**

■ In selecting components for the swell control pedal, which is in constant use, Hammond Organ Company exercised traditional care to make certain their new spinet will remain a lifelong companion. Therefore, Hammond engineers conducted extensive tests to determine the control that would provide the longest life in this quite abusive application. Because of the wide degree of amplification, an *extremely low noise level* is tremendously important. Based on such tests, the Hammond engineers selected the Allen-Bradley hot molded Type J variable control as their No. 1 choice. The special tapers necessary for this type of application are easily accomplished in the Type J control.

Hammond Organ Company's new spinet also uses A-B hot molded fixed resistors, which are world famous for their consistently uniform characteristics, low noise level, and complete freedom from catastrophic failures.

You can be certain of protecting the reputation of your equipment by always insisting on A-B fixed and variable resistors. For more complete information on the entire line of A-B quality electronic components, please write for Publication 6024.

Type J controls are rated 2.25 watts at 70°C and are available in standard tapers and standard total resistance values up to 5 megohms. Special tapers and special, as well as higher resistance values, are also available.



Allen-Bradley Co., 1342 South Second Street, Milwaukee 4, Wisconsin • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

QUALITY ELECTRONIC COMPONENTS | ALLEN-BRADLEY

LETTERS

to the Editor

(*Continued from page* 64)

straight to the effect that the articles represent mainly current practice in commercial organizations, and do not necessarily represent the most advanced technology for all dc power supply applications.

Dr. Victor Wouk
President
Electronic Energy Conversion Corp.
342 Madison Ave.
New York 17, N. Y.

Ed: This article, "Power Supplies—Definitions to Design," was one of the most popular articles ever published in ELECTRONIC INDUSTRIES. In all, some 50,000 reprints have been ordered of various articles within the feature, and 5,700 copies of the total package, have been distributed.

We fully expect, that, as Dr. Wouk predicts, this article will be a reference work for some time to come. With that in mind, we are forwarding copies of this letter to the authors of the articles to which Dr. Wouk refers. Their comments will be printed here in succeeding issues.

"Directed Energy Weapons"

Editor, ELECTRONIC INDUSTRIES:

Regarding the article, "Directed Energy Weapons" by Dr. Jack De Ment, in ELECTRONIC INDUSTRIES, August issue, 1962.

I should like to state that as a partner and associate in this project with my brother, Dr. J. A. De Ment of Portland, Oregon we have received inquiry and requests for re-prints on a world wide basis. We have also received many requests from various colleges and universities for the article. Although we have referred the inquiries to your department for such reprints, we should greatly appreciate fifty (50) reprints of this article, if available.

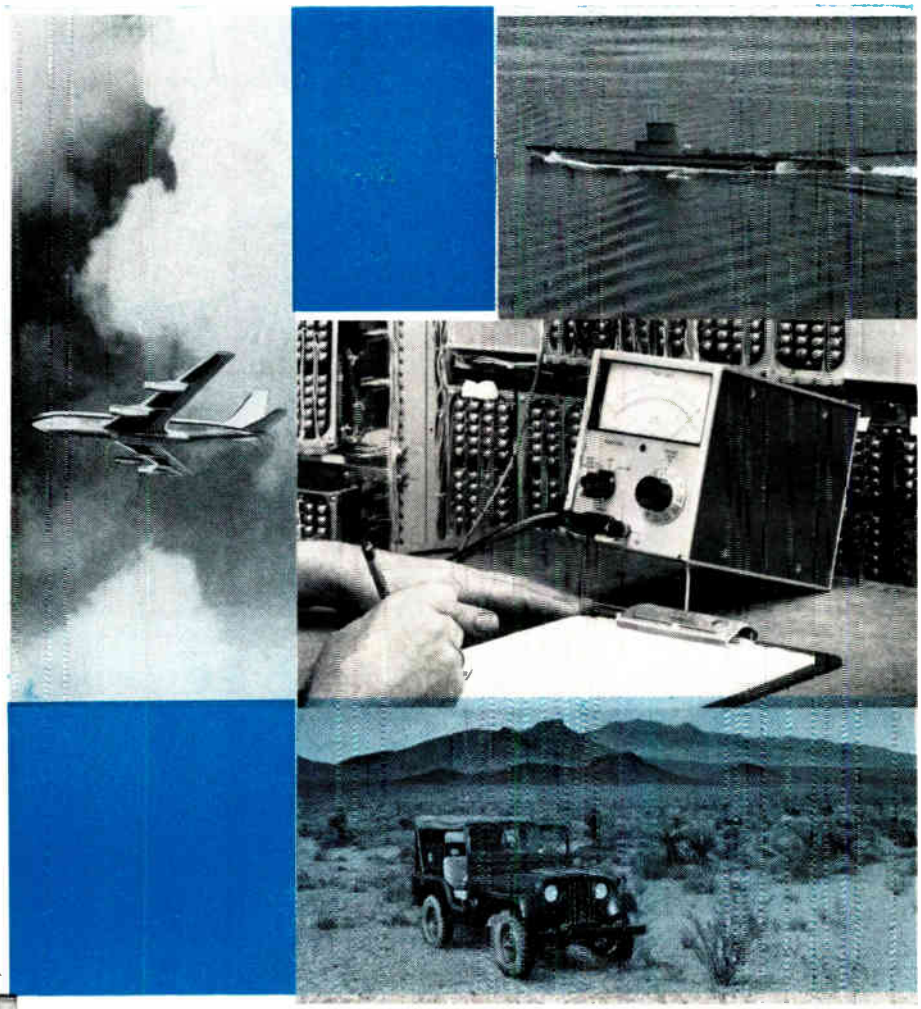
Dr. Gene A. De Ment
Moscow, Idaho

Editor, ELECTRONIC INDUSTRIES:

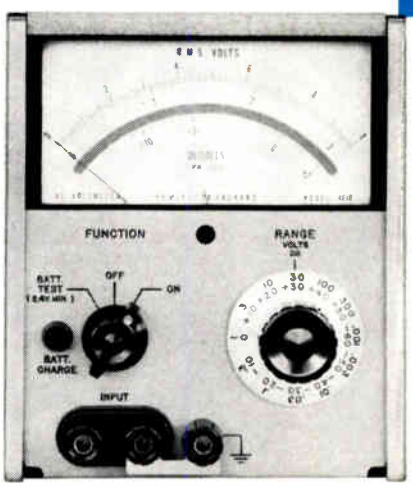
As per your offer in the September, 1962 issue of "Electronics Industries," please send me a reprint of the article titled "A Shortage of Engineers?"

This article was impressive, and, to those who have been alert to the activities of the industry, appears correct.

Lyle K. Porter
Sandia Corporation
Albuquerque, N. M.



Use it anywhere!



New *hp* portable AC Voltmeter

100 μv to 300 v · 5 cps to 2 MC

2% accuracy is yours over a major portion of the frequency range with this new battery-operated hp 403B AC Voltmeter. Carry it anywhere and quickly make direct measurements from 100 microvolts to 300 volts, 5 cps to 2 mc.

Battery charge, easily checked with a front-panel switch, is automatically restored while you use the 403B on your bench or from your ac line.

The instrument itself always operates from its battery supply, and the battery operation permits complete isolation of the 403B from power line and external grounds—eliminating hum and ground loops. Signal ground may be ±500 v dc from external chassis. The meter responds to the average value of the input, is calibrated in the rms value of a sine wave. The solid state, compact 403B weights only 6½ lbs.

Call your Hewlett-Packard representative or write direct for a demonstration on your bench.

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

SPECIFICATIONS

Range: 0.001 to 300 v rms full scale, 12 ranges

Frequency: 5 cps to 2 mc

Accuracy:

Frequency	Temperature	
	0°C to +50°C	0°C to −20°C
1 mc 10 cps to	±2%	±8%
5 to 10 cps 1 to 2 mc*	±5%	±8%

*±10% on 300 v range

Nominal Input Impedance: 2 meg-40 pf, 0.001-0.03 v ranges; 20 pf, 0.1-3 v ranges; 15 pf, 10-300 v range

Maximum Input: 600 v peak, 0.3-300 v ranges; 25 v rms, 600 v peak, 0.001-0.1 v range

Power: 4 rechargeable batteries (furnished) 40-hr operation per recharge, up to 500 recharging cycles. Self-contained recharging circuit functions when instrument is operated from ac line

Size: 5⅛" wide, 6-3/32" high, 8" deep

Price: 403B, $310.00

8034

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Circle 51 on Inquiry Card

BOOKS

Introduction to Electronics

By Wolter H. Evans. Published 1962 by Prentice-Hall, Inc., Publishers, Englewood Cliffs, N.J. 518 pages. Price $14.00.

Book was written for an introductory course in electronics, both for electrical engineering students and for others interested in electronic instrumentation. A background in circuit analysis is assumed. Several areas in electronics are covered which are not included in most introductory texts.

The major objective is to stimulate creativeness in the electronic field. This is done by considering several types of design problems at the end of each chapter. Analysis of a broad group of circuits is presented in an interesting manner.

A brief explanation of vacuum diodes, gaseous diodes, solid state diodes, transistors, tunnel diodes, vacuum triodes, photoelectric cells, and many others, is provided.

Anatomy of Automation

By Amber & Amber. Published 1962 by Prentice-Hall, Inc., Englewood Cliffs, N.J. 256 poges. Price $10.60.

Book starts out with commonly known facts concerning primary industrial practices and builds up to fully automatic systems. Functional aspects of automation take precedence over equipment design details.

The two main elements of useful work, energy and information, are discussed thoroughly. By following the framework developed in the text, the reader learns what levels of automation involve the mechanization of energy and what levels involve the mechanization of information.

The role of self-correcting feedback control and computer control in automation is carefully analyzed.

Introduction to Electronic Data Processing Equipment

By Robert V. Ookford. Published 1962 by McGrow-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y. 340 poges. Price $10.00.

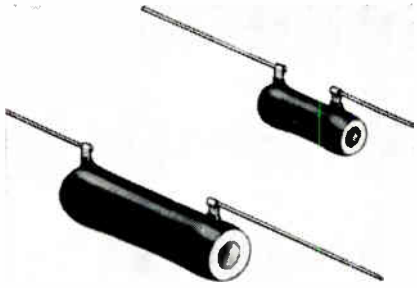
Emphasizing man-machine communications, this book explains how to communicate with electronic computers and auxiliary punched card equipment and discusses the principles of the equipment's operation. Introduced are: number and coding systems as the basic language of computers; the basic components of an electronic computer: machine language: symbolic and algorithmic language programming; Program testing: and the programming of plug-board controlled auxiliary equipment. Existing rather than hypothetical equipment and languages are discussed.

(Continued on page 74)

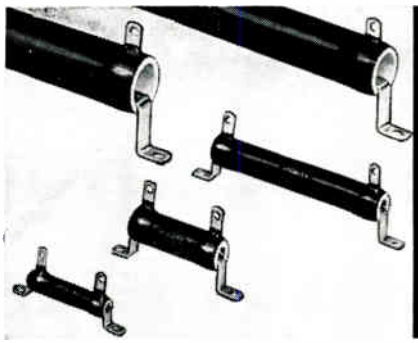
FAST DELIVERY ON OHMITE STOCK RESISTORS

Call Your Distributor or the Factory

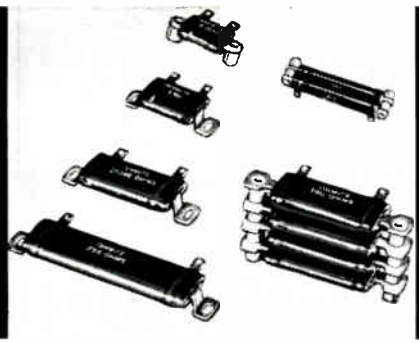
Write for Revised Stock Catalog 30



BROWN DEVIL®: Vitreous enameled, wire-wound; 5, 10, 20 watts in 121 values, 0.5 to 100,000 ohms.

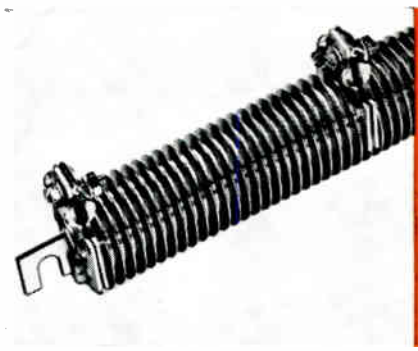


LUG TYPE: Vitreous enameled, wire-wound; 10, 25, 50, 100, 160, 200 watts, 0.51 to 250,000 ohms.*



THIN TYPE: Vitreous enameled, wire-wound; 10, 20, 30, 40, 55 watts in 158 values, 1 to 50,000 ohms.

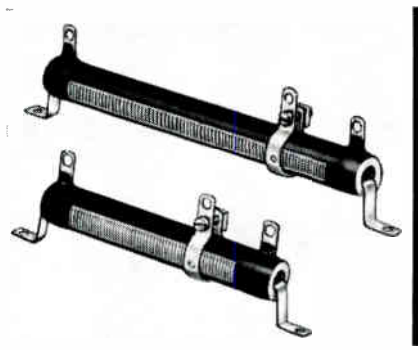
AXIAL LEAD: Vitreous enameled, wire-wound; 1, 3, 5, 10 watts in 292 values, 1 to 50,000 ohms.



HIGH CURRENT, POWR-RIB: Fixed *and adjustable*, ribbon or round wire; 0.1 to 25 ohms, 5.1 to 100 amps.

HIGH CURRENT, CORRIB®: Vitreous enameled, *fixed and adjustable;* 300 watts in 48 values, 0.1 to 20 ohms.

INSULATED: Molded silicone-ceramic, wire-wound *precision;* 3, 5, 10 watts in 101 values, 1 to 51,100 ohms.



ADJUSTABLE DIVIDOHM®: Vitreous enameled, wire-wound; 10, 25, 50, 75, 100, 160, 200 watts; 1 to 100,000 ohms.

MIL-R-26C (FIXED): All sizes; tubular, flatt, axial leadt, insulatedt, ceramic jacketedt. †*Not illustrated.*

MIL-R-19365C (ADJUSTABLE): Vitreous enameled, wire-wound; all 8 MIL sizes from 11 to 210 watts, 1 to 15,000 ohms.

**Also NON-INDUCTIVE resistors of 10, 50, 100, and 160 watts.*

WORLD'S LARGEST SELECTION OF STOCK RESISTORS

RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS
TANTALUM CAPACITORS • TAP SWITCHES • RELAYS • R.F. CHOKES • GERMANIUM DIODES

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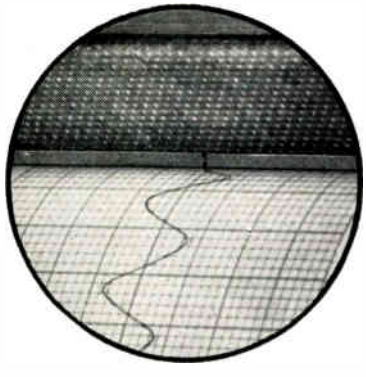
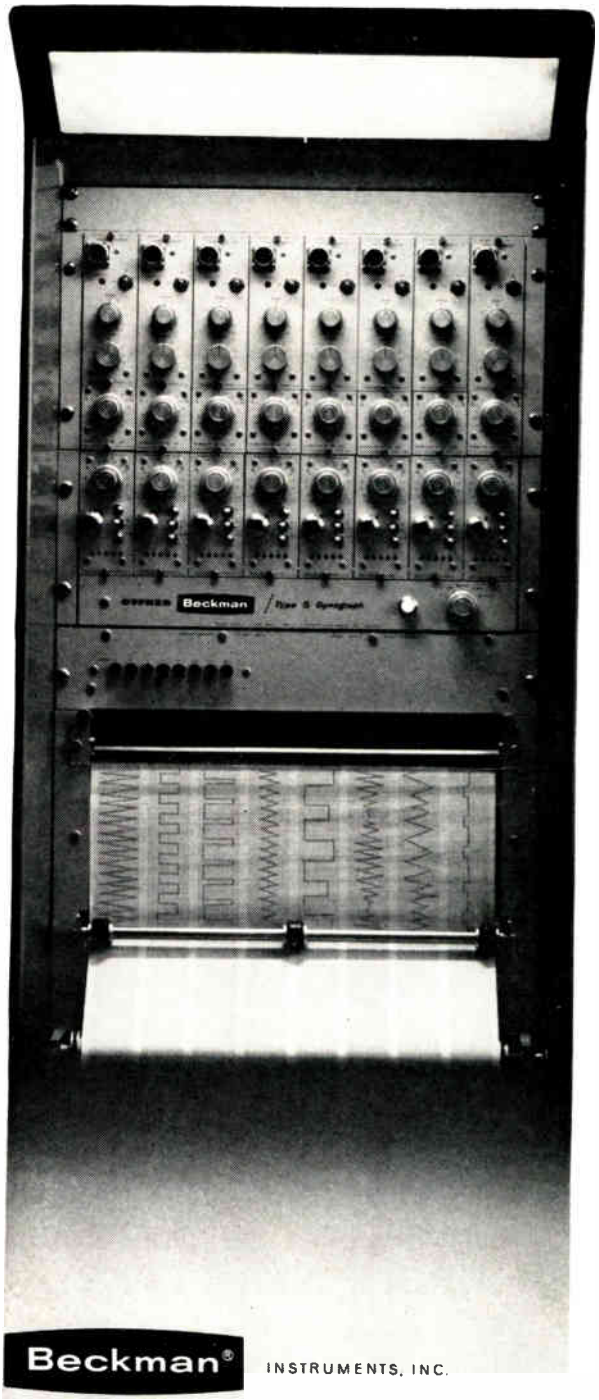
PEN POINTS ARE SERVO CONTROLLED BY INPUT SIGNAL—POSITIVELY CONSTRAINED TO A SINGLE STRAIGHT LINE • PRESSURE INK SYSTEM ASSURES MAXIMUM LEGIBILITY—MINIMUM MAINTENANCE • TRANSISTOR CIRCUITRY FOR INSTANT WARM-UP, LOW POWER CONSUMPTION • GIVES ALL ADVANTAGES OF OTHER OFFNER RECORDERS PLUS INK-RECTILINEAR TRACINGS • FOR COMPLETE DATA SEE YOUR OFFNER REPRESENTATIVE, OR WRITE US.





SPECIFICATIONS

NUMBER OF CHANNELS:
1—8 standard; to 24 special
EVENT MARKER:
One or more available
SENSITIVITY:
With preamp 1 μv/mm to 5v/mm
Without preamp 1 mv/mm to 5v/mm
FREQUENCY RESPONSE:
DC to 150 cps
PHASE ERROR:
0–100 cps <0.1 msec delay error
0–150 cps <0.7 msec delay error
RESPONSE TIME:
2.5 msec at 5 mm deflection
4.0 msec at 10 mm deflection
NOISE:
With preamp <0.5 μv, RMS
Without preamp invisible
HYSTERESIS:
0.1% (full scale) locked in by positional feedback
RESOLUTION:
0.1% (full scale) locked in by positional feedback
LINEARITY:
0.15% (full scale) for DC; or AC within maximum amplitude envelope
DRIFT:
With preamp 1 μv/hr at max. gain
Without preamp <0.05 mm/hr (shorted input)
RECORDING AMPLITUDE:
Full chart channel width from DC —30 cps with progressive reduction to 5mm at 150 cps
INPUT:
With preamp ... differential
Without preamp ... single-ended
INPUT IMPEDANCE:
With preamp 2 megohms
Without preamp 1 megohm
ZERO SUPPRESSION:
With preamp 50cm
Without preamp 15cm
CALIBRATION:
Internal
PAPER SPEEDS:
8 push button selected, standard speeds 0.1, 0.2, 0.5, 1, 2.5, 5, 10, 25 cm/sec. Other speeds on special order
PAPER SPEED ACCURACY:
1.0%
AMBIENT TEMPERATURE RANGE:
–20°C to +50°C
INPUT COUPLERS:
All types available
POWER REQUIREMENTS:
60 w. average; 140 w. max (8 channels)
WARM-UP TIME:
Instantaneous
AUXILIARY POWER AVAILABLE:
+15v, 0.5 amps DC
–15v, 0.5 amps DC
6v, 10 watts, 400 cps
HIGH-IN, HIGH-OUT SWITCH:
For recording DC or low frequency signals. Signal frequencies above 50 cps (approx) attenuated in "High-Out" position
NOMINAL COST/CHANNEL:
With preamp $1,250
Without preamp $850

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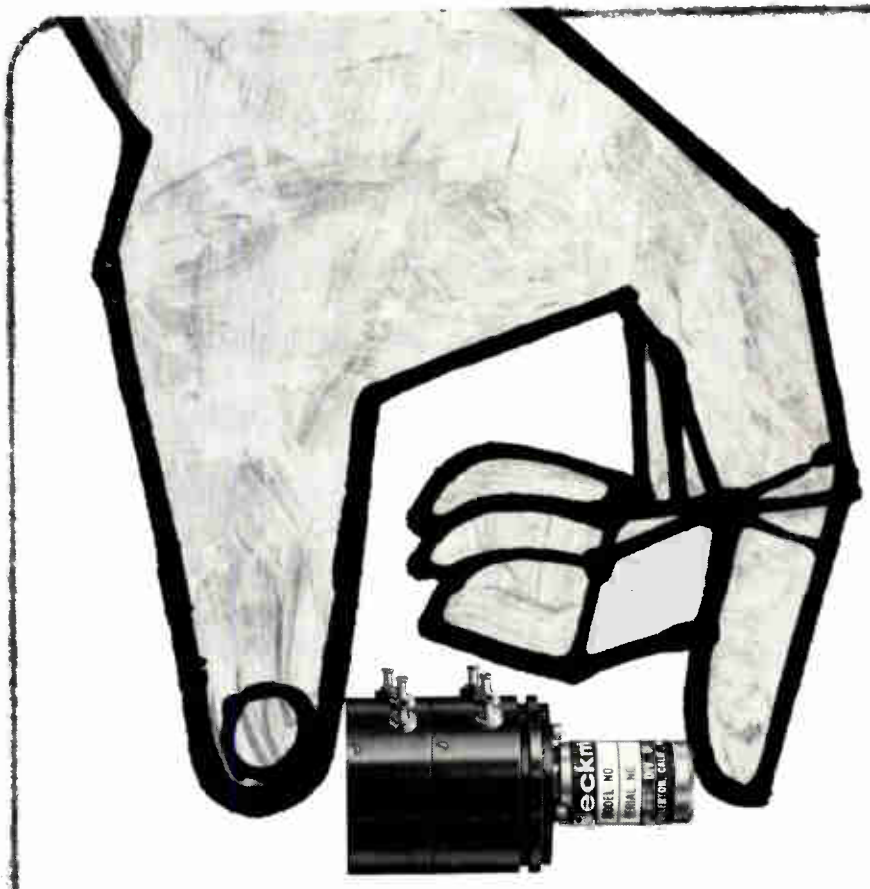
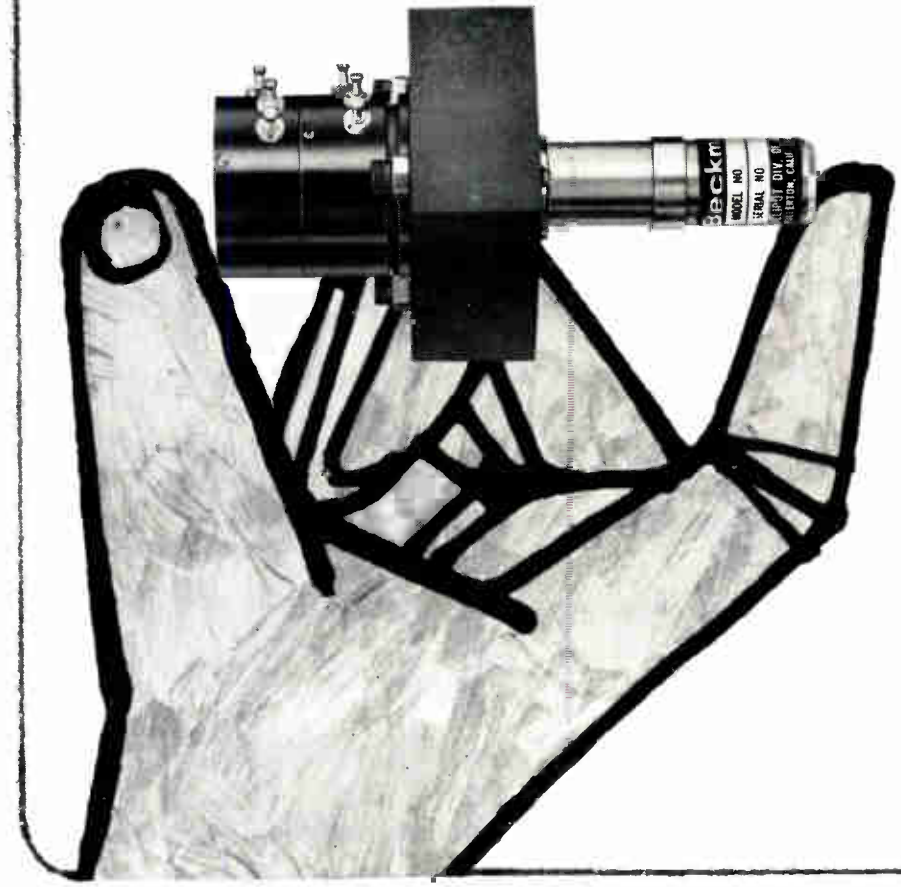
International Subsidiaries: Geneva, Switzerland; Munich, Germany; Glenrothes, Scotland

063-208



both the same size... performance-wise



NEW...
FIRST READY-BUILT SERVOPACKAGE SAVES YOU 30% ON SIZE AND WEIGHT

Introducing the Motor-Pot – the year's best example of pint-sizing. In a single package, you get high-performance servomotor, precision potentiometer and gearhead at a 30% saving in size and weight over typical in-line subassemblies. We've done it by cleverly placing the gearhead and part of the motor right inside the pot.

There are two standard models. The Model 45 Motor-Pot with its 1-1/16" diameter single-turn pot and size 5 servomotor. And the Model 46 with a 2" diameter ten-turn pot and size 8 motor. Also any number of custom variations.

The ready-made 45 and 46 give a clue to our in-line capability. And our experience furnishes the proof. We'll meet your most demanding spec with component matching you can count on. One-stop shopping also saves you time and money. There's no testing, positioning and aligning of components purchased from different suppliers. No more do-it-yourself assembly at all!

Your nearest Helipot rep has our full servopackage story. For more information, contact him or write us direct.

ALSO... NEW-GENERATION HALL EFFECT DEVICES, CLEAN-DESIGN METERS.

Beckman INSTRUMENTS, INC.
HELIPOT DIVISION
Fullerton, California

INTERNATIONAL SUBSIDIARIES: GENEVA, SWITZERLAND; MUNICH, GERMANY; GLENROTHES, SCOTLAND.

BOOKS

A Primer of ALGOL 60 Programming

By E. W. Dijkstra. Published 1962 by Academic Press Inc., (Landon) Ltd., Berkeley Square House, Berkeley Square, London, W.I., England. 114 pages. Price $6.00.

ALGOL is a language which is being developed with the aim of describing computer processes. This language is defined so exactly that an ALGOL description of a computer process is enough for a computer to perform its actual execution.

ALGOL 60 should bring the potentials of modern automatic computer machines within the reach of a large group of potential users. This primer has been written in order to ease the problem of learning ALGOL 60.

Books Received

RF Interference Control Handbook

By Barran Kemp. Published 1962 by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis 6, Ind. 224 pages, hardbound. Price $6.95.

Electronic Test Instrument Handbook

By Joseph A. Risse. Published 1962 by Howard W. Sams & Co., Inc. 4300 West 62nd St., Indianapolis 6, Ind. 288 pages. Price $4.95.

RCA Transmitting Tubes

Published 1962 by Electron Tube Div., Radio Corp. of America, Harrison, N.J. 320 pages, paperbound. Price $1.00.

ABC's of Tunnel Diodes

By Peter Galaan. Published 1962 by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis 6, Ind. 96 pages, paperbound. Price $1.95.

NEREM Record 1962

Record of the Northeast Electronics Research and Engineering Meeting—1962, held in Bastan, Mass., Nov. 5-7, 1962. Published 1962 by Lewis Winner, 152 West 42nd St., New York, N.Y. 198 pages, paperbound. Price $7.50.

Modern Communications Course, Vol. 1

Published 1962 by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis 6, Ind. 256 pages. Price $4.95.

NARM Relay Symposium Papers

A compilation of papers presented at the Tenth Annual Relay Symposium at Stillwater, Oklahoma. Published 1962 by NARM. Available from Mr. Alex White, Nat'l. Assoc. of Relay Manufacturers, P.O. Box 1, Bellerose 26, N.Y. 132 pages, paperbound. Price $2.00.

Industrial Automatic Systems (AS 1-1962)

Published by the National Electrical Manufacturers Assoc., 155 East 44th St., New York 17, N.Y. Price $4.00.

Instrument Transformers (EI 2-1962)

Published by the National Electrical Manufacturers Assoc., 155 East 44th St., New York 17, N.Y. Price $1.65.

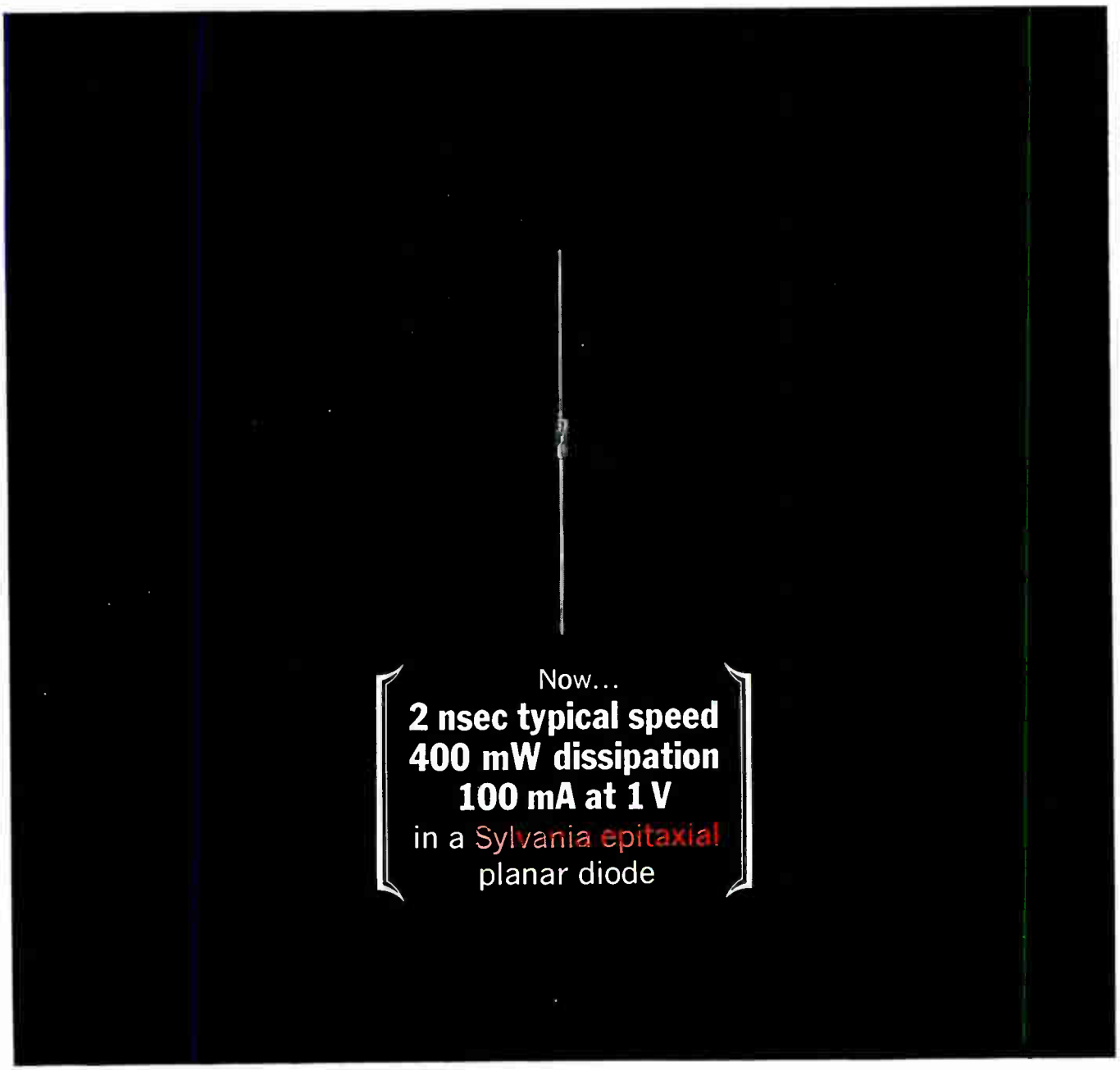
RCA Transistor Manual (SC-10)

Published 1962 by RCA Commercial Engineering, Somerville, N.J. 304 pages. Price $1.50.

RCA Battery Manual

Published 1962 by Electron Tube Div., RCA, Harrison, N.J. 64 pages. Price $0.50.

(Continued on page 80)



Now...
2 nsec typical speed
400 mW dissipation
100 mA at 1 V
in a Sylvania epitaxial
planar diode

Line 1 of the table shows the best combination of computer diode characteristics available today—all in an epitaxial planar diode with 400 mW power dissipation. ■ Not just the 1N3731, but all of these Sylvania silicon diodes are epitaxial planar, for these very good reasons: Epitaxial techniques—pioneered by Sylvania—provide the high speed, low forward resistance, and an optimum balance of breakdown voltage versus capacitance. The planar process adds other important features: low leakage and high reliability. It puts a protective passivated layer over the entire junction area. Reliability is further enhanced by the double hermetic seal—100% pressure-tested in Zyglo. And by the rugged one-piece construction, which stands up to the severest conditions of vibration and shock. ■ Rely on Sylvania for epitaxial planar diodes, and rely on your Sylvania Sales Engineer or Franchised Semiconductor Distributor to get them for you. For technical information, write directly to: Semiconductor Division, Sylvania Electric Products Inc., Dept. 2011, Woburn, Massachusetts.

	Avg. Fwd. Current mA (min)	Fwd. Current at +1 V mA (min)	Reverse Current μA (max)	Capacitance at 0 V μμf (max)	Reverse Recovery time nsec (max)	Reverse Peak Voltage V (min)
1N3731	275	100	0.05 at −50 V	2.0	3.0	100
1N3604	75	50	0.05 at −50 V	2.0	2.0	75
1N3064	115	10	0.1 at −50 V	2.0	4.0	75
1N914	75	10	.025 at −20 V	4.0	4.0	100
1N914A	75	20	.025 at −20 V	4.0	4.0	100
1N916	75	10	.025 at −20 V	2.0	4.0	100
1N916A	75	20	.025 at −20 V	2.0	4.0	100

SYLVANIA
SUBSIDIARY OF
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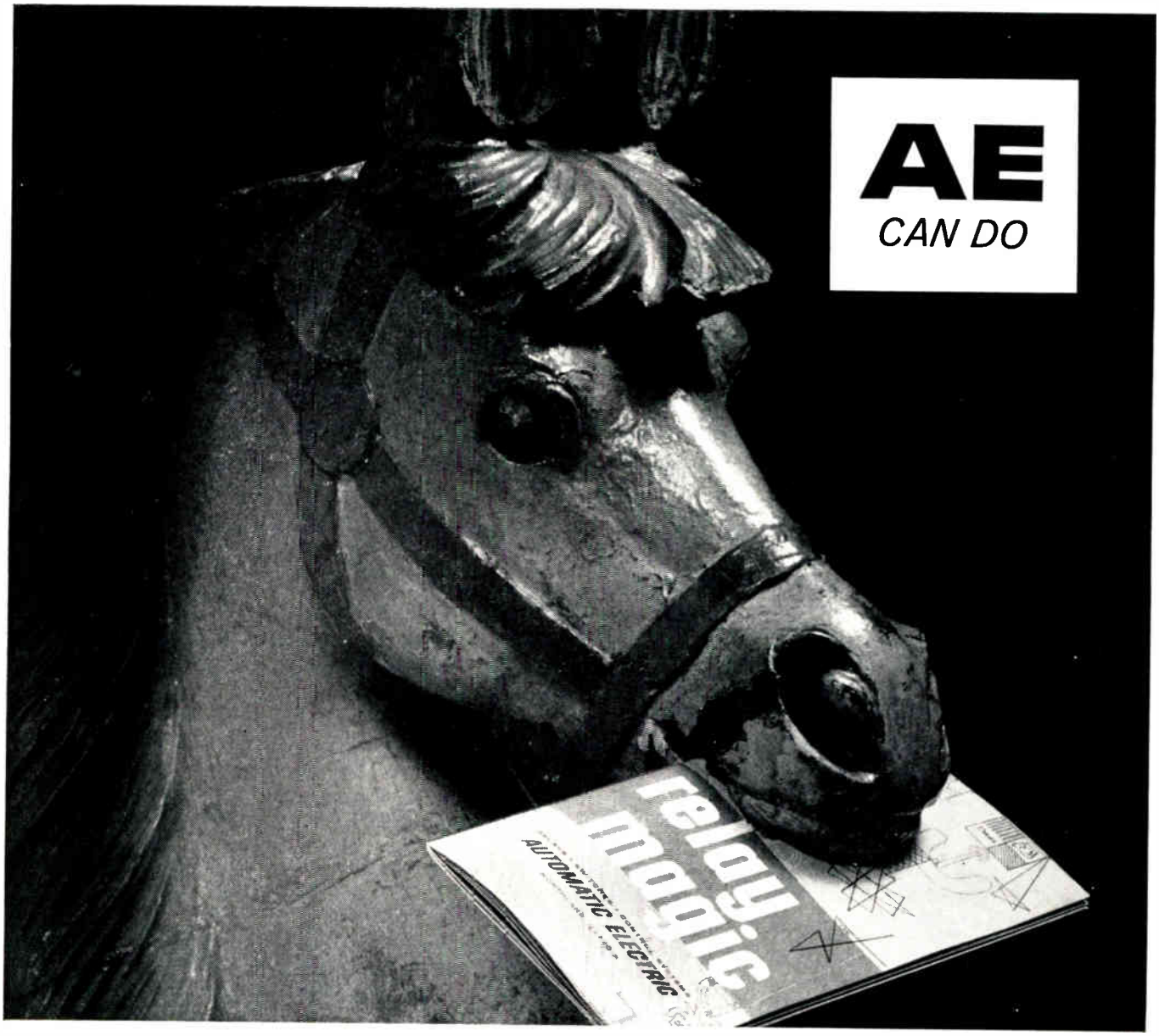
STANDARDS LABORATORY ACCURACIES / PRODUCTION LINE DURABILITY



Yours—**free**—right from the horse's mouth

If you design around relays—or ever expect to—you'll want a copy of "Relay Magic," by the "boys who wrote the book" on time-tested circuits.

This 40-page booklet, that is yours for the asking, contains 31 basic circuits that represent the best relay tricks of the trade to date. And, to keep you out of trouble, 6 seemingly practical circuits that you should avoid like the plague.

Included are circuits for dividing, multiplying, stretching and shortening pulses; counting chains; storage, scanning and cycling systems; delayed operation; binary addition, as well as decimal-to-binary and binary-to-decimal conversion.

If you already have a working circuit, AE's regional sales representative can help you select and order the exact relay or rotary stepping switch configuration for the job. You'll find him listed in the Yellow Pages under "Relays."

To get your copy of "Relay Magic," write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

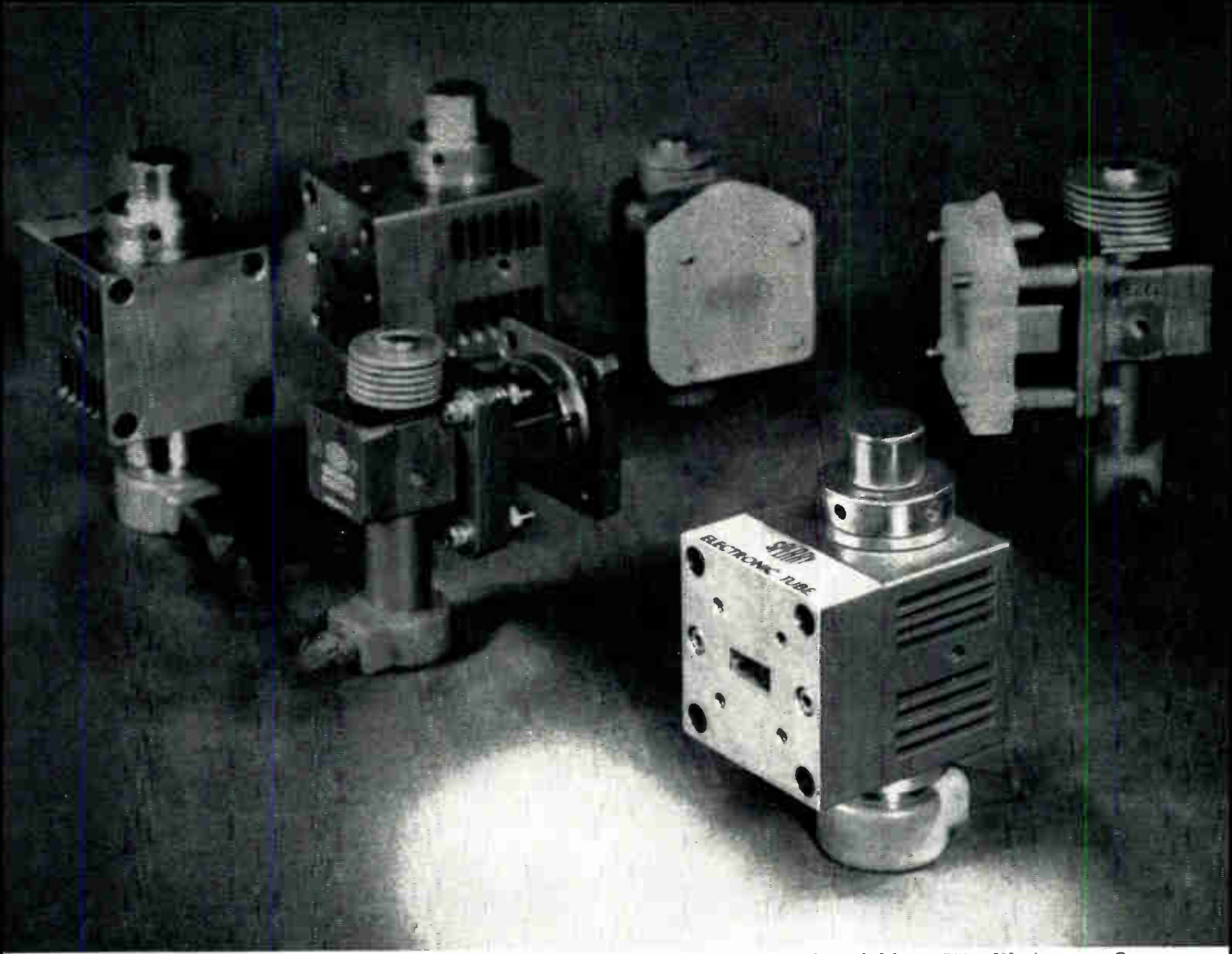
AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Circle 61 on Inquiry Card→



New SOV-2200 pumps paramps and masers at 35 Gc and delivers 500 mW of power. Operation at any frequency from 31 to 40 Gc is possible with this new oscillator family. Although miniaturized these Sperry oscillators have the frequency, high power, and stability of heavyweight tubes.

New miniature, high-power oscillators push range to 40 Gc for paramp pumping

A new family of V band two-cavity klystron oscillators provides high power levels for parametric amplifier and maser pumping, doppler systems, and FM communications systems. These tubes cover the frequencies from 31 to 40 Gc. You now get off-shelf to 60-day delivery of two-cavity oscillators from Sperry Electronic Tube Division at any frequency from 12.5 to 40 Gc.

The unique combination of 500 mW power output at frequencies up to 40 Gc, exceptional AM stability, and small size is found only in Sperry's two-cavity design.

These Sperry miniaturized pump tubes weigh just 12 ounces – yet offer the performance formerly found only in much larger, heavier tubes.

The flat-topped "output power vs. beam voltage" mode shape results in outstanding amplitude stability, since variations in beam voltage and temperature produce only negligible variations in output power.

Sperry's two-cavity oscillators deliver power outputs ranging from .5 to 2 watts. Typical output at U band is 2 watts and at V band, 500 mW.

Use of two-cavity klystrons also permits considerable system simplification, since equipment such as reflector power supply, automatic power leveler, and – in most applications – automatic frequency control can be eliminated.

For applications where outputs up to 300 mW and wide tuning ranges are required, ask about Sperry's tunable, low-voltage reflex klystron pumps.

A free technical booklet describing the entire Sperry line of paramp pump tubes – both two-cavity and reflex – is now available. For your copy, write Sperry, Sec. 183, Gainesville, Florida, or contact Cain & Co., Sperry's national representatives.

SPERRY ELECTRONIC TUBE DIVISION

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

BOOKS

Translations

On the Principles of Constructing a Digital Logical Machine

A. O. Stogniy. Academy of Science of the Ukrainian Socialist Republic, Kiev. 1962. 4 pages. 62-11759. Price $0.50. (OTS)

Magnetic Elements of Computer Engineering Equipment

Collection of articles. Edited by S. A. Lebedov Academy of Sciences, USSR. Moscow 1961. 62-11734. Price $4.00. (OTS)

Growth of Crystals, Vol. 3

Contoins papers read by Soviet crystallographers at the Second All-Union Conference on Crystal Growth, held in Moscow, March 23-April 1, 1959. Edited by A. V. Shubnikov and N. N. Sheftal. Published 1962 by Consultants Bureau Enterprises, Inc., 227 West 17th St., New York 11, N. Y. 380 pages. Price $25.00.

Governmental Publications

Orders for reports designated (OTS) should be addressed to the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Make check or money order payable to: "OTS, Dept. of Commerce." OTS reports may also be ordered through the Dept. of Commerce Field Offices. Prepayment is required. Use complete title and PB number for each report ordered. All other reports may be ordered from the Supt. of Documents, Government Printing Office, Washington 25, D. C.

Nuclear Radiation Damage to Transistors, Vol. 1—Permanent Damage

By R. Puttcomp, Diomond Ordnonce Fuze Laboratories. Nov. 1961. 161 pages. AD 270 264. Price $2.75. (OTS)

Evaluation of DOFL Transistors Employing Concentric Ring Geometry

By J. Vonderwall, Diomond Ordnonce Fuze Laboratories. Oct. 1961. 13 pages. AD 266 472. Price $0.50.

Functional and Design Problems of the NBS RF Voltage Bridge

By L. F. Behrent, National Bureou of Stondards, U.S. Dept. of Commerce. Jon. 1961. 47 pages. PB 161 624. Price $1.00. (OTS)

Survey of Fuel Cell Development With Emphasis on Maritime Applications

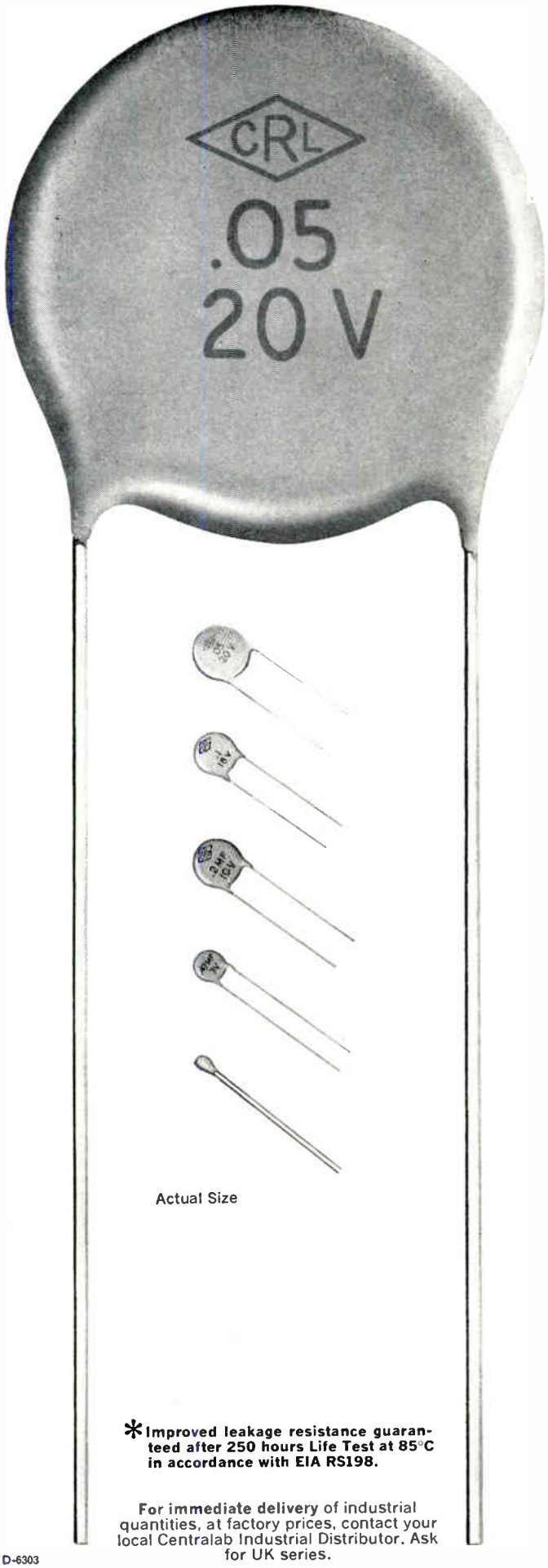
By S. C. Y. Chen and W. Morks, Stevens Institute of Technology, for U.S. Moritime Administration. Sept. 1961. 50 pages. PB 181 101. Price $1.25. (OTS)

Federal Funds for Science X, Fiscal Years 1960, 1961, and 1962

Notionol Science Foundotion Report. Price $0.75. (Supt. of Doc.)

Handbook Preferred Circuits, Vol II, Semiconductor Device Circuits

NAVWEPS 16-1-519-2, issued April 1, 1962, 178 pages. Prepared by the Not'l Bureou of Stondords, U. S. Dept. of Commerce, for the Bureou of Noval Weapons, U.S. Dept. of Novy. Price $1.75. (Supt. of Doc.)



Actual Size

FIELD-PROVEN
DEPENDABILITY
WITH CENTRALAB ULTRA-KAPS®
SEMICONDUCTOR CIRCUIT
CERAMIC CAPACITORS

ULTRA-KAPS . . . the original low voltage, high capacity ceramic capacitors are manufactured under Centralab patents. With years of production experience behind them, these units are *dependable*—in *rating*, in *performance*, in *delivery*.

Ultra-Kaps are exceptionally reliable. Electrical failure is virtually unknown among the millions of units now in the field.

They exhibit no deterioration of leakage resistance after Life Test with excellent temperature stability from −55°C to +85°C.

Compared to papers or electrolytics of equivalent values, Ultra-Kaps offer the important advantages of smaller size, higher reliability and easier production handling. For additional information, write for Engineering Bulletin EP 1245R.

20 Volt Ultra-Kaps —Rating: 20 VDCW, **Tolerance**: +80% −20%. Dissipation factor at 1 KC: 10% maximum.

Capacity, mF	.05	.1	.2
Maximum Diameter, inches	.408	.590	.844
Min. Leakage Resistance*	400K	200K	100K

16 Volt Ultra-Kaps —Rating: 16 VDCW, **Tolerance** +80% −20%. Dissipation factor at 1 KC: 10% maximum.

Capacity, mF	.05	.1	.2
Maximum Diameter, inches	.408	.590	.844
Min. Leakage Resistance*	600K	300K	150K

10 Volt Ultra-Kaps —Rating: 10 VDCW, **Tolerance**: +80% −20%. Dissipation factor at 1 KC: 10% maximum.

Capacity, mF	.05	.1	.2	.47
Maximum Diameter, inches	.290	.408	.590	.844
Min. Leakage Resistance*	400K	200K	100K	50K

3 Volt Ultra-Kaps —Rating: 3 VDCW, **Tolerance**: GMV.

Cap. Mfd. (uF)	Max. Diam.	Dissipation Factor Max. — 1KC	Minimum Leakage Resistance*
.005	.120″	10%	30K
.01	.120″	10%	30K
.02	.120″	10%	30K
.1	.220″	10%	12K
.22	.290″	5%	8K
.47	.408″	5%	3K
1.0	.590″	5%	2K
2.2	.844″	5%	1K

*Improved leakage resistance guaranteed after 250 hours Life Test at 85°C in accordance with EIA RS198.

For immediate delivery of industrial quantities, at factory prices, contact your local Centralab Industrial Distributor. Ask for UK series.

D-6303

Centralab®

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
938A E. Keefe Avenue • Milwaukee 1, Wisconsin
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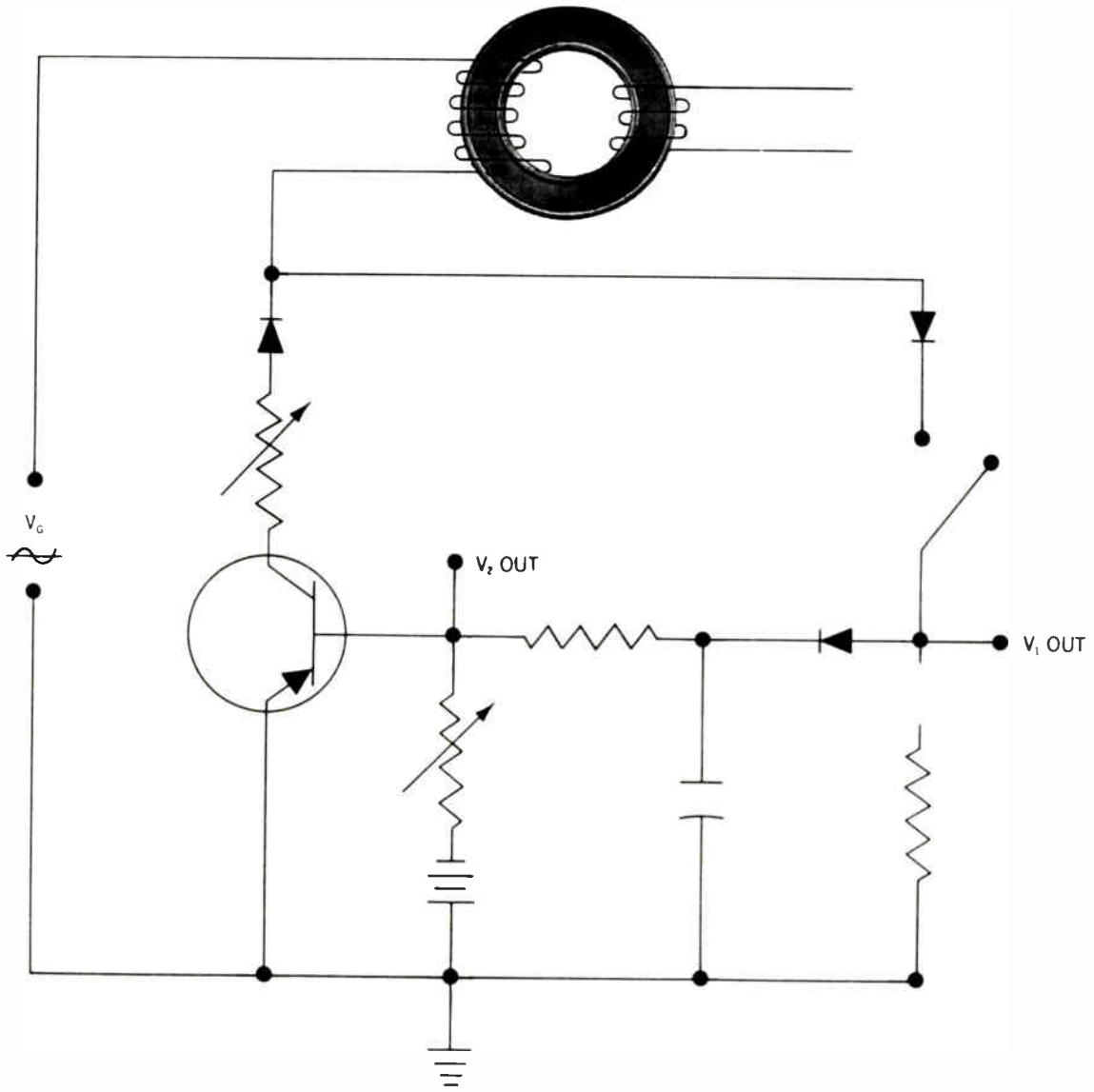


HOW TO GET 2 MINUTES TIME DELAY WITH 1% ACCURACY

HERE'S AN ADVANCED DESIGN that uses alternate positive and negative volt-second signals to pulse an Orthonol® core to produce time delays up to 2 minutes with 1% accuracy. Key to extreme accuracy in this bi-directional trigger technique: the nearly ideal rectangular loop characteristics of Magnetics Inc.'s Orthonol® that permit switching sharply from the unsaturated to the saturated state.

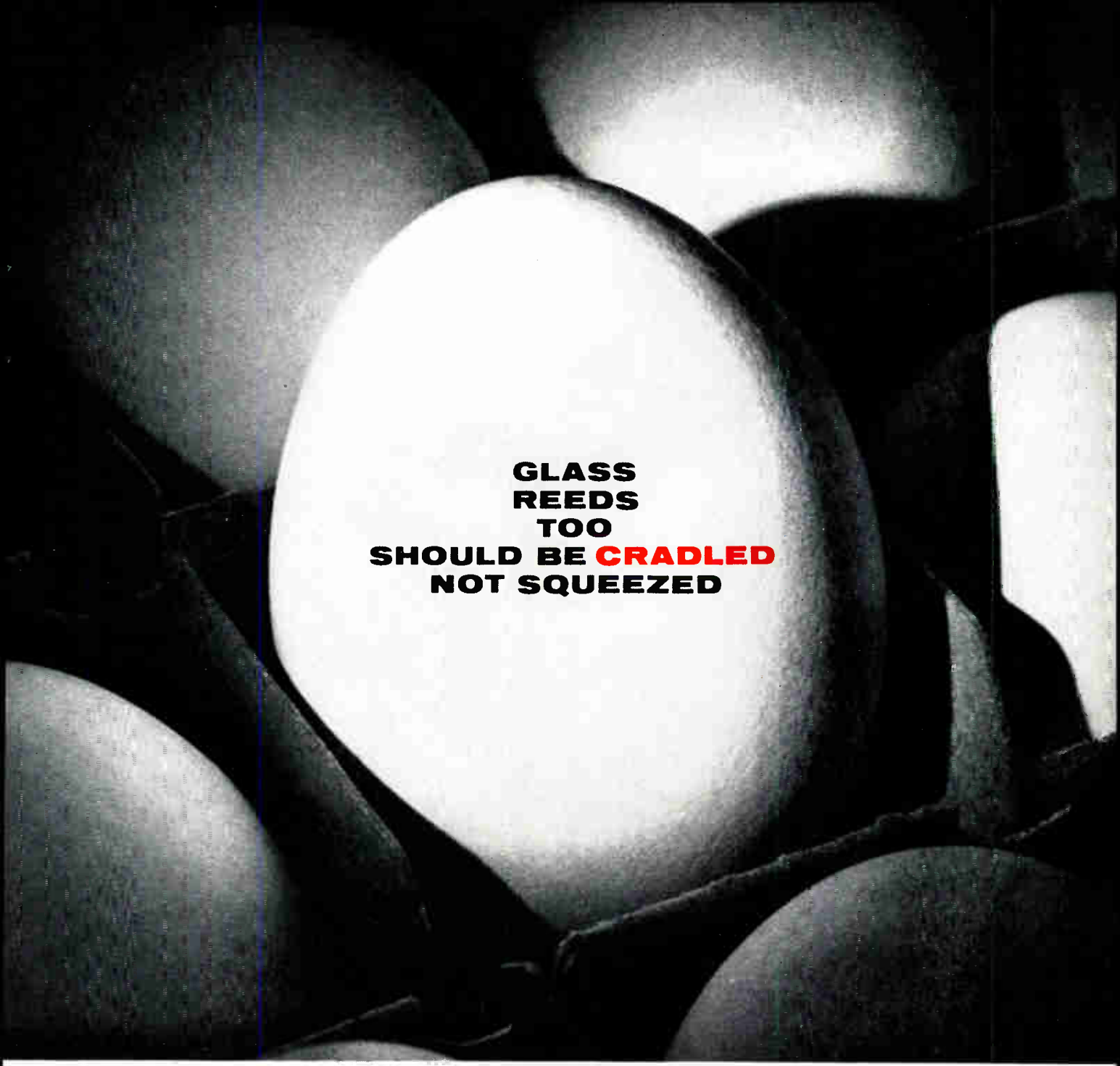
What makes the circuit superior to mechanical devices, commonly used r-c circuits or magnetic core circuits of the past? Just this. Trigger pulses can come from any constant frequency source. The circuit is symmetrical; hence, compensating for effects of variations in temperature, voltage and frequency.

And because the circuit features solid state devices, high reliability is assured.

Useful for electronic counters and timers where accuracy and reliability are paramount, the circuit can also be applied to converting low level analog signals to frequency signals. By using the storage capacity (volt-second capacity) of the Orthonol® core, high sensitivity for any desired frequency range can be achieved.

For specific information about this circuit and the Magnetics Inc. cores that make it possible, write to *Magnetics Inc., Dept. EI-1, Butler, Pa.*

MAGNETICS inc.®



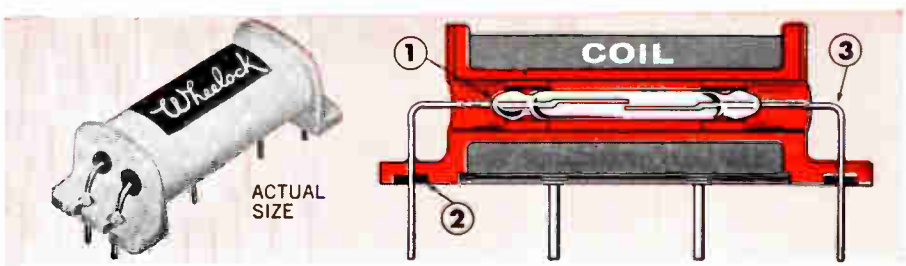
NO EPOXY POTS FOR REED RELAYS! In Wheelock Reed Relays, the glass reed switch is safely cradled and locked in the cavity of a *shock-absorbing, nylon frame.*

Wheelock does *not* encapsulate the glass reed in epoxy for this reason: When epoxy hardens, curing stresses are transmitted to the fragile reed switch, often changing its operating characteristics . . . sometimes fracturing the glass envelope! Other advantages offered by Wheelock?

Reed leads are pre-cut, pre-bent and pre-positioned at no extra charge. Why do this job in your plant and risk changing the electrical parameters by as much as 30%. Why risk breaking fragile reeds?

YOU specify the reed switch you want . . . the one with characteristics to match YOUR requirements.

Write for Catalog describing Wheelock Reed Relays — a complete line of 1 to 4 pole models. Wheelock Signals, Inc., 273 Branchport Ave., Long Branch, N. J.



(1) Reed safely cradled & locked — no epoxy — no curing stresses. (2) Leads firmly anchored by adhesive. (3) Leads pre-cut & pre-positioned.

Wheelock

LONG BRANCH, N. J.

DROPOUT PROTECTION

MINCOM SERIES CM-100 RECORDER / REPRODUCER

Data loss from dropouts is practically eliminated in the CM-100, due to this unique system's predetection recording capability. In ordinary post-recording, a dropout more than 6 db down is generally considered a data loss; the CM-100's operational predetection performance retains such signals through superior phase characteristics and extended bandwidth. **Mincom's CM-100 Recorder/Reproducer,** performing longitudinal recording with fixed heads up to 1.5 mc at 120 ips, also offers 7 or 14 tracks, trouble-free dynamic braking, complete modular plug-in assembly, built-in calibration, instant push-button selection of six speeds. Versatile, reliable, a model of simple maintenance and operation, the CM-100 is tops in its field. Write today for detailed specifications.

Mincom Division 3M COMPANY

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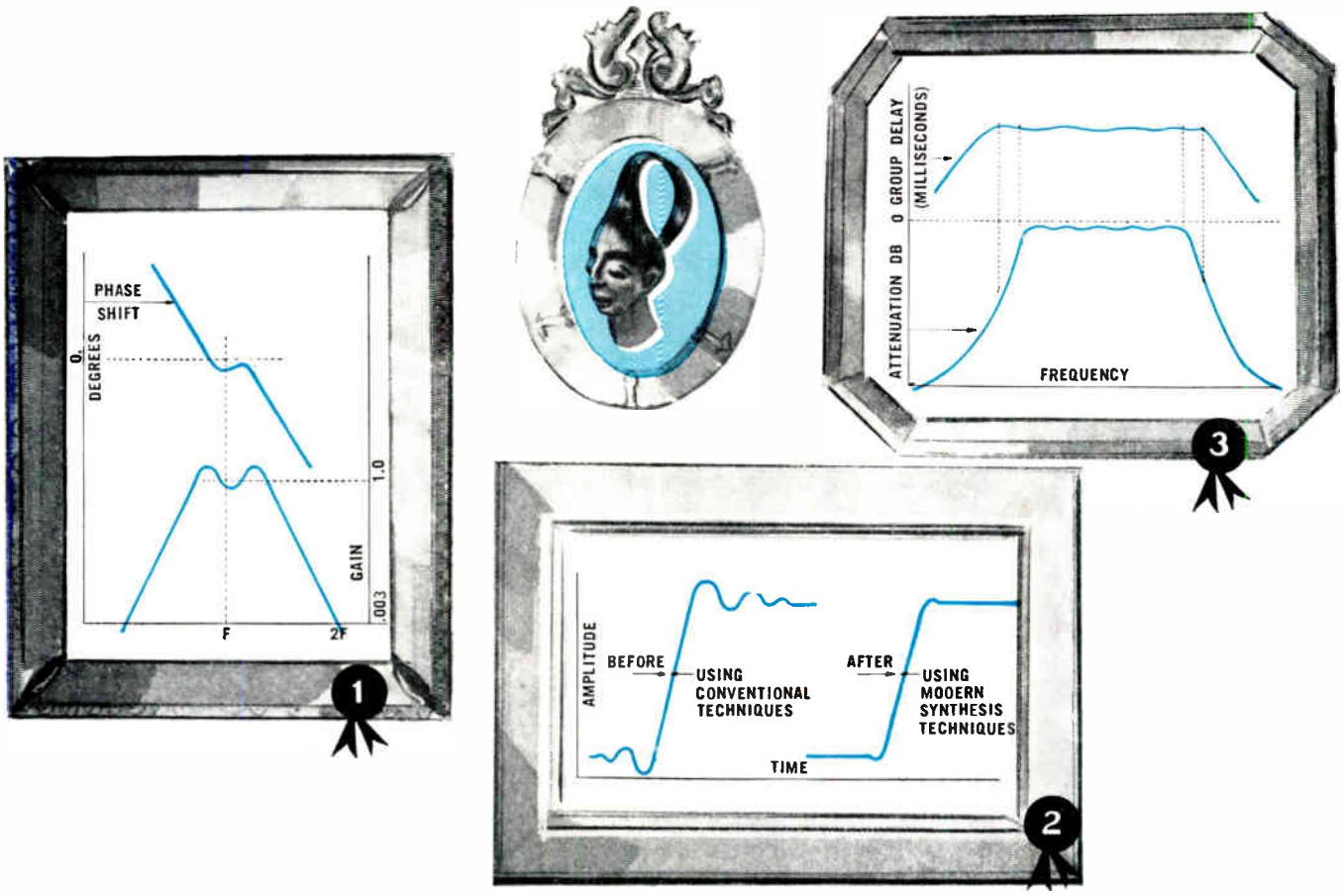

Burnell advances the state of the art with three new filter families

If you are concerned with new systems development, and would like to take advantage of advanced technology and the kind of sophistication that will improve transient response and eliminate obsolete circuitry . . . then here are three new filter families, that have advanced the state of the art, which you can immediately incorporate in your network designs – exclusive from Burnell. Call or write today for literature and technical assistance.

Burnell offers the most complete line of communications network components available to the electronics industry, with a versatility of experience unmatched in the production of filters, delay lines and toroids for interpretation of *complex signals*. Burnell will custom design filter networks to your specifications which may include special delay, attenuation, and transient response, involving precisely specified rise time, overshoot and ringing.

1

ZERO PHASE FILTERS

Impedance 1000 ohms/Grid 400 cps Center			
ATTENUATION & PHASE CHARACTERISTICS			
OP SERIES	OP400 L	OP400 M	OP400 H
Pass Band (3 DB)	±20 cps	±20 cps	±20 cps
Harmonic attenuation 2nd harmonic and all higher frequencies			50 DB
Harmonic attenuation (2nd)	>15 DB	>25 DB	
Harmonic attenuation (3rd)	>40 DB	>60 DB	
Max. phase ±20 cps	±1°	±1°	±1°
Max. phase ±30 cps			±5°
Phase shift at Center Frequency	0°±½°	0°±½°	0°±½°
Gain =	UNITY	UNITY	UNITY
60 cps equivalent filters are also available having a pass band of ±5% with phase of ±1°.			

For the Servo Engineer . . .
By specifying Burnell's new line of Zero Phase Shift networks, it is possible to recover, without phase shift, the fundamental frequency from any periodic wave form without using complex squaring circuitry. This advancement in the state of the art is accomplished by combining zero phase shift in the vicinity of the center frequency — with high attenuation in the stop bands.

2

LOW PASS FILTERS WITHOUT DISTORTION

This family of filters is designed with modern synthesis techniques to have specified transient characteristics such as fast rise time, low overshoot and ringing.

60/3 DB Shape Factor	Ringing (over/undershoot)
2:1	<5%
3:1	<2%
4:1	<1%

3

This is part of a family of constant delay band pass filters of unusual characteristics, for example:

1—Group delay is constant well into the stop band!

2—Matched delay—as an example of delay matched band pass filters, we have produced a set of four filters having the same band widths of 500 cycles at 1½ DB with center frequencies ranging from 680 cycles to 2720 cycles; having a 20 DB band width of 710 cycles with group delay constancy of ±3½% over the pass band and between channels.

3—Constant flat delay band pass filter.

Frequency	Attenuation
5210 cps to 8336 cps	< .5 DB
1,000 cycles & below	>20 DB
10,000 cycles & higher	>20 DB
Delay: Group delay constant ±1% from 3,500 cps to 9,900 cps.	

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EXECUTIVE OFFICE AND PLANT
DEPT. EI-31
PELHAM, NEW YORK
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TELETYPE PELHAM 3633

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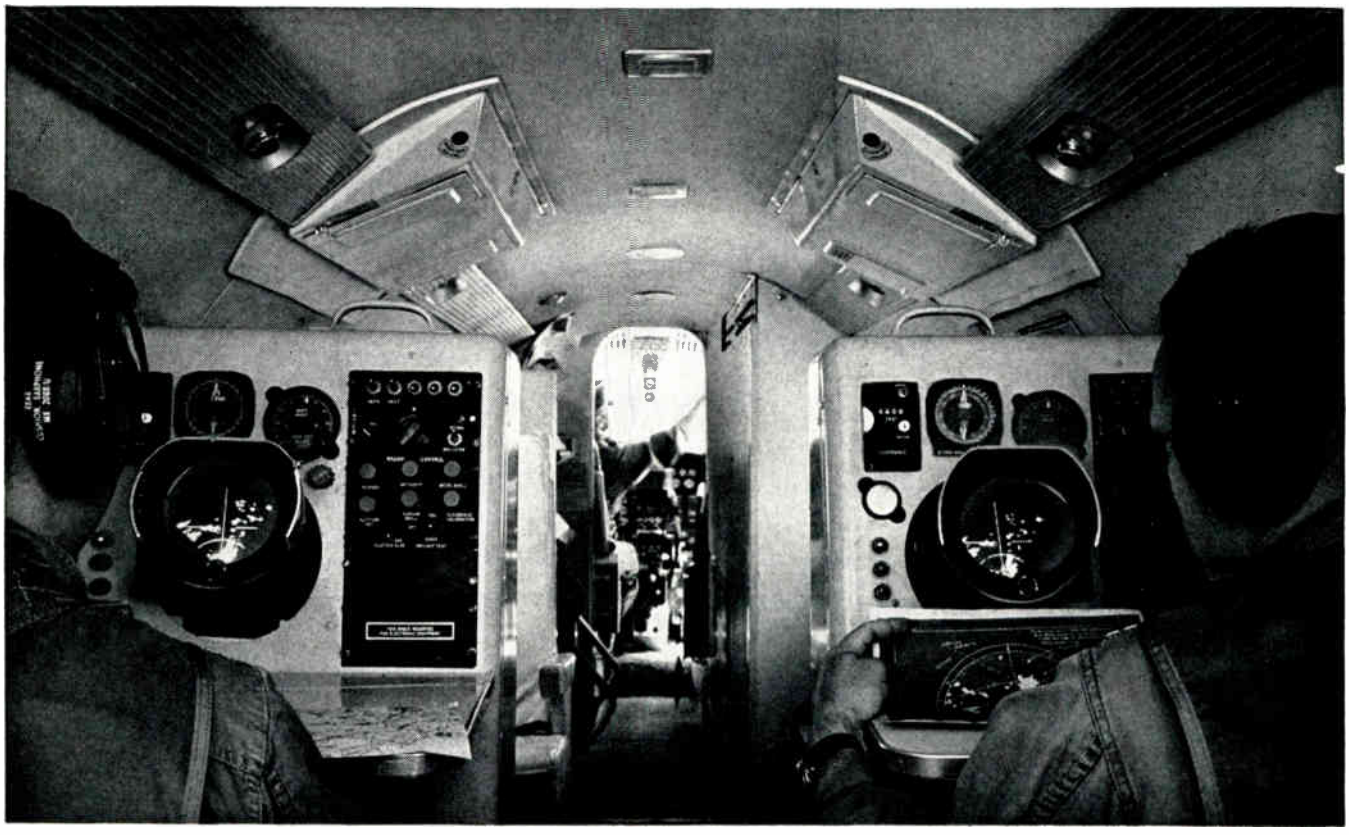
SUBSIDIARIES: Gray & Kuhn, Inc., Pelham, New York • GLP Electronics, Inc., Bristol, Conn.

TODAY'S PILOTS SEE FROM TAKEOFF TO TOUCHDOWN WITH HUGHES TONOTRON TUBES



Fighter-bomber pilots rely on Hughes Tonotron* direct-view storage tubes to get them to the target and back. Instant information is provided continuously for pilot use by AUTONETICS' R-14 NASARR monopulse radar system.

Cockpit presentation of radar data is made on the Hughes family of H-1010 Tonotron tubes in an easy-to-read, visual display.

Hughes Tonotron tubes prove ideal for optimum, high-resolution display of radar information. These rugged and reliable storage tubes have a built-in brightness which makes reading easy even under difficult light conditions. And their controllable persistence permits storage of half-tone displays for extended periods, or instantaneous erasure, if desired.

Product of over 10 years' experience in storage tube design and development, today's Hughes Tonotron tubes are a result of the complete integration of capabilities from research through manufacturing —our guarantee of your satisfaction.

Need help on your display problems? Call, wire or write today: HUGHES STORAGE TUBES, 2020 Short St., Oceanside, Calif., Area 714, SAratoga 2-2101.

For export information, write: Hughes International, Culver City, California.

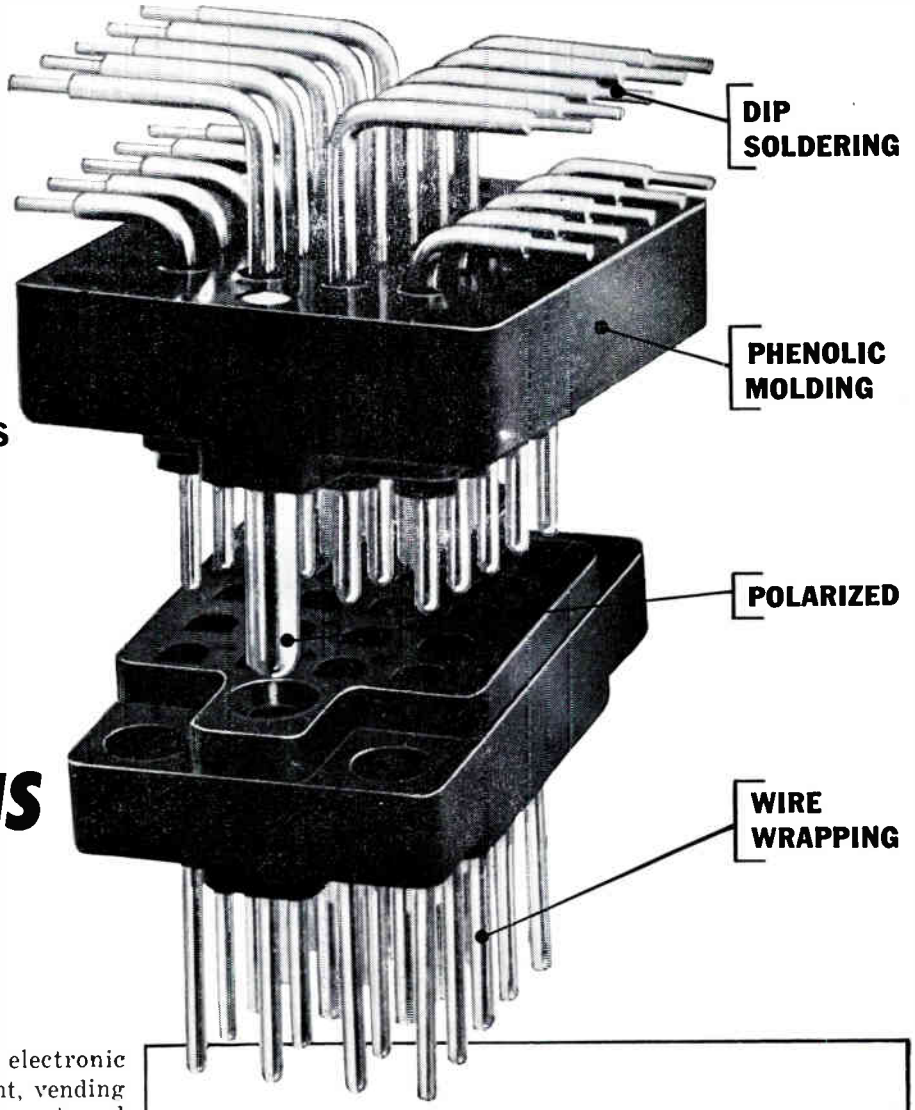
Century-series pilots train aboard T-39B in using R-14 NASARR. Radar modes include: ground-mapping, contour-mapping, terrain avoidance, air-to-ground, air-to-air search, attack.

Creating a new world with Electronics

HUGHES

HUGHES AIRCRAFT COMPANY
VACUUM TUBE PRODUCTS DIVISION

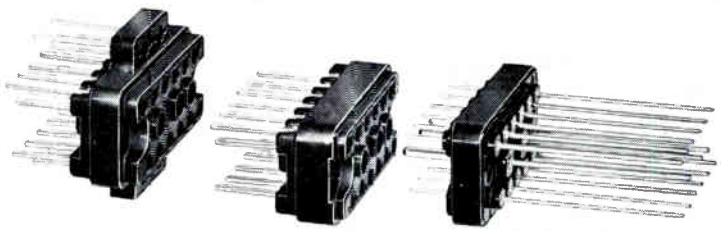
*Trademark Hughes Aircraft Company



new
PLUG & SOCKET CONNECTORS

•LOW COST
•BUILT-IN RELIABILITY
•UNLIMITED APPLICATIONS

...provide compact packaging of electronic circuitry in communication equipment, vending machines, data processing, test equipment, and other automated applications. Maximum concentration of contacts provided in minimum space. If you're designing around printed circuits or require a low cost yet reliable connector, then CONTINENTAL's new plug and socket units are ideally suited to your needs. For additional technical data or application to your requirements write Sales Department, Continental Connector Corporation, 34-63 56th Street, Woodside 77, New York or phone (212) TW 9-4422.



OTHER CONFIGURATIONS AND CONTACT ARRANGEMENTS

MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK

this is the Brush Mark II...

anyone can plug it in

put it in writing anywhere

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Ink or electric writing models. Immediate shipment from stock.

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ELECTRONIC INDUSTRIES

Coming Next Month

OSCILLATOR FREQUENCY CONTROL BY LOGIC SWITCHING

Many electronic system designs must use circuits with an input of any of several oscillation frequencies, and in which the frequency change can be automatically initiated by a control signal. However, the ability to change frequencies usually requires large amounts of circuitry. This article proposes a simple method of automatically doing the job. It makes use of a logic control to actuate three logic switches that determine the output frequency. The logic control may be any device such as a relay, a gate circuit, or a tape-controlled stimulus. The three logic blocks, which may be any logical switch, permit the desired frequency elements in the loop to be selected.

DESIGNING A VARIABLE FREQUENCY MULTIVIBRATOR

An astable multivibrator is a constant frequency square wave oscillator which can be used to operate pulse sensitive circuits such as digital counters. It can also be used simply as a square wave oscillator. In most applications, the astable multivibrator is run at a frequency greater than 100 CPS and probably greater than 1 KC. This article describes the design and operation of a circuit for a 6 to 100 CPS variable frequency astable multivibrator whose frequency and waveshape are stable over wide temperature and voltage ranges.

CONSTRUCTING BROADBAND R-F SWITCHES

By using ordinary computer type diodes, it is possible to build broadband, r-f switches that can be turned on and off in a few nanoseconds, operating at frequencies up to and above a few thousand megacycles. This article presents the design considerations to do it. Below 2 GC, it is possible to achieve near ideal "switch like" characteristics, i.e., less than 0.5 db insertion loss in the "closed" position, and as much as 90 db isolation in the "open" position. Above the 1 to 2 GC range, insertion loss of 1 to 2 db and isolation of 30 to 40 db are typical. Switching speed depends, of course, on driver circuitry. However, the inherent switching speed, limited by the switch itself, is about 10 nsec. Bandwidth of the switches over which these characteristics may be maintained is typically an octave or more.

THE SOLID-STATE CIRCUITS CONFERENCE

Broad advances in the field of solid-state device applications and circuits will be covered in 53 papers by over 90 specialists from here and abroad at this highly-regarded conference. As a special feature, we will highlight the papers which will be presented at each session. The general subject areas include digital memories, logic, low-frequency circuits, microwave circuits, digital design techniques, linear circuits, integrated circuits, and opto-electronics. At the conference, invited and tutorial speakers will cover high-frequency generation and amplification, transistor switching circuits, and solid-state sensing.

PLUS ALL OTHER REGULAR DEPARTMENTS

Our regular editorial departments are designed to provide readers with an up-to-the-minute summary of world wide important electronic events. Don't miss Radarscope, As We Go To Press, Electronic Shorts, Coming Events, late Marketing Statistics, Snapshots of the Electronic Industries, EI International, News Briefs, Tele-Tips, Books, Representatives News, New Products, Industry News, Personals, Systems and Circuits, etc.

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IEEE Show	Annual All-Reference Issue	WESCON Show Issue

The magnetron is not the most modern power generator. Yet, it plays a vital role in microwave electronics because it continues to be the smallest, most efficient, and most powerful oscillator available. It is also usually the least expensive.

COAXIAL MAGNETRONS A NEW CLASS OF TUBES

MAGNETRON DESIGN ADVANCES have dealt more with technology than with new principles. This is a credit to its original concept. Increasing demands, however, for higher power at higher frequencies, for more frequency stability, and for more flexible tuning systems have been difficult to satisfy. Magnetron technology has been heavily taxed to meet these requirements.

Until the development of the coaxial magnetron[1] a few years ago, it appeared that the margin between magnetron capability and system requirements would vanish entirely. The margin has been increased by the coaxial magnetron, however; and, design limitations are now found to be in other system components. Although some have forecast its doom for more than five years, the magnetron not only remains with us —it is a part of our most modern weapons systems.

The Mode Problem

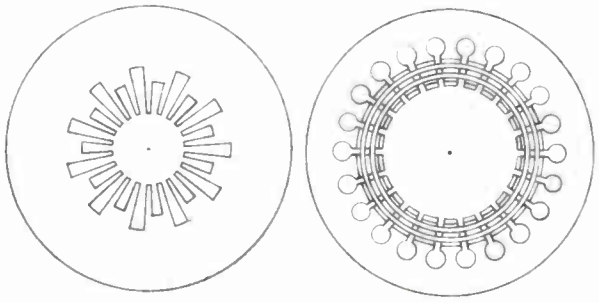
Attempts to realize higher power and higher frequency with a magnetron have been thwarted by the small physical size of its internal structure. The anode area becomes too small for the dissipation required—the cathode, too small for emission required. Increases in the size of the structure have been limited by the lack of adequate mode control. The plurality of modes or resonances which a magnetron anode can support has long been a dominant problem.

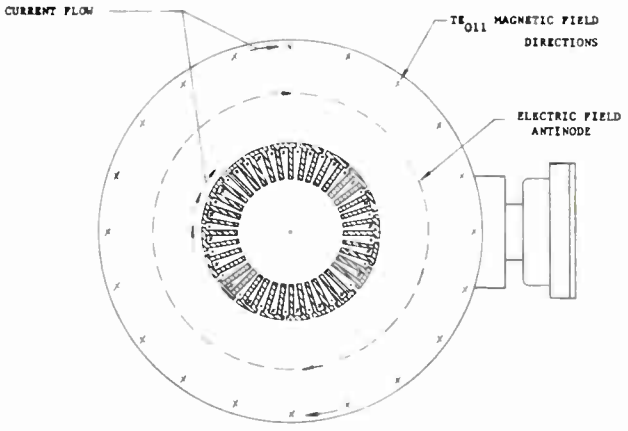
The magnetron anode consists of a number of resonators disposed in a circle around the cathode. The use of larger numbers of resonators will enlarge the structure because these, being fixed in size by the frequency, will determine the anode diameter and therefore the amount of anode and cathode area.[2] Mode control becomes more difficult as the number of resonators is increased. The two most common methods of mode control have been the use of strapped anodes and rising-sun anodes, Fig. 1.

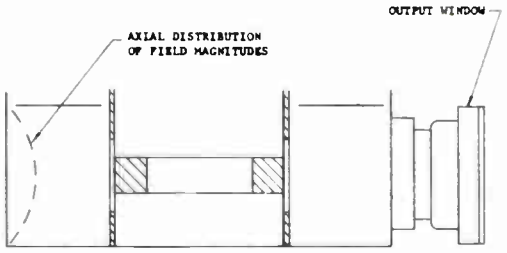
The object of these designs is to ensure that oscillation takes place in the π-mode. This requires that the r-f electric field across the vane tips of any resonator is exactly out of phase with that on the ad-

Fig. 2 (right): In the coaxial magnetron, alternate resonators are slot-coupled to stabilizing cavity which surrounds anode.

Fig. 1 (below): The rising-sun anode, left, and the strapped anode, right, are the most common methods of mode control.







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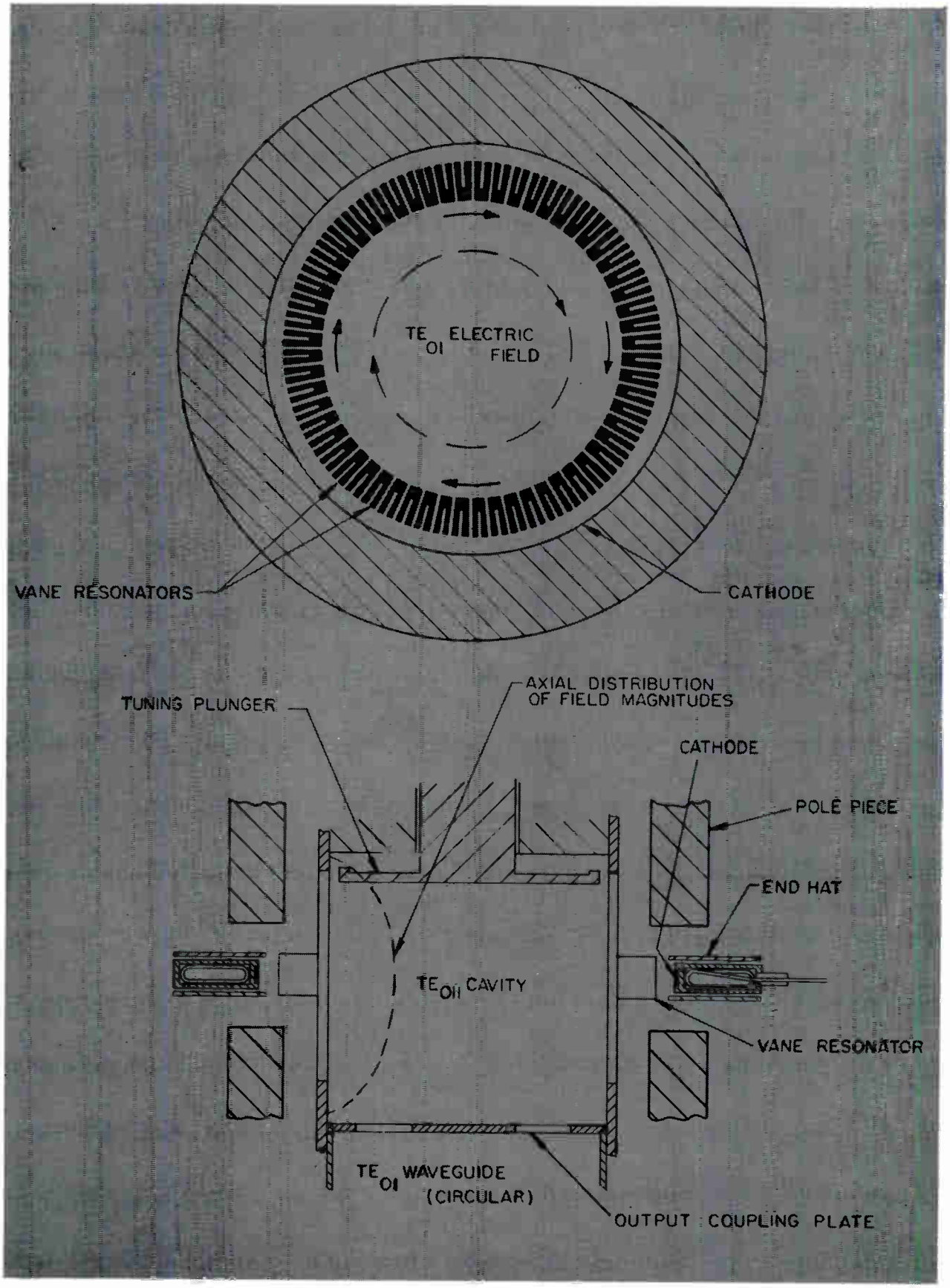


Fig. 3: The inverted coaxial magnetron was developed to extend the power and frequency range using the same basic mode control principle as the tube in Fig. 2. Here, the coaxial magnetron is literally inverted to give structure shown.

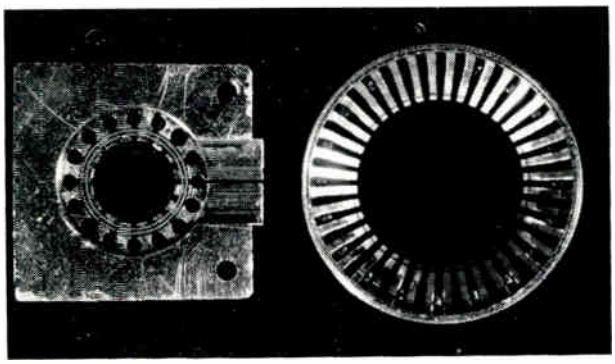


Fig. 4: Comparison of strapped and coaxial magnetron anodes. Note that these anodes are for use at the same frequency.

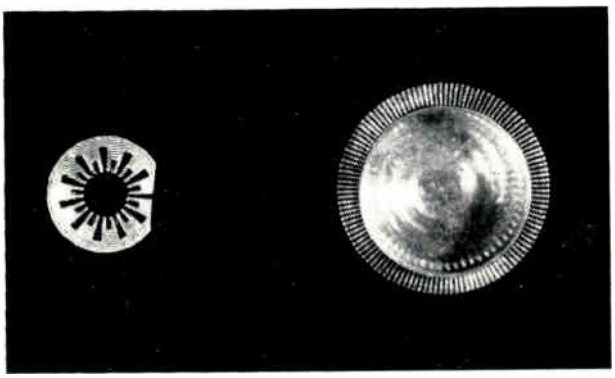
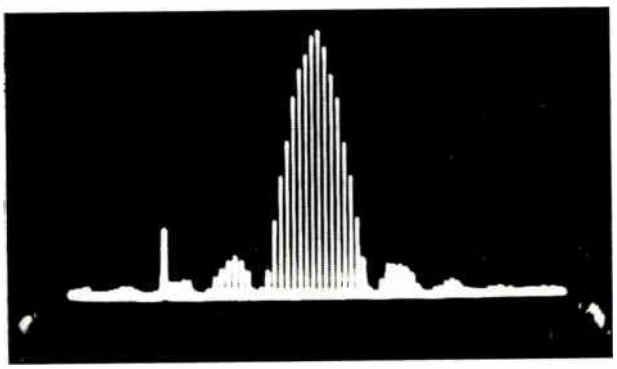
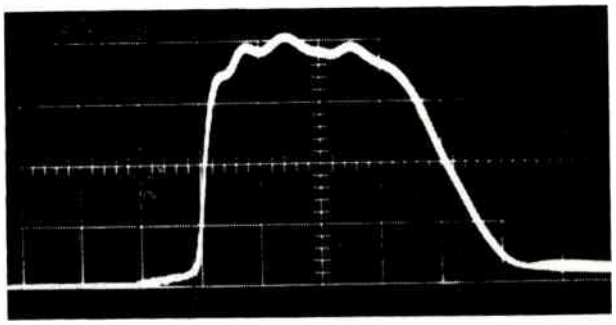


Fig. 5: Rising-sun and inverted coaxial magnetron anodes. Note that these anodes are for use at the same frequency.

COAXIAL MAGNETRON (Continued)

Fig. 6: The top picture is the spectrum of a coaxial magnetron; bottom is the current pulse which generated spectrum.





jacent resonators. When this condition is met, there are π-radians of phase shift per resonator, hence the mode name. For an anode of N resonators, a total of $N/2$ r-f cycles of phase shift results around the anode circuit. Competing modes would have $(N/2)$-1, $(N/2)$-2, etc. r-f cycles of phase shift around the circuit, and when excited they result in oscillations at different, and lower, frequencies.

Mode suppression techniques upset the anode symmetry required to support the competing modes but in a manner having the least disturbing effect on the π-mode. Strapped and rising-sun anodes do this as follows. Straps connect alternate vane tips and pair off the resonators in a pattern that repeats itself $N/2$ times around the circuit. The rising-sun anode has large and small resonators which also form a pattern repeating itself $N/2$ times around the anode. The symmetry is therefore favorable for the π-mode, but unsuited to other modes. When N becomes large enough, however, the small difference between $(N/2)$ and $(N/2)$-1 makes the mode selection process marginal, and moding ensues.

The Coaxial Magnetron

The coaxial magnetron has neither straps nor large and small resonators, Fig. 2. Alternate resonators are slot-coupled to a stabilizing cavity which surrounds the anode. This forms an $N/2$ cycle pattern around the anode. The cavity is dimensioned so that it supports the TE_{011} mode at the desired frequency. The importance of the TE_{011} mode in coaxial magnetrons warrants further comment on its properties.[3]

1. Electric field lines are circular, and close on themselves.
2. The r-f currents in the cavity walls are purely circumferential and have no axial components.
3. The r-f current at every point on a circumference circle has the same phase.
4. The attenuation or loss of this mode is lower than for all others.

The mode is also interesting because it has no counterpart in rectangular geometries.

In the mode control process, r-f current on the inner wall of the stabilizing cavity flows into the slots of alternate resonators with the same phase. Since the impedance of the resonator at the slot, its normally shorted end, is low, there is a good match between resonator and stabilizing cavity. This current establishes a 2π radian phase shift between alternate resonators. Adjacent resonators, because of mutual flux linkage with the slotted resonators, are strongly coupled 180° out of phase. This results in

a π-mode field distribution. For competing modes $(N/2)$-1, $(N/2)$-2, etc., to be excited on the anode, modes other than TE_{011} have to be excited in the stabilizing cavity.

Modes other than TE_{011} can be supported in the stabilizing cavity because it is not the dominant mode. These can be suppressed with relatively little difficulty because of the differences between the properties of TE_{011} and all other modes. For example, the TE_{011} mode is the only one which does not require current to flow across the corners of the cavity. The cavity wall can be broken at this point with no effect on the TE_{011} mode but with strong damping effects on the other modes.

This type of mode control is so effective that coaxial magnetrons can be made with larger numbers of resonators than have previously been used successfully. This has raised their power capability. Perhaps more significant, however, are the other properties which the stabilizing cavity imparts to the coaxial magnetron. Because straps or two different resonator sizes are no longer needed, the resonator can be designed for optimum efficiency rather than compromising between efficiency and mode control. The stabilizing cavity changes the energy storage distribution in the magnetron so that only 10% or so of the total stored energy is in the resonators, the bulk of it being in the cavity. Because of the large volume and low loss of the cavity, the unloaded Q's are increased by an order of magnitude. Circuit efficiency is also increased, although the addition of cavity losses to resonator losses would seem to contradict this. The elimination of straps, however, reduces resonator loss sufficiently to more than compensate for the cavity losses added. Further, the optimum resonator design which yields maximum electronic efficiency corresponds to reduced r-f electric field strengths for a given power level. This design cannot be used in conventional unstabilized magnetrons because of frequency stability problems. Its selection here contributes to the high over-all efficiency of the coaxial magnetron.

The Inverted Coaxial Magnetron

As one proceeds to higher frequencies, the coaxial magnetron structure will also become smaller and its size will be a limiting factor although only at power levels higher than could be realized with conventional magnetrons. In a contract program[4], the inverted coaxial magnetron was developed to extend the power and frequency range using the same basic mode control principle. In this design, the coaxial magnetron is inverted to give the structure shown, Fig. 3.

The stabilizing cavity is in the structure center enclosed by the anode, whose resonator vanes point outward instead of inward. The cathode surrounds the anode. Alternate resonators are slot-coupled to the cavity as in the standard coaxial magnetron. The operation and performance of the inverted magnetron are essentially the same, with one exception—the method of coupling the output power. In the standard coaxial magnetron, power is coupled via a slot in the outer wall of the cavity and is fed through an appropriate impedance transformer to standard rectangular waveguide. Power is coupled out of the inverted magnetron through one of the cavity end walls and is fed axially into circular waveguide which, as an extension of the cavity, is driven in the TE_{01} transmission mode.

Power

The large number of resonators possible with coaxial magnetrons has increased the anode and cathode areas so that higher power is possible without exceeding the specific anode dissipation and cathode emission current densities compatible with long life. A coaxial magnetron rated for 1.5 megawatts peak, 1000 watts average at 9.375 GC, has delivered 2.0 megawatts in the laboratory. This is reasonable to expect. Fig. 4 shows a typical 16 resonator strapped X-band anode and an X-band coaxial magnetron anode with 40 resonators. Of particular significance is the space available for the cathode. The strapped anode is normally rated at 250 kw and operates at about 30 kv and 30 a. The coaxial anode operates at 33 kv and 83 a.

The disparity in size is more striking between a 22 vane rising-sun anode for 35 GC and a 120 vane inverted coaxial magnetron anode for the same frequency, Fig. 5. The coaxial anode is from a coaxial magnetron, rated at 100 kw peak, 50 w average. The cathode used with the inverted coaxial magnetron is enormous by comparison, and operates at a lower emission current density than conventional magnetrons of comparable power at X-band. An inverted magnetron has generated 300 kw at 35 GC.

Table 1

Power Output Potential of Inverted Coaxial Magnetrons

Frequency Band	Power Output Peak	Average	Voltage	Efficiency
C-band	5 megw	5 kw	35 kv	55%
X-band	3.5 megw	3.5 kw	33 kv	50%
Ku-band	500 kw	500 w	25 kv	40%
Ka-band	200 kw	100 w	23 kv	30%
70 GC	60 kw	20 w	15 kv	15%

COAXIAL MAGNETRON (Continued)

Efficiency

The best resonator design and the higher circuit efficiency possible with the coaxial magnetron increase the overall efficiency considerably. Table 1 shows typical efficiencies which can be expected at various frequencies. By comparison, the typical efficiency of X-band magnetrons ranges between 30 and 40%, while coaxial magnetrons at X-band range between 45 and 55%. The higher efficiency adds, of course, to the power potential of these tubes by reducing the dissipation and emission required for a given power output. The high efficiency is not realized at the expense of pulling figure, which is possible in conventional magnetrons by overcoupling them to the load.

Life

Direct comparison of the life of coaxial and conventional magnetrons is difficult because specifications requirements usually are different for the two. Broadly speaking, for the same operating requirements, the coaxial magnetron can have anywhere from 2 to more than 5 times the life of conventional magnetrons. At very high power levels, where conventional magnetrons are marginal, comparisons are less meaningful.

Field life data for the units operating at 100 kw peak, 25 w average at 35 GC after 5600 hours of r-f operating time with one failure, show a mean time between failures of 1860 hours with a 90% confidence level.

Data on magnetrons, operating at 1 megw peak, 900 w average at X-band, show no failures yet, but the maximum field operatinge time reported is only between 600 and 1000 hours.

Pulling Figure

The pulling figure, or variation of frequency with load mismatch, of coaxial magnetrons is lower by a factor of 3 to 5 than that of conventional magnetrons. The reason lies in the very high unloaded Q, or Q_o, provided by the stabilizing cavity. This can be seen in the following exercise. If the coaxial magnetron were only required to have the same circuit efficiency as a conventional magnetron, the formula for circuit efficiency,

$$\eta C = \frac{1}{1 + \frac{Q_e}{Q_o}}$$

shows that the ratio Q_e/Q_o (where Q_e is the coupling or external Q) would have to remain the same. By having a Q_o 10 times higher in the coaxial magnetron the Q_e can be made 10 times higher. From the expression,

$$PF = \frac{kf}{Q_e}$$

the pulling figure is reduced by a factor 10. The circuit efficiency is normally made much higher in coaxial magnetrons so that the decrease of pulling figure is somewhat less. Lower pulling figures either result in a more stable system or, for a given stability, permit the system designer much more latitude in the choice or components for the antenna and transmission line. Typical pulling figures at X-band are 3 to 5 MC compared with 10 to 15 MC for conventional magnetrons.

Pushing Figure

The pushing figure is lower by an order of magnitude in coaxial magnetrons. Pushing, which is the variation of frequency with anode current, results from susceptance which the electron stream presents across the resonator. In conventional magnetrons, this is a very noticeable effect because the resonators are the frequency-determining elements in the magnetron. In coaxial magnetrons, their role has been transferred to the stabilizing cavity which becomes the frequency-determining element since it stores 90% of the total energy stored. The electronic susceptance has little effect therefore on the operating frequency. Typical X-band pushing figures are less than 20 KC per amp compared with some hundreds of KC per amp for ordinary magnetrons.

The benefits of a lower pushing figure are important. Spectrum quality, that is, the spectrum bandwidth and side lobe ratio, is determined by the combination of pushing figure and the current pulse shape (disregarding other spectrum aberrations such as missing pulses, etc.). The normal desire to have the current pulse as rectangular as possible has been dictated by frequency pushing. Pushing can sometimes occur when there is ripple on the top of the pulse, but it always occurs on the leading and trailing edges of the pulse as the current rises to and falls from the operating current level. The edges of the pulse are thus periods during which energy is being delivered to the load at the wrong frequencies. This tends to smear the spectrum in a variety of ways. The flatness of the pulse top is often less significant because the pushing figure, which is usually not constant over the current range, can be made very small at the operating current level, during the tube design.

Pushing effects are more troublesome at long rather than short pulse lengths because of the width

of the spectrum, which varies inversely as the pulse length. Pushing during a 0.05 μsec pulse may not result in spectrum distortion because the spectrum main lobe is about 40 MC wide. During a 2 μsec pulse, however, where the main lobe may be less than 1 μsec wide, the pushing effect can have a pronounced effect on spectrum shapes.

Coaxial magnetrons, therefore, yield extremely good spectra with a minimum of care in pulse shaping. Fig. 6, shows the spectrum and current pulse for an SFD-303 operating at 1.1 megw peak power at 9.375 GC. The marker amplitude is 10 db below the top of the main lobe. Bandwidth here is 0.7 MC and the side lobe ratio is 14 db. Excellent symmetry is preserved in spite of the long fall time of the trailing edge of the pulse.

Weight

A high power, pulsed, coaxial magnetron is always lighter than conventional magnetrons for a given power and life. For a given anode area, the larger anode diameter permits a smaller anode height and the magnetic gap can be reduced. The larger diameter pole pieces with a small pole-piece separation form a more efficient magnetic circuit in which leakage factors are sharply reduced. Smaller magnets and smaller weight result.

Because of its high power capability, the inverted coaxial magnetron is generally heavier than the lower power conventional tubes in the same frequency band. Comparisons in weight between this structure and conventional magnetrons is difficult because no conventional magnetrons have the same power capability. As an example, however, a standard ICEM coaxial magnetron capable of more than 100 kw peak at Ka-band would weigh about 20 pounds. Recent developments will permit the reduction of this weight considerably. A 50 kw Ka-band magnetron in design now is expected to weigh 7 pounds.

Weight and life have to be considered together. A tube can generally be made smaller by designing it with higher dissipation densities. This in turn will reduce life. The weights which have been considered here are compatible with lifetimes in excess of 1000 hours.

References

1. Feinstein, J. and Collier, R. J., "A Magnetron Controlled by a Symmetrically-coupled TE011 Mode Cavity"; *La Vide*, No. 70 July-August 1957.

2. For another approach to the problem, see: Okress, E., *Crossed-Field Microwave Devices*, Academic Press, New York (1961). Vol. II, Section 5.3 "Long Anode Magnetrons" by H. A. H. Boot, pps. 261-274.

3. See for example, Southworth, G. C., *Principles and Applications of Waveguide Transmission*, D. Van Nostrand Co., Inc., New York (1950), pps. 119 ff.

4. Sponsored by the Electronic Technology Laboratory, Wright Air Development Division under Air Force Contract No. AF 33(616)-7130.

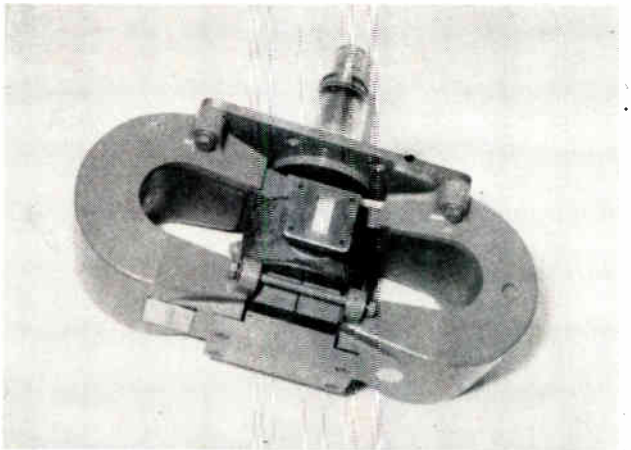


Fig. 7: This is the SFD - 303A; a 1.5 megawatt, X - band, coaxial magnetron. Pulse widths to over 2 microseconds can be used.

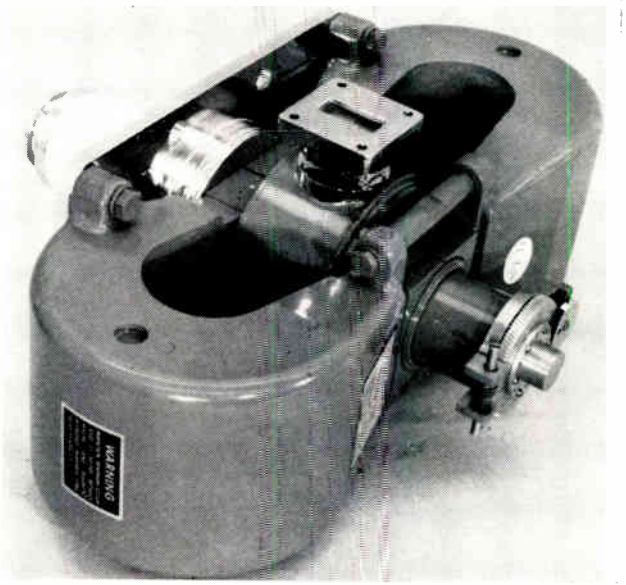
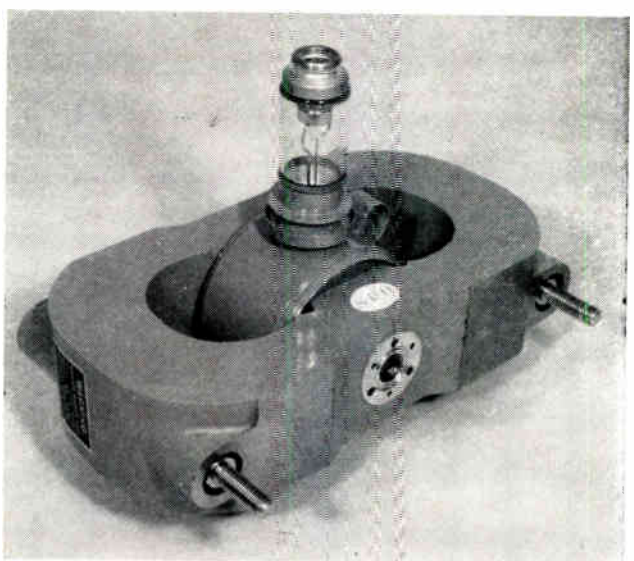


Fig. 8 (above): This coaxial magnetron, the SFD - 312, is easily tunable at 1 megawatt peak from 8.5 to 9.4 gigacycles.

Fig. 9 (below): The SFD - 301 is a fixed frequency Ka - band ICEM coaxial magnetron. Tunable versions are also available.



Reliable and fast global communications are receiving more and more attention. A variety of skills are required for their design, not the least of which are complex mathematical techniques. Some of these concepts are examined and illustrated.

HIGH-SPEED DIGITAL COMMUNICATION NETWORKS

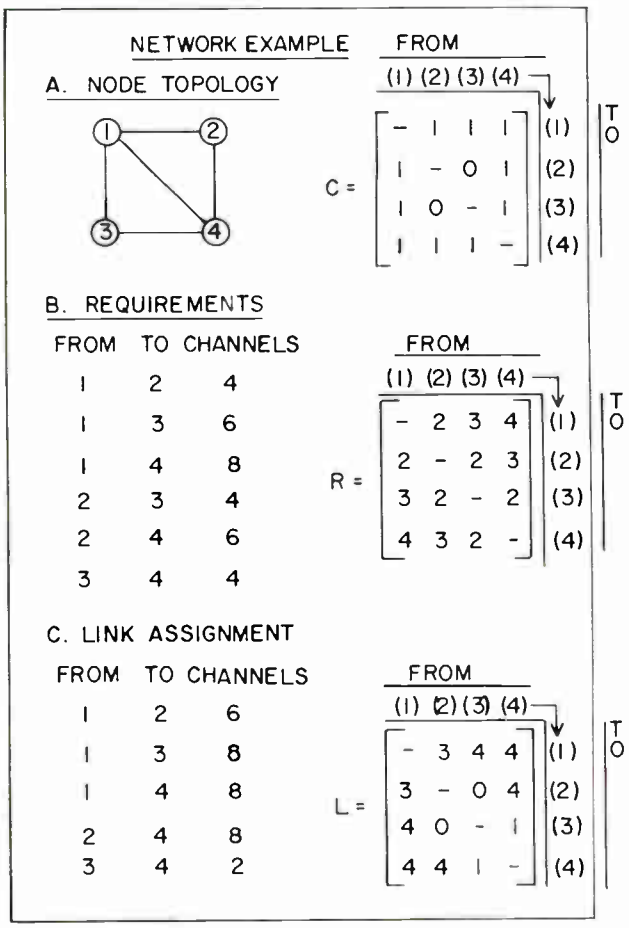
A DIGITAL DATA TRANSMISSION SYSTEM is a highly engineered electronic system. It consists of subsystems and components through whose interaction the system becomes an operating communication network.

System components may be subdivided into three classes of functional elements. The first class includes message processors located at major switching or communications centers. The processors are of the magnitude of large-scale digital computers; they can be mobile or fixed plant installations. These computers process messages arriving at, or leaving from, a communications center. The data processing computers must be connected to the outside world. This connection is accomplished by devices which have been given the generic term "embolic equipment." They serve the "interface" function of bringing data and messages into and out of the computer; of translating or changing codes; of "encrypting" and "decrypting"; and of other functions which must be performed at the interface between computer and the human user.

A second function performed at the communications centers involves message and data switching for the purpose of establishing circuits. Messages and data are routed from a source to a sink, from a message injection point to its destination. Switching in a large system is an automatic function not one needing slow human operators. In this article, we shall deal with networks designed to do message or circuit switching. However, we should mention at least two other types of systems: point-to-point and store-and-forward. All of these systems have common problems, some of which we try to illuminate here.

The third functional element is the transmission device. Usual media over which such devices operate are metallic cables or the electromagnetic ether. A variety of means may be used to effect propagation of messages. Modulation methods, time division, and/or frequency division multiplexing, are some of these.

Fig. 1. The problem of finding link transmission capacities from given node topology and traffic requirements is illustrated.



System Analysis

A major job faced is the description of an existing systems function. Its characteristics or performance parameters, such as percentage lost calls (messages), may be the object of such an analysis.

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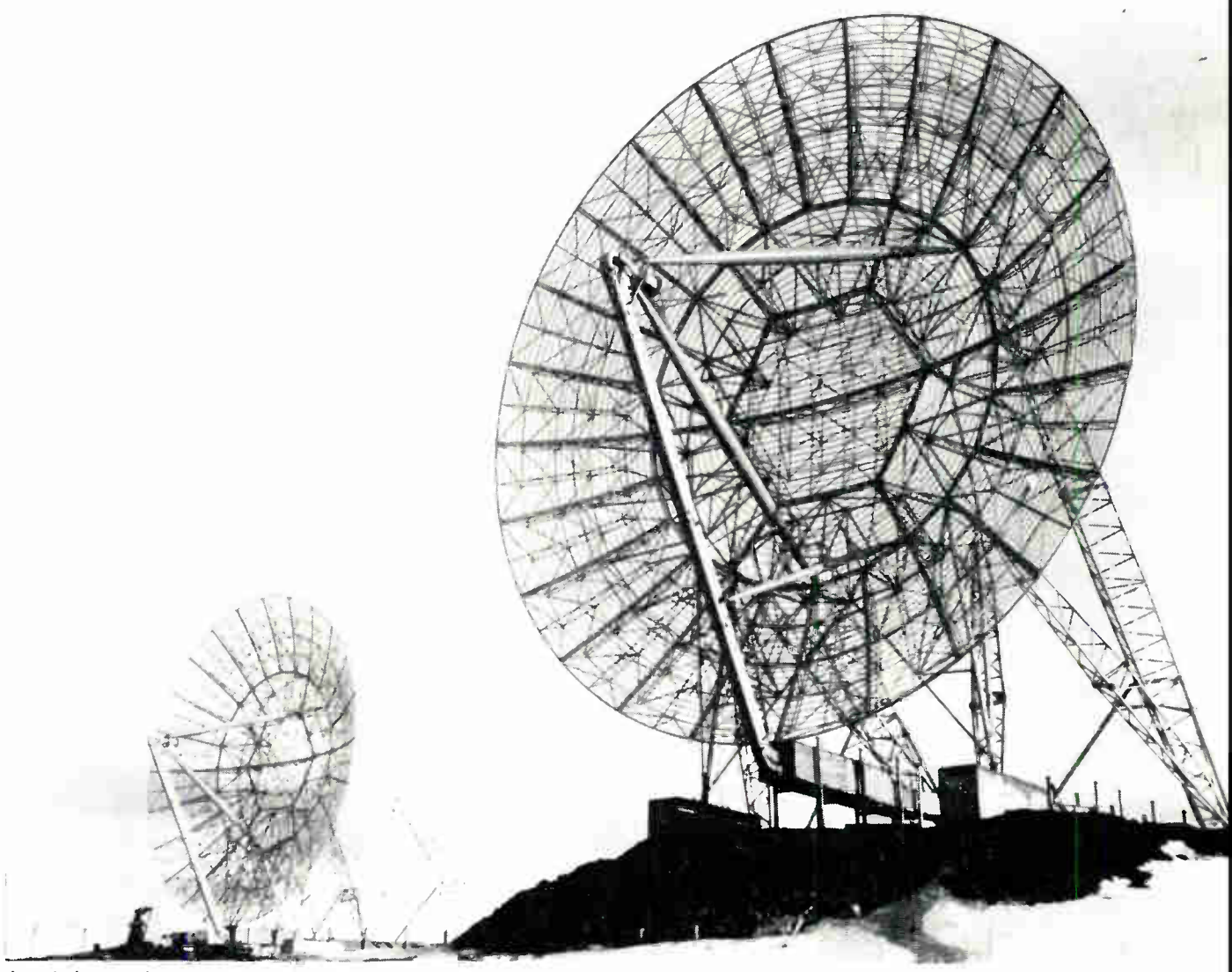


A typical tropospheric scatter antenna diversity configuration.

The first elements under scrutiny in a system are the links connecting its nodes. Each link can be said to possess a certain transmission capacity. A closer look at the performance of a link may establish that it is not always available. It may only be "on the air" eight hours each day, or it may be operative less than 24 hours per day. This is due to electromagnetic effects, or (random) equipment failures which require time for maintenance.

In a far-flung network one must also look at the system's ability to establish and disconnect the circuits required at its node switching capacity. Systems capable of switching messages or calls rapidly and without excessive delays use their links more efficiently. Thus, the trend toward development of complex, automatic switching equipment.

A system parameter, which is often subjected to analysis, relates to traffic assignment. This term expresses ability of the system to look at the streams of messages going through its nodes, and to adjust direction and flow velocity of the streams such that no part of the system becomes overloaded. In a quiescent system, assignment of traffic is easily made. However, if parts, or the entire system, approach saturation level, assignment becomes a critical variable.

Modern systems operate for some time near or above saturation levels. This mode of operation leads to queuing of users and messages, to loss of calls because of user's impatience, and to increasing delays. In a global system two saturation problems arise.

The first has to do with local traffic peaks in the sense that small parts of the system operate near saturation level while other parts of the system are relatively quiescent. This behavior pattern in a system may be caused by the users' demands, or simply by

existing time zones. For example, calls initiated in Europe and destined for the U.S. have different time peaks than those originating in the U.S. and destined for the Far East. The second problem is connected with routing and switching. Development of an optimum routing "strategy" may be the answer to the need of orderly (albeit random) system operation. This "strategy" would be in the form of a learning process from programmed traffic assignment.

Traffic Routing

Efficient assignment of message traffic is the main concern of traffic routing. Pertinent automatic equipment establishes circuits from sources to sinks in an efficient manner, using a variety of devices.

Traffic recorders at communications centers produce statistically useful outputs. These perturb routing doctrines and patterns according to predicted and observed demands. The doctrine cannot be executed by human beings, as it would lead to inefficiency, large average delays, and lost calls. Modern systems, therefore, use central computers at major centers. They are used to observe and assess the output of the traffic recorders and to adjust the (perturbed) local routing doctrine over short periods of time. Computers are also used to predict future peak loads on the basis of past performance. Further, they transmit load estimates and control information to computers in other centers. This permits adjustment of overall routing doctrines according to demand loads.

These operations will still be subject to interference by human operators. Hence, displays must be available at every site. The human mind can recognize unusual patterns, including those for which no provision in the computer program has been made. Therefore, the computer control program will be one that grows with experience.

In a large system information concerning long-haul traffic must be transmitted from one computing center to all others. Special data transmission links are provided between the major centers, more specifically between the computers themselves. The transmitted information will permit them to mutually adjust routing doctrines in line with present or future demands.

Traffic routing at a major center, over available trunklines, also involves network switching. The computer can do this rapidly, thus time lost due to switching is reduced to a minimum.

Traffic Recorder

What kind of information may be needed by the central computers and what information should, therefore, be observed and made available for analysis can be found. The device that performs this function at local centers is called a traffic recorder. Such recorders could be installed even in secondary nodes and could transmit their information over special data control links to the major centers. Among the items assessed by the traffic recorders should at least be the following:

Local Call or Message Delay, either average or delay distributions arising at the time of demand for a line.

Local Call or Message Counts, made over fixed time intervals to determine the number of calls answered by local operators. Also the number of lost calls not answered by operators due to the users' impatience. In case of store-and-forward systems, messages are sometimes delayed in queuing; even lost due to low priority.

Service Delay, experienced by the user following his access to the local line.

Trunk Delay, incurred by a customer wishing to make a long-distance call.

Number of Trunk Calls, completed or lost over a fixed time interval.

Trunk Usage, the average trunk occupancy (a fraction less than or equal to unity) which is affected by (wasted) disconnect time.

Systems Synthesis

Global networks are necessary and must be designed according to stated specifications. Synthesis of such systems is a complex problem.

For example, a simple case may be discussed. Given is a matrix which expresses connectivity between various nodes of the system. This matrix [C] is also known as the incidence matrix. It states where there exists a link between two nodes, and where no links exist.

Further, there may exist requirements for transmission between some of these nodes. These needs will include data transmission between nodes that are not directly connected but that can be connected by making a circuit of existing links. Transmission requirements are written, again, in matrix form: [R]. These must be assigned to the links which are chosen to make the required circuits. Thus, one can establish

transmission needs for individual links by adding up the assigned transmission needs between stated nodes. All of this work resolves into pseudo-operations on the connectivity and requirements matrices, expressible by L = C X R.

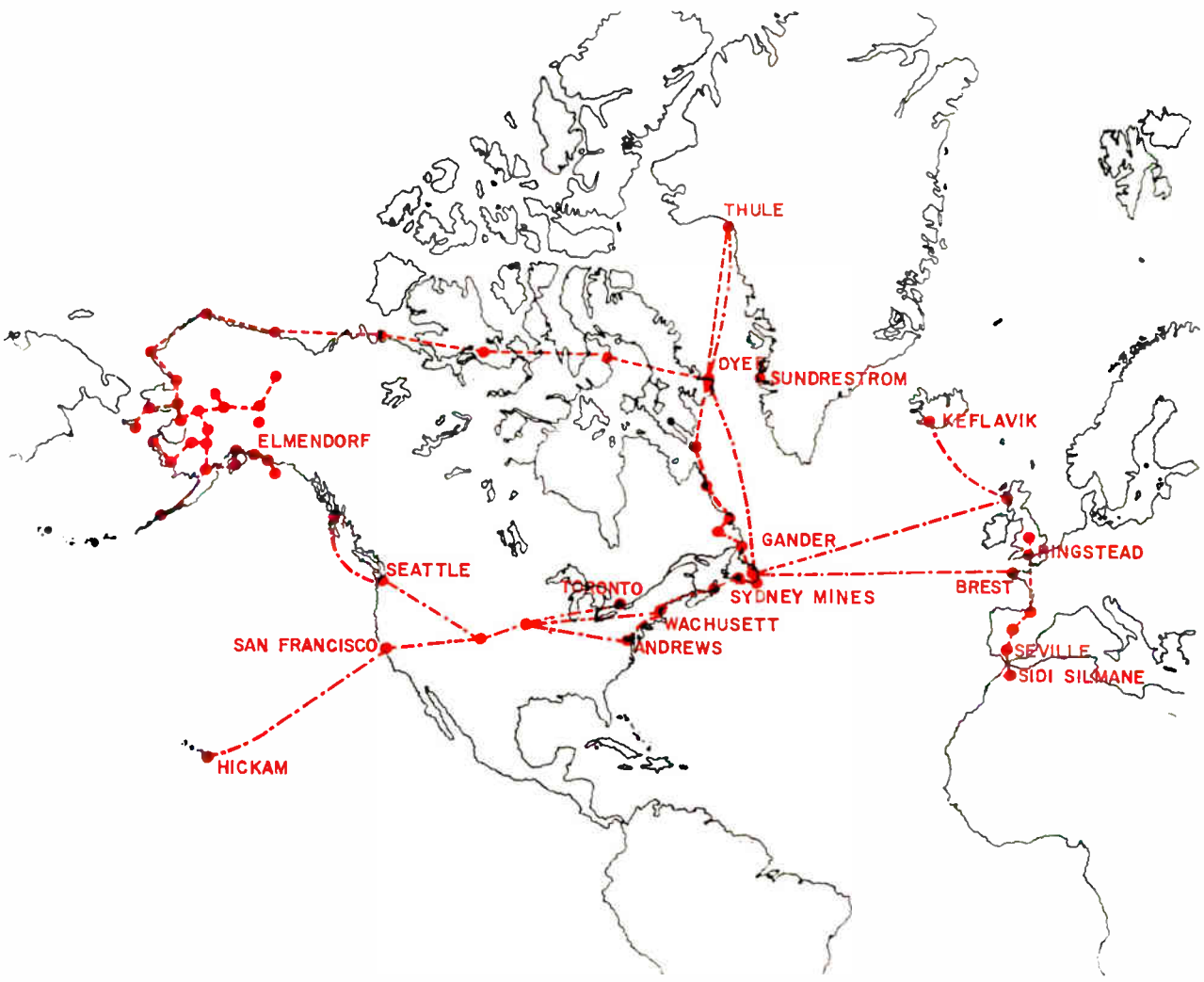
A system designed on such a basis appears as a net with permanently switched channels and circuits. It satisfies all the requirements made between primary nodes. The next question is, how to optimize these assignments. Should one optimize them over the shortest available routes or should one optimize them so as to achieve a balanced traffic system? Answers are provided by such methods as operations analysis and linear programming. They require deep mathematical thought.

The over-designed system is sometimes referred to as the "Standard Reference System." It may be reduced in scope by allowing (i) queuing at the nodes, (ii) a stated percentage of lost messages, (iii) a permissible level of delays. Such systems in telephone terminology are referred to as P and T engineered systems. Any permissible reduction of the link transmission capacity will also lower the system's cost. How far this reduction can be carried, e.g., how much queuing the users are willing to put up with is again a problem.

Illustrative Example

Fig. 1 illustrates the problem of finding link transmission capacities from given node topology and traffic requirements. The first diagram shows a system of four nodes, arranged in a square, with one diagonal connection. Equivalent incidence matrix to this topology is shown to the right. It is a 4 x 4 matrix with two zero-entries. Diagonal elements of this matrix need not be expressed; they may be assumed one-s since every node is connected to itself.

Fig. 2. Drawing illustrates the elements of a global communications network.



DIGITAL NETWORKS (Concluded)

Now suppose that traffic requirements are as shown in the next diagram. For example, it is required that four channels be available between nodes 2 and 3. This traffic must be routed over either nodes 1 or 4, or in equal or unequal parts over both. The requirement matrix is shown to the right of the second diagram; it has no zeros.

We must make the link assignments by performing suitable pseudo-operations on matrices C and R. We add the channel requirements for all links having a direct connection. To this sum we add the distributed traffic arising from requirements between non-connected nodes. This sum expresses the needed link capacity for existing links, as shown in the node topology. No link capacity can exist on those links which do not connect primary nodes. In particular, no traffic, for the topology shown here, may be assigned to the non-existing link between nodes 2 and 3. Therefore, the final link matrix L shown to the right of the third diagram has zeros in the respective two positions. Assuming unidirectional traffic we shall split up the channels equally from, and to, connected nodes. For example, the total of six channels required between nodes 1 and 2 is shown in the matrix as three channels between nodes 1 and 2, and three channels between nodes 2 and 1.

Mathematical tools of this nature and more refined methods are used today to assist with the synthesis and design of large-scale systems.

Applications

Applications of large-scale, high-speed digital communications systems are found in both the commercial and military worlds. Some such systems already exist; others are in the planning stage. Existing systems are still in the rudimentary state while the proposed systems are given a great deal of attention, especially with regard to cost, use, and efficiency.

Fig. 2 illustrates the elements of a global network which consists of leased telephone lines, microwave links, submarine cables, landlines, and tropospheric scatter links. Topology of this system is not complicated. The system has only two minor loops, one in the U. S., the other in Canada. Even so, analysis of such a simple system turns out to be a formidable task. One must establish the need for each link; look at signal deterioration over each; and establish criteria for permissible message degradation over successive links which are connected in tandem. Transatlantic cables, for example, are only designed to carry (multiplexed) telephone traffic. However, the large number of channels in each cable permits digital data transmission at high rates. In this manner, for example, digitalized traffic can be assigned to the transmission of live or taped TV programs, albeit at a high cost. Increasing needs for such traffic will cause expansion of existing systems to provide greater channel capacities at higher digital rates. Plans are now being made to develop new links capable of handling traffic in the megabit rate.

The Future

Developments we have talked about are reality. Systems of this magnitude are in the design stage. Equipment capable of handling traffic at high rates will become available in a few years. The communication industry today is in a position similar to that of the data processing industry ten years ago. Volume of traffic over existing networks is beginning to choke the lines.

Global nets are faced with the need for accepting, processing, switching, routing, and delivering of traffic at a high rate. One of the transatlantic cables, for example, is capable of carrying 96 telephone conversations simultaneously, or binary message traffic up to 384,000 bits/sec. Even so, crudest estimates indicate that in ten years the demand will be at least one hundredfold that of today. Introduction of wideband tropospheric scatter links, of satellite and microwave relays where possible, will possibly solve the transmission problem. Development of faster, general-purpose, real-time computers capable of handling the switching and routing problems will give us the required control over traffic flow.

The similarity between the computer industry of ten years ago and the communication industry of today is not a mere coincidence. Rapid progress of our technology causes an explosion in engineering requirements everywhere. Man's need to communicate will increase as his ability to change and create his own environment improves.

1962 ELECTRONIC INDUSTRY STATISTICS

1962 ELECTRONIC MARKETS

CONSUMER GOODS	2,300,000,000
MILITARY & GOVERNMENT	7,600,000,000
INDUSTRIAL	2,400,000,000
REPLACEMENT PARTS	800,000,000
	13,100,000,000

For the first time, we are listing the factory sales figure for "Consumer Goods." Previously, we published retail sales figures, which would be some 50% higher.

PHONOGRAPH SALES—1962

Type	Factory Sales (units)	Retail Sales (units)
Monaural	1,100,000	1,200,000
Stereo	3,200,000	3,350,000

SEMICONDUCTOR SALES—1962

	Factory Sales	Factory Sales $
Transistors	250,000,000	290,000,000
Rectifiers/Diodes	388,000,000	188,000,000

VITAL TELEVISION STATISTICS 1946-1962

	Total TV Sets Manufactured		Receiving Tubes Used in New TV Sets and for Replacements		Total TV Picture Tubes Manufactured		Total AM-FM-TV Receiving Sets Manufactured	TV Stations on the Air	Total TV Sets in Use in U. S.	At Close of
	Number	Retail Value	Number	Retail Value	Number	Retail Value				
1946	10,000	$ 5,000,000	350,000	$ 588,000	20,000	$ 1,000,000	14,010,000	5	8,000	1946
1947	250,000	100,000,000	8,500,000	15,000,000	300,000	15,000,000	17,250,000	20	230,000	1947
1948	1,000,000	350,000,000	32,200,000	53,000,000	1,500,000	75,000,000	17,000,000	44	1,000,000	1948
1949	3,000,000	950,000,000	87,000,000	146,000,000	3,500,000	210,000,000	13,000,000	100	3,800,000	1949
1950	7,500,000	2,700,000,000	225,000,000	378,000,000	8,000,000	400,000,000	22,100,000	107	10,500,000	1950
1951	5,600,000	2,100,000,000	161,000,000	270,000,000	6,000,000	300,000,000	19,100,000	108	15,750,000	1951
1952	6,300,000	2,360,000,000	168,000,000	380,000,000	6,500,000	260,000,000	16,300,000	123	21,800,000	1952
1953	7,300,000	1,675,000,000	210,000,000	400,000,000	9,000,000	360,000,000	20,700,000	350	28,000,000	1953
1954	7,300,000	1,278,000,000	215,200,000	409,000,000	10,300,000	360,500,000	17,700,000	415	33,000,000	1954
1955	7,800,000	1,263,600,000	220,000,000	407,000,000	10,600,000	371,000,000	20,000,000	457	39,400,000	1955
1956	7,500,000	1,237,500,000	200,000,000	400,000,000	11,000,000	318,000,000	21,900,000	491	42,300,000	1956
1957	6,500,000	1,270,000,000	175,000,000	371,000,000	10,000,000	340,000,000	22,000,000	519	45,500,000	1957
1958	5,300,000	912,000,000	128,000,000	270,000,000	8,200,000	332,000,000	18,350,000	570	50,000,000	1958
1959	6,200,000	1,070,000,000	150,000,000	319,000,000	9,500,000	368,550,000	21,500,000	554	53,500,000	1959
1960	5,900,000	1,020,000,000	159,000,000	399,000,000	8,500,000	329,000,000	22,800,000	583	57,000,000	1960
1961	6,200,000	1,080,000,000	162,000,000	412,000,000	9,100,000	350,000,000	22,000,000	599	60,000,000	1961
1962	6,800,000	1,150,000,000	177,000,000	450,000,000	9,050,000	348,000,000	24,000,000	624	62,000,000	1962

U. S. PRODUCTION OF RADIO SETS—1922 TO 1962

	Total Radio Sets Manufactured		Total Receiving Tubes Manufactured		Automobile Sets Manufactured		Auto Sets in Use	Households with Radio Sets	Total Radio Sets In Use in U. S.	
	Number	Retail Value	Number	Retail Value	Number	Retail Value	Number	Number	Number	
1922	100,000	$ 5,000,000	1,000,000	$ 6,000,000	.....	.....	.....	260,000	400,000	1922
1923	550,000	30,000,000	4,500,000	12,000,000	.....	.....	.....	1,000,000	1,100,000	1923
1924	1,500,000	100,000,000	12,000,000	36,000,000	.....	.....	.....	2,500,000	3,000,000	1924
1925	2,000,000	165,000,000	20,000,000	48,000,000	.....	.....	.....	3,500,000	4,000,000	1925
1926	1,750,000	200,000,000	30,000,000	58,000,000	.....	.....	.....	5,000,000	5,700,000	1926
1927	1,350,000	168,000,000	41,200,000	67,300,000	.....	.....	.....	6,500,000	7,000,000	1927
1928	3,281,000	400,000,000	50,200,000	110,250,000	.....	.....	.....	7,500,000	8,500,000	1928
1929	4,428,000	600,000,000	69,000,000	172,500,000	.....	.....	.....	9,000,000	10,500,000	1929
1930	3,827,000	300,000,000	52,000,000	119,600,000	34,000	$ 3,000,000	.....	12,048,762	13,000,000	1930
1931	3,420,000	225,000,000	53,000,000	69,550,000	108,000	5,940,000	100,000	14,000,000	15,000,000	1931
1932	3,000,000	140,000,000	44,300,000	48,730,000	143,000	7,150,000	250,000	16,809,562	18,000,000	1932
1933	3,806,000	180,500,000	59,000,000	49,000,000	724,000	28,598,000	500,000	20,402,369	22,000,000	1933
1934	4,084,000	214,500,000	58,000,000	36,600,000	780,000	28,000,000	1,250,000	21,456,000	26,000,000	1934
1935	6,026,800	330,192,480	71,000,000	50,000,000	1,125,000	54,562,500	2,000,000	22,869,000	30,500,000	1935
1936	8,248,000	450,000,000	98,000,000	69,000,000	1,412,000	69,188,000	3,500,000	24,600,000	33,000,000	1936
1937	8,064,780	450,000,000	91,000,000	85,000,000	1,750,000	87,500,000	5,000,000	26,666,500	37,600,000	1937
1938	6,000,000	210,000,000	75,000,000	93,000,000	800,000	32,000,000	6,000,000	28,000,000	40,800,000	1938
1939	10,500,000	354,000,000	91,000,000	114,000,000	1,200,000	48,000,000	6,500,000	28,700,000	45,300,000	1939
1940	11,800,000	450,000,000	115,000,000	115,000,000	1,700,000	60,000,000	7,500,000	29,200,000	51,000,000	1940
1941	13,000,000	460,000,000	130,000,000	143,000,000	2,000,000	70,000,000	8,750,000	29,700,000	56,000,000	1941
1942	4,400,000	154,000,000	87,700,000	94,000,000	350,000	12,250,000	9,000,000	30,800,000	59,340,000	1942
1943	.....	.....	17,000,000	19,000,000	.....	.....	8,000,000	32,000,000	58,000,000	1943
1944	.....	.....	22,000,000	25,000,000	.....	.....	7,000,000	33,000,000	57,000,000	1944
1945	500,000	20,000,000	30,000,000	35,000,000	.....	.....	6,000,000	34,000,000	56,000,000	1945
1946	14,000,000	700,000,000	190,000,000	200,000,000	1,200,000	72,000,000	7,000,000	35,000,000	60,000,000	1946
1947	17,000,000	800,000,000	220,000,000	260,000,000	3,200,000	194,000,000	9,000,000	37,000,000	66,000,000	1947
1948	14,000,000	600,000,000	200,000,000	230,000,000	4,100,000	293,000,000	11,000,000	40,000,000	74,000,000	1948
1949	10,000,000	500,000,000	190,000,000	350,000,000	3,500,000	240,000,000	14,000,000	42,000,000	81,000,000	1949
1950	14,600,000	721,000,000	383,000,000	644,000,000	4,760,000	248,000,000	17,000,000	43,000,000	90,000,000	1950
1951	13,000,000	605,000,000	430,000,000	640,000,000	4,800,000	255,000,000	20,000,000	44,100,000	100,000,000	1951
1952	10,000,000	500,000,000	330,000,000	740,000,000	2,750,000	148,000,000	25,000,000	45,200,000	114,500,000	1952
1953	13,400,000	536,000,000	410,000,000	920,000,000	4,800,000	250,000,000	29,000,000	46,000,000	120,500,000	1953
1954	10,000,000	400,000,000	400,000,000	880,000,000	4,300,000	220,000,000	32,000,000	46,200,000	127,000,000	1954
1955	14,400,000	559,000,000	481,000,000	852,000,000	6,900,000	346,000,000	35,700,000	47,400,000	138,700,000	1955
1956	14,000,000	553,000,000	465,000,000	906,000,000	5,000,000	258,000,000	37,500,000	48,500,000	143,500,000	1956
1957	15,500,000	603,000,000	450,000,000	882,000,000	5,500,000	303,000,000	39,600,000	49,200,000	146,400,000	1957
1958	12,550,000	468,000,000	330,000,000	729,000,000	3,570,000	193,000,000	41,900,000	50,300,000	165,200,000	1958
1959	15,300,000	548,000,000	430,200,000	731,700,000	5,620,000	304,000,000	43,900,000	51,250,000	175,000,000	1959
1960	16,920,000	606,000,000	456,000,000	830,000,000	6,480,000	350,000,000	46,000,000	52,600,000	186,000,000	1960
1961	17,000,000	610,000,000	362,000,000	656,000,000	6,200,000	335,000,000	49,000,000	53,250,000	198,000,000	1961
1962	18,200,000	654,000,000	365,000,000	624,000,000	.....	.....	52,000,000	55,700,000	207,000,000	1962

ELECTRONIC INDUSTRIES editors look at the key segments of the industry, evaluate the state-of-the-art, and predict the course of future developments.

LOOKING AHEAD...

COMPUTERS

The computer industry is growing faster than the electronic industry as a whole. Added impetus will be given by a growing space computer market as an increasing number of space projects are undertaken both by the government and private enterprise. The major role that computers have been playing in space technology was evidenced by the recent Eastern Joint Computer Conference held in Phila. —theme of this conference was "Computers in the Space Age." Computers will "take to space," and some will possibly even be landed on some other celestial body. Reliability and capacity of computers will be increased and improved—from necessity.

Future potential of the computer market is also enhanced by a growing **foreign market.** This market, especially the Western European segment, will be a prime target of American computer manufacturers. This section of Europe is still a labor shortage area, which will make it necessary for them to automate in order to maintain and expand their economic position.

Another prime target will be (or should be) the underdeveloped countries. This market is due to blossom. As their economies develop these countries should take very quickly to these comparatively new machines. The fact that they are not familiar with the old methods should make it that much easier for them to adapt to the new methods.

On the other side of the ledger, competition from foreign manufacturers continues to increase. Manufacturers in countries such as Great Britain are behind those in this country, but they are closing the gap.

The health services market is one of the nation's largest economic factors, and it is growing. Use of computers for these services is also growing. There are several good reasons for this—increasing medical costs could be compensated for by the use of these machines; much medical data which now consumes a great deal of time could be done by electronic data processing; and automation would release professional personnel from many routine tasks and they could thus spend more time doing the things they were trained to do. As the problems of introducing automation into medicine are solved more and more computers will be used.

Computers are finding increased usage in the communications industry. Multiplying traffic loads have made the use of **digital communications systems** a necessity. Also, global operations of the military have made long distance communication networks necessary. These networks can be made more effective through the use of high-speed automatic data processing equipment.

Look for computers to be used more and more for executive decision making. These machines make it possible to quickly assemble, store, and evaluate economic data. Thus much guesswork can be eliminated. Management will also make more use of edp for planning and allocating resources to specific projects. Efficient use of available manpower will be made by using edp.

Other areas of **increased computer use** will be: weather forecasting, transportation and for process control. Hybrid systems composed of combinations of digital and analog computers will be used more often, especially for process control.

As was the case last year, much of the activity in the field will be centered around memories and input-output devices. Improvements in magnetic thin films and in manufacturing techniques may bring about a revolution in memories. Several film memories are now in production or pilot production. As computer speeds climb, the problems concerning these devices will also climb—thus the increased attention.

This year will see more effort devoted to getting more "parallel operation" from large-scale machines. This will result in more efficient use of computers and thus a cost saving.

COMPONENTS

Recognizing the threat of **microelectronics,** the major passive device manufacturers are devoting considerable effort and funds to the development of mass production techniques for thin films and integrated circuits. But in the immediate future, firms primarily considered semiconductor device manufacturers will continue to be the standard bearers in the microelectronic device race.

At the recent EIA Radio Fall Meeting in Toronto, Canada. there was an interesting presentation which commented on the lack of anything new in the consumer field since television, with the possible exception of magnetic tape recording. The emphasis has been on cost reduction of present products.

The field of **integrated circuits** may find a profitable market in the consumer product. This assumption is not based on the fact that the new techniques can provide the circuitry in much less volume than is now required but rather on the fact that integrated circuits and thin films offer excellent approaches to automation. This is another reason why the passive component manufacturers are so actively engaged in these activities.

With **automation** comes cost reduction. And while this follows the present trend of consumer electronics rather than offering a new item, it is interesting to ponder on how these new circuit packages will be used. Externally, there may be no change to a consumer item; however, taking a look at what should be the chassis we may find from one to a dozen of what appears to be transistor cans.

But while there are a few integrated circuit and thin film devices on the market, passive **component manufacturers** will still receive the bulk of their income from discrete components—miniaturized, but still discrete.

The Signal Corps continues to express its pleasure with the Micromodule by annually upgrading expenditures for this program. The main reason for this funding is that the Micromodule concept provides answers here and now to urgent military needs for smaller, lighter, and more reliable electronic components, devices, and systems. The concept also provides for the incorporation of new microelectronic techniques.

It must be remembered that the Micromodule, although made up of discrete components, is a module—largely constructed by manual operations. These operations are costly; and so, this concept does not appear to ever be headed for a large consumer market.

MAGNETICS

Progress in manufacturing and control of present materials, and development and application of new materials will be slow—as in the past. Most authorities are in agreement that we are still in the "beginner's stage" when it comes to controlling even the simplest materials, during manufacturing—and their opinion is, we will continue at this present rate for some time.

Permalloy, around for a number of years, and widely used today, is gradually becoming more controllable. This will lead to a greater improvement in meeting "tight" specifications — because manufacturing process control is now among the highest in the industry.

The **garnets,** discovered and developed in France, are receiving much attention in a number of labs throughout the country. This year of 1963 should, and will, see a quantity of useful products appear, mainly for use in the microwave industry. They will feature higher resistivities, increased efficiencies, and narrower absorption bandwidths.

The Ferros-Plana family of magnetic ceramics will find, and is already, more widespread uses in communications, extending our present frequency ranges even higher than they already have done.

There is abundant amount of information available on research and development in the **magnetic ceramic's** field—looking for higher energy products and higher coercive forces. Manganese bismuthide, which in present development already has extremely high coercive force, will begin to find a solid area for itself — with an increase in practical, commercial applications.

Look for more information to appear describing the continuing work being done on fine iron particles of single domain size (ellipsoidal shape) agglomerate to make permanent magnetics, with energy products a good bit in excess of 5×10^6.

Watch for announcements of magnetic amplifiers with newly developed ferrite core

MAGNETICS (Continued)

materials, which will be operational above 10mc.

Continued progress in using **ferrite as magnetostrictive transducers** in high frequency filters will receive more attention, as they extend their area in the megacycle range.

Look for increased availability of practical microwave ferrite devices, including: resonance isolators; phase shifters; circulators (above 160TC); isolators (of the magneto-plumbites family, with increase anisotropy, useful to 75TC); strip lines; cavity resonators; SSB modulators; and switches.

Where computers are concerned, look for more news on developments of **smaller magnetic memories** — and new transmission line techniques. When these are combined, computers will be available with access times in the low nanosecond range.

Higher quality, thinner recording surfaces, which have received much time and money in the past, should produce some real worthwhile news this year. Look for major developments to break in the last half of '63 at the latest, especially in increasing automated production of thin films.

MATERIALS

Gallium arsenide is assuming new roles in the electronic field. The material has been recently used as an infrared source. Several companies have developed GaAs diodes that emit light of a relatively narrow spectral width in the near-infrared region. There are several possible uses for these devices such as optical communication links, light source for card or tape readers, IR radar light source, and transmission of TV signals. At the moment it is still too early to know what will be the final uses of these devices.

Even more recently, several companies have announced the use of GaAs in a device referred to as **injection lasers.** The semiconductor device promises a family of coherent light sources that can be pumped electrically instead of with a high-power flash source. This type of pumping should permit high frequency modulation, a tough problem in conventional lasers.

We believe that GaAs will be in the news again in the near future as some of the problems that cropped up awhile back are overcome. At least one research organization says they have solved the problem of insufficient purity, which appeared when the material was being used for tunnel diodes.

Niobium has been showing up lately as the dielectric in a new series of capacitors. There has been quite a bit of controversy about the benefits to be derived by using this material as the dielectric. Now the National Bureau of Standards will conduct research studies aimed at the production of **niobium-tin alloy** for application to high energy solenoidal magnets. The problem appears to be the alloy's brittleness, making fabrication very difficult. The magnets should be capable of producing fields of 200 kilogauss or more.

The need of reliable performance requirements for electronic equipment in cryogenic environments has stimulated work in developing new **adhesives.** New adherend materials such as ceramics, semiconductors, noble metals and newly developed plastics require a bonding material that will stick-to-the-job at extremely cold temperatures. Along with the ability to stick, the new adhesives will have to overcome brittleness, e.i. maintain a degree of flexibility, and withstand shock.

A **piezoelectric material,** ammonium dihydrogen phosphate (ADP), has good possibilities as a light modulator for lasers. The ability of this material to change size when an electrical voltage is applied is the key. When this material changes size, it also changes its index of refraction, and hence could be used to modulate the light beam. More detailed information is available on page 90 of our November 1962 issue.

MICROWAVE

Some of the most important work going on in the microwave field is in the so-called **millimeter region** — the frequencies from 30Gc to 300Gc. Sub-millimeter frequencies are defined as the wavelengths shorter than 1mm. (higher than 300Gc).

The orignal investigation in this field was by scientists in the field of microwave gas spectroscopy, where these frequencies are used to measure the absorption due to molecular rotational transitions.

The millimeter region is looked to particularly, to provide greatly enlarged room for communications channels. Bandwiths of even 10's of gigacycles will be made available when these techniques have been refined.

At the moment the greatest problem is the lack of suitable

MICROWAVE (Continued)

self-excited sources of power. Until recently, tubes available were operating only up to approximately 75Gc, a wavelength of 4 millimeters. However, recent developments have considerably extended this limit.

A number of strikingly new designs are now reaching the market, one of them developed by CSF in France. This tube has a bandwidth of 10% and an output power of up to 15mw in the 0.7mm wave region. Two other approaches to **submillimeter wave generation** are the Tornadotron, proposed by Dr. Weibel of the General Telephone & Electronics Laboratories and the Cerenkov radiator proposed by Prof. Coleman of the University of Illinois.

In the **laser field**—and there seems to be hardly a limit to the possible application of these devices—a program is expected to be initiated soon at the Aeronautical Systems Div., Electronic Technology Laboratory into the electron energy spectrums of gaseous lasers. The investigation will be made through the use of Langmuir probes. The research is seen feasible as a result of Air Force advancements in the plasma diagnostics area, credited to Dr. Gustav K. Medicus, ETL Research Physicist.

In another laser development, the General Telephone & Electronic Laboratories announced that they have completed the preliminary research on a gallium arsenide—gallium phosphide alloy laser. In a paper presented at the American Physical Society meeting, three GTE scientists reported that quasi binary alloys containing 10%, 25%, 30% and 50% gallium phosphide in gallium arsenide had been prepared by the epitaxial growth technique.

At Westinghouse, scientists have developed a 96kmc **continuous wave maser** using a superconducting magnet for the applied field. The maser has a pump frequency of 65kmc and the system is being used to investigate the feasibility of high frequency coherent microwave amplifiers. Gains of more than 10db have been achieved at noise levels near 2db. This is accomplished by using a new low frequency pumping technique that incorporates 5 paramagnetic spin energy levels to obtain inversion, with a pump frequency lower than the signal frequency.

TEST EQUIPMENT

RFI test equipment for collecting spectrum signatures is slowly becoming automated. The automation of this equipment is becoming a necessity in today's crowded spectrum. However, a deterrent in the development of such equipment is that the exact data collection needs are not clear enough to allow companies to develop the needed equipment.

Today's complex electronic systems are making the use of **automatic test equipment** a prerequisite. Some of the systems are so intricate that the equipment could be "worn out" just making confidence checks by manual means. These complicated systems place the test equipment manufacturer in the role of a systems manufacturer. The test equipment manufacturer is going to have to "live" with the systems designers to provide the proper test equipment for the systems to be tested.

In the future, automatic test equipment is going to have to be flexible. The automatic test systems will have to be adaptable to systems other than those it was designed to be used with. Otherwise it is conceivable that the automatic test system could cost as much as the system being tested.

The Space Age is placing the stringent requirements of more accurate test equipment. Not only must the test equipment be more accurate than ever, it must be maintained that way. This opens up the need of more **standards** locations to accurately calbrate the test equipment. The cost of owning a standards laboratory is very costly. Several companies owning secondary standards have made their facilities available to other companies to offset some of the cost. In many cases these locations are not evenly distributed. Hence, more standards locations will be needed.

Test equipment **repair and maintenance** has been a problem. In many cases the equipment must be shipped back to the manufacturer for repairs. One enterprising company has assembled calibration and maintenance equipment in a van and intends to make regular, periodic calls on users of their equipment. In the past some test equipment users have let the location of the manufacturer dictate what equipment they bought. They felt that the closer the manufacturer was the sooner they could get their units back into operation. Look to other test equipment manufacturers to make similar moves.

Transfer parameters of ceramic bandpass filters suggest a comparison with the "ideal" narrow-band filter. Actual measurements closely agree with calculated values. By correlating these results, filter response to many important transients is evaluated as a function of bandwidth and phase response.

TRANSIENT RESPONSE OF CERAMIC FILTERS

CERAMIC BANDPASS FILTERS are finding increasing use in commercial and military communication equipment. They offer a wide range of high quality filter characteristics in a small and rugged package. Their basic building blocks are piezoelectric resonators which may be arranged in various circuit schemes.[1, 2,3,9,10] The filters in this article are cascades of the ladder, lattice or coupled resonator TC® schemes of Fig. 1. A few sample amplitude response curves are shown in Fig. 2; a typical phase response in Fig. 3.

Transient input signals contain an infinite frequency spectrum, only part of which can be propagated through a filter bandpass. The transient filter response is therefore distorted and delayed with respect to the input signal.

In communication systems, transient phenomena may be due to interference, e.g., atmospheric or ignition discharges, or to the nature of the transmitted signal itself—as in pulse signalling systems. In the latter, the transient behavior not only causes signal distortion, but also limits the minimum useful pulse width and the effective separation of neighboring channels.

"Ideal" Narrow-Band Filter

Fig. 4 shows a filter circuit with matched input and output terminations. If the system is linear, the output voltage $e_2\ (t)$ may be found from the inverse Fourier transform

$$e_2\ (t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} H\ (j\omega)\ E_1\ (j\omega)\ e^{j\omega t}\ d\omega \qquad (1)$$

where $H\ (j\omega) = e^{-(\alpha + j\beta)}$ is the filter transfer function and $E_1\ (j\omega)$ the complex frequency spectrum of the input voltage $e_1\ (t)$,

$$E_1\ (j\omega) = \int_{-\infty}^{\infty} e_1\ (t)\ e^{-j\omega t}\ dt \qquad (2)$$

The exact solution of Eq. (1) for multi-resonator filters is not practical because the expression of $H(j\omega)$ becomes too complicated. Several approximate approaches have been suggested. One of them assumes the idealized filter transfer characteristics of Fig. 5 with infinite attenuation in the stopband and constant attentuation and linear phase response within a relatively narrow ($f_o >> B$) passband. Although these characteristics cannot be realized in practice, this approach yields useful results for the interpretation of the transient behavior of multisection ceramic filters whose steep cutoff skirts and quasilinear phase responses approach the ideal conditions.

The transient analysis of the "ideal" filter, introduced by Kuepfmueller[4,5], has been treated and ex-

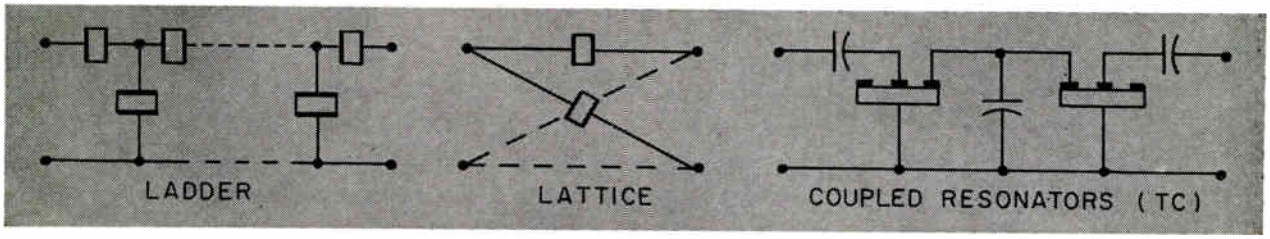


Fig. 1: Cascades of these configurations are used in this article.

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panded in a number of publications.[6,7,8] It will not be repeated here. Rather, the results for a number of transient input signals are discussed.

Suppose the signal $e^1(t) = E \sin(\Omega t + \varphi)$ is applied to the filter input at the time $t = 0$, with a switching angle φ. The carrier frequency Ω may be either equal to the filter's angular center frequency ω_0, or close to it, or, finally, far removed from it. Here's the response to each of these three cases.

(a) $\Omega = \omega_0$

The resulting output voltage is

$$e_2(t) = E\, e^{-\alpha} \left\{ \frac{1}{2} + \frac{1}{\pi} Si \left[\pi B (t - t_h) \right] \right\} \cos(\omega_0 t - \varphi) \quad (3)$$

This function is discussed in textbooks[6] and plotted in Fig. 6. As compared to the input signal, it is marked by

(α) Time delay. The time t_D during which the output envelope increases to half the steady state value is equal to the slope of the phase response,

$$t_D = \frac{d\beta}{d\omega} \quad (4)$$

(β) Distortion. While the input envelope rises abruptly to a constant level, the output envelope has a finite buildup time t_B. It is defined as the time during which the envelope amplitude changes from zero to the steady state value at a rate corresponding to that of the half-amplitude point. The buildup time is inversely proportional to the filter bandwidth,

$$t_B = \frac{1}{B} \quad (5)$$

Further, the output envelope is characterized by over- and under-shoots. The maximum overshoot is 18% (approx.)

(b) $\Omega \neq \omega_0$

If the carrier frequency is far removed from the filter bandpass, the input frequency spectrum may be considered constant within the narrow bandpass. Then

$$e_2(t) = 2\, e^{-\alpha} B \left| E_1 \right| \frac{\sin \pi B (t - t_D)}{\pi B (t - t_D)} \cos(\omega_0 t + \psi) \quad (6)$$

Eq. (6) describes a carrier of angular frequency ω_0, modulated by a function of the form $\sin x/x$. Fig. 7 shows the response. Both the delay time t_D and the buildup time t_B, Fig. 6, reappear here. Since $\Omega \neq \omega_0$ may also be zero, Eq. (6) holds for transient changes of dc input level.

The maximum response amplitude,

$$e_{2\,max} = 2\, e^{-\alpha} B \left| E_1 \right| \quad (7)$$

occurs at $t = t_D$ and is proportional to the filter

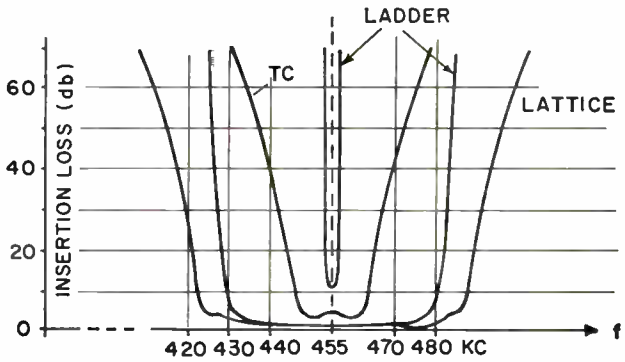


Fig. 2: Selectivity of the various filter configurations.

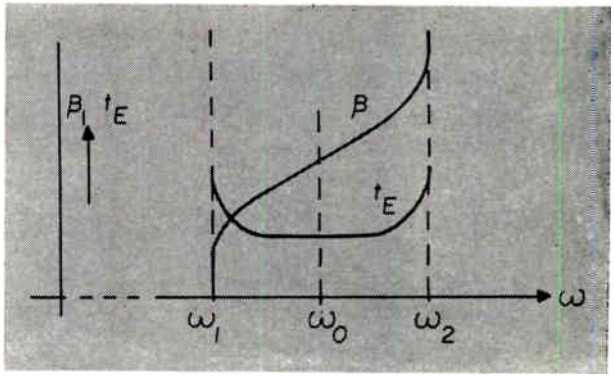


Fig. 3: Phase response & envelope delay of ceramic filters.

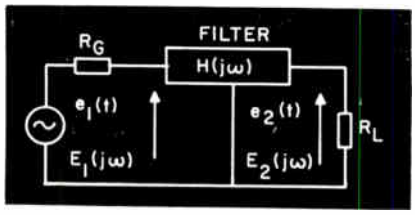


Fig. 4: Filter circuit with matched input and output terminations.

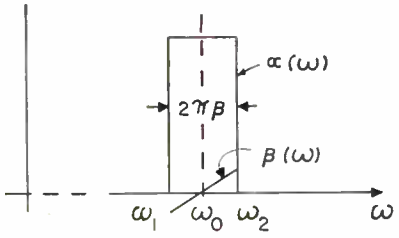
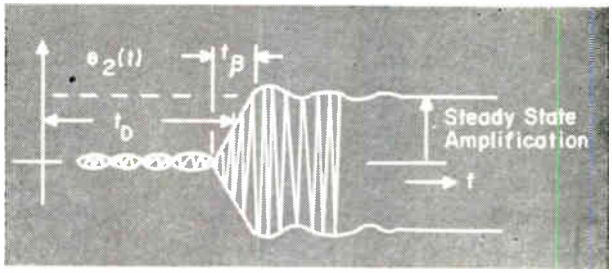


Fig. 5: The transfer characteristics of an idealized filter.

Fig. 6: The delay time and buildup time are shown.



CERAMIC FILTERS (Continued)

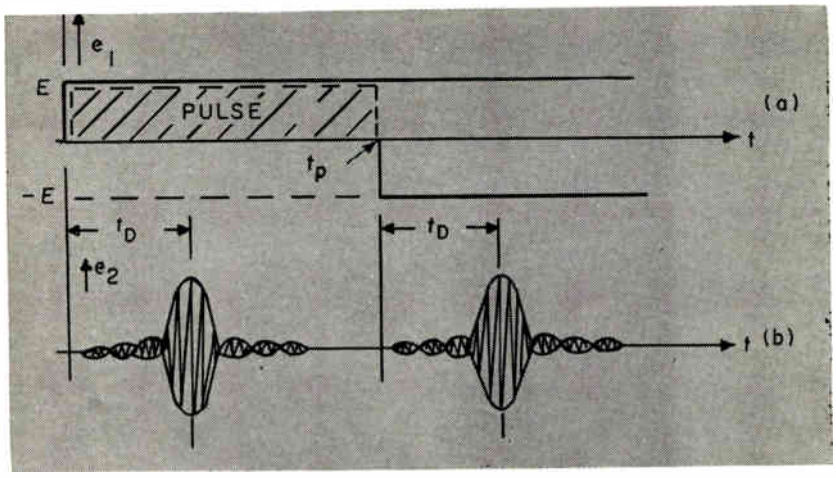


Fig. 8: The dc pulse input is shown in (a) and the response below in (b).

bandwidth and the amplitude of the input frequency spectrum. It is evaluated for the following particular input signals:

(c) Carrier far removed from Passband, $|\Omega - \omega_0| >> \pi B$

The maximum output voltage

$$e_{2\,max} = \frac{2\,e^{-a}BE}{\Omega^2 - \omega_0^2}\sqrt{\omega_0^2\cos^2\varphi + \Omega^2\sin^2\varphi} \qquad (8)$$

decreases with increasing frequency deviation $(\Omega - \omega_0)$ and depends on the switching angle φ.

(d) Carrier close to Passband, $\Omega/\omega_0 \approx 1$

Here, the approximation of a constant frequency spectrum within the filter passband seems no longer justified. However, measurements on narrow band ceramic filters show good correspondence with analytical values derived from Eq. (7) under the assumption $\Omega/\omega_0 \approx 1$. The maximum response becomes then

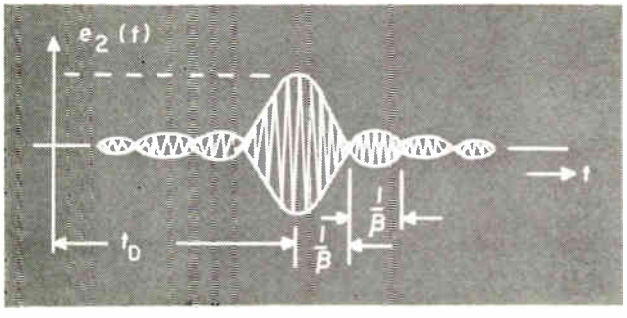
$$e_{2\,max} = \frac{e^{-a}BE}{\Omega - \omega_c} \qquad (9)$$

(e) DC Step, $\Omega = 0$

The maximum response is directly proportional to the filter's relative bandwidth,

$$e_{2\,max} = 2\,e^{-a}\frac{BE}{\omega_0} \qquad (10)$$

Fig. 7: Response of carrier modulated by sin x/x function.



(f) DC Pulse

This case can be considered as the superposition of two DC steps. It is shown in Fig. 8 for a wide pulse, $t_D >> 1/B$, which causes two distinct step responses due to the buildup and decay of the pulse. With decreasing pulse width t_p, the individual response voltages interfere and add up vectorially. Since their mutual phase angle is $180 + \omega_0 t_p$, the resulting output voltage varies between maxima at

$$t_p = (1 + 2K)/2f_0$$

and minima at

$$t_p = K/f_0$$

for

$$K = 0, 1, 2 \cdots$$

The maximum possible output equals twice the maximum step response of Eq. (10) and is obtained for a pulse with $t_p = 1/2f_0$.

A further decrease of pulse width results in a decrease of e_2 max, which becomes approximately

$$e_{2\,max} = 4\,e^{-a}\frac{BE}{\omega_0}\cos\omega_0 t_D \sin\frac{\omega_0 t_p}{2} \qquad (11)$$

(g) Impulse

An impulse of value E is defined as a pulse of infinite amplitude and infinitesimal duration whose time integral equals E. An input of this kind does not occur in practice. However, if the pulse duration t_p is short as compared to the filter time constant $1/f_0$, it may for practical purposes be called an impulse. Then Eq. (11) simplifies to

$$e_{2\,max} = 2\,e^{-a}BE\,t_p\cos\omega_0 t_D. \qquad (12)$$

which is directly proportional to t_p.

Measurements

Transient response measurements on ceramic ladder, lattice and TC configurations reveal a close analogy between the behavior of the ideal and the

real filter. Hence, the previously derived expressions for the ideal filter response may be applied either directly (for the maximum response amplitude) or with a constant correction factor (for rise and delay time) to the transient response of ceramic filters.

Fig. 9 shows a simplified diagram of the test circuit for ac-step measurements. Recurrent signals are used to obtain a continuous scope display. The readings are taken from photographs of the display, with an estimated accuracy of ±5%.

(a) Carrier frequency $\Omega = \omega_o$.

All filters tested show a response of the general shape shown in Fig. 6. The maximum overshoot is about 10%. The values measured are listed in Table 1. Here the bandwidth is specified as that of the 6 db points (B_{6db}). Instead of the buildup time t_B (which is inconvenient to measure in practice), the rise time t_R is listed. This is the time during which the envelope amplitude rises from 10% to 90% of its steady state value. For ceramic filters, t_R is proportional to t_B.

From Eq. (5), the ideal filter buildup time is inversely proportional to the filter bandwidth. Table 1 shows that the product $t_R B_{6db}$ is almost constant for ceramic filters of the same basic type. Hence the rise time may be approximated as

$$t_R = K_R / B_{6db} \qquad (13)$$

where $K_R = 0.6$ for TC filters

$K_R = 0.86$ for ladder and lattice filters.

The delay time t_D of the ideal filter is defined as the slope of the linear phase response. For the ceramic filters, the phase slope is proportional to the number N of filter resonators. The product $t_D B_{6db}/N$ as listed in Table 1 is essentially constant for the individual filter groups; so, one may write approximately

$$t_D = K_D N / B_{6db} \qquad (14)$$

where $K_D = 0.3$ for TC filters

$K_D = 0.15$ for ladder and lattice filters.

The phase slope $d\beta/d\omega$ is also referred to as the envelope delay, t_E. For ceramic filters, Fig. 3, it approaches the constant level of the ideal filter over the major (center) portion of the passband, but increases sharply towards the cutoff frequencies. One may therefore expect the envelope delay at ω_o to equal the time t_D. This is confirmed by measurement, as shown by values in the last column in Table 1.

(b) Carrier Frequency $\Omega \neq \omega_o$

As long as the carrier frequency lies within the passband, the response is approximately the same as for $\Omega = \omega_o$. If the frequency deviation is increased beyond the passband, the steady state response amplitude, Fig. 6, decreases proportionally to the steady state filter selectivity. The maximum transient response amplitude, however, decreases less sharply along a curve which might be called the "transient selectivity" of the filter. This curve is evaluated from Eq. (9) and plotted in Fig. 10. Since it is fairly symmetrical to the center frequency, only one-half of it is shown. The frequency scale is normalized to the 6 db bandwidth, and the response is referred to zero db at f_o. A typical steady state selectivity curve is indicated with dotted lines in the same figure.

The "transient selectivity" measured on a number of ceramic filters falls—with the exception of the wide band ladder filter No. 9—within the shaded area of Fig. 10 and corresponds quite closely to the theoretical curve. The deviation of the wide band filter is due to the fact that the approximation of a constant frequency spectrum within the bandpass becomes coarser with widening bandwidth.

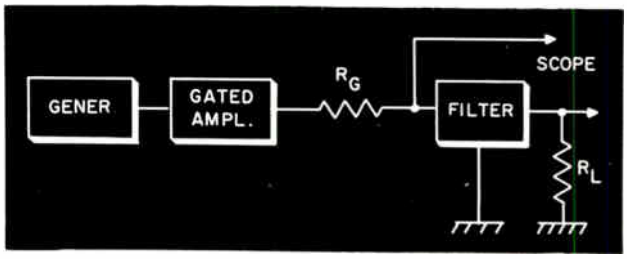


Fig. 9: The basic transient response test diagram.

(c) DC Step

Since a step generator with a rise time small compared to the filter time constant $1/t_o$ was not available, Eq. (10) for the ideal-step response could not be verified by measurement. However, the validity of the more general Eq. (7) for ceramic filters may be examined. Table 2 lists response data obtained on ladder filters of different bandwidths for an input step of 4μ sec rise time and 47 v amplitude. The ratio $e_{2max}/e^{-\alpha}B_{6db}$ is approximately constant, indicating that these filters follow the trend of the ideal filter.

(d) Pulse and Impulse

Fig. 11 compares the pulse response measured on a narrow band (2 kc) ladder filter to that calculated from Eq. (11). The correspondence, especially for narrow pulses, is close. For pulse widths $t_p >> 1/f_o$, the pulse response becomes an impulse response which, in agreement with Eq. (12), is directly proportional to t_p.

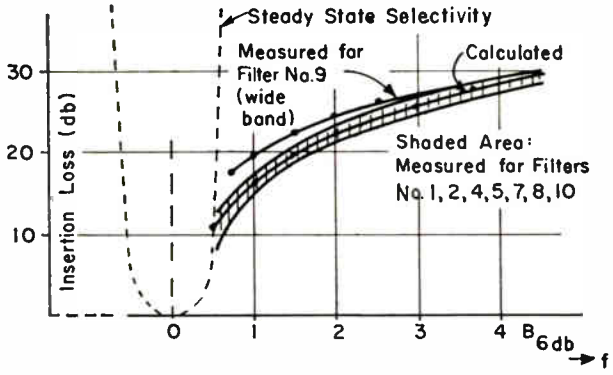


Fig. 10 (above): Transient selectivity measured on several ceramic filters falls within the shaded area; #9 does not.

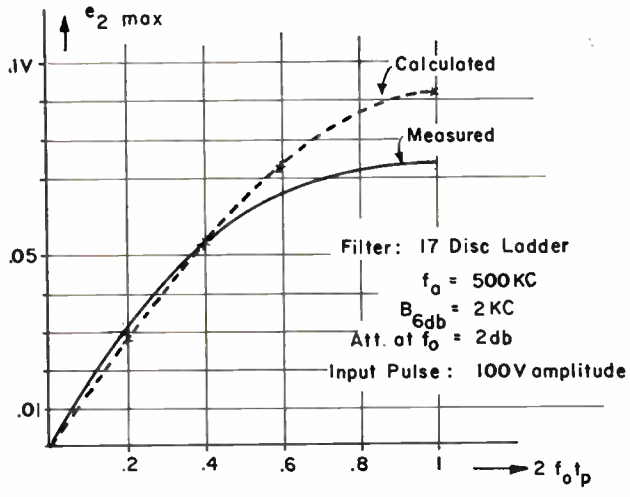


Fig. 11 (right): The pulse response of a ladder filter.

CERAMIC FILTERS (Concluded)

The expressions for the output response amplitude contain the attenuation factor $e^{-\alpha}$, which is constant for the ideal filter. However, the attenuation of the ceramic filters has a minimum at center frequency and increases toward the passband edges. In the preceding numerical calculations, the factor $e^{-\alpha}$ is referred to the attenuation at center frequency.

TABLE 1.

Filter No.	No. Reson.	f_0 KC	B_{6db} KC	t_R μ sec	t_D μ sec	$t_R B_{6db}$	$t_D \frac{B_{6db}}{N}$	$t_E \omega_0$ μ sec
				Combination				
1	4	455	6	100	200	.6	.3	200
2	4	455	10	60	120	.6	.3	110
3	4	455	20	30	60	.6	.3	55
4	6	455	13	50	130	.65	.28	125
5	6	455	20	30	85	.6	.28	80
6	3	455	6	110	150	.66	.3	
				Ladder				
7	17	455	18	46	140	.82	.15	125
8	17	455	32	27	80	.87	.15	70
9	17	435	48	18	60	.86	.17	50
10	17	432	5.4	160	450	.86	.14	430
11	13	432	5.7	155	300	.88	.13	
12	9	432	6.7	130	170	.87	.13	
				Lattice				
13	16	490	70	12	30	.85	.13	

TABLE 2.

Filter No.	B_{6db} KC	Atten. at f_0 db	$e^{-\alpha}$	t_D μ sec	$e_{2\,max.}$ V	$\frac{e_{2\,max.}}{e^{-\alpha B_{6db}}}$
7	18	2.6	.74	150	.068	5.1×10^{-5}
8	32	1.6	.84	80	.135	5×10^{-5}
9	48	2.	.8	70	.155	4.8×10^{-5}

Acknowledgment

The writer wishes to thank Mr. Antonio Lungo, of Clevite Corp. for helpful suggestions.

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Motor-driven variable transformers and swept-electronic regulated supplies have certain disadvantages in providing slow sweep voltages for recorders. Most of these disadvantages are overcome when a saturable core reactor replaces the motor driven transformer. It is used to sweep the primary of any transformer or ac powered dc output supply.

FOR X-Y PLOTTING... SATURABLE REACTOR SWEEP SUPPLY

X-Y-RECORDERS often require slow sweep supplies. Motor-driven variac supplies and swept-electronic regulated supplies have been used for this purpose, but both have disadvantages.

When using *motor-driven* supplies voltage varies in discrete steps rather than as a smooth varying function. Also, mechanical devices have transmission and brush-contact problems.

When using *electronic* supplies several heavy-duty pass tubes or transistors are required in order to develop much power output. In addition, the electronic supplies are complex, heavy, and bulky.

A saturable-core-reactor sweep supply was designed for use with the recorder of an electron-tube-characteristics curve tracer. This supply overcomes most of the above disadvantages. A saturable core reactor replaces the motor-driven variac. It is used to sweep the primary of any transformer or ac powered dc output supply.

The saturable reactor inductance (hence impedance) is maximum when no current flows through the dc control winding. As direct current flows through the control winding, the core saturates so that the impedance of the ac coil decreases. A control current change of less than 60 ma. is enough to vary loads of 1a. or more, depending upon reactor design. Fig. 1 shows a simplified sweep circuit. The ac output voltage will sweep from almost zero to the maximum level desired when a non-linear element such as an incandescent bulb parallels the load. This occurs because the bulb resistance is very low when cold, so that the input voltage is essentially across the reactor rather than the load. As reactor impedance decreases, bulb and load voltage increases; but, since the bulb is getting warmer, its filament resistance rises and presents less of a load to the circuit. The choice of R and C in Fig. 1 determines the sweep time. Fig. 2 shows the reactor output controlling a conventional rectifier supply in order to obtain a dc output sweep.

The magnitude of R, C, and the dc control voltage required becomes impractical for sweep durations beyond a few seconds. Sweep time is extended by means of a vacuum tube in the control winding circuit. Sweep time is then determined by the grid circuit R and C. Thus one value of C and a resistor

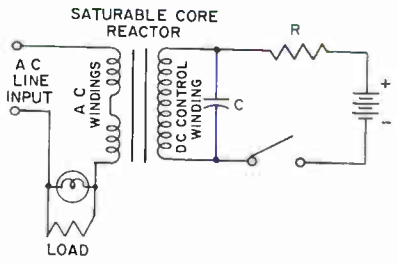

Fig. 1. A simplified sweep circuit is shown. Choice of R and C determines the sweep time.

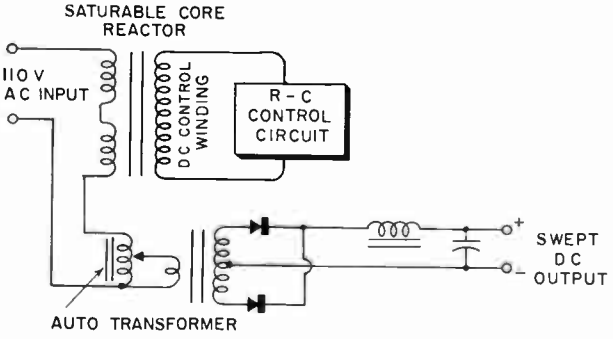

Fig. 2. Reactor output controls a conventional rectifier in order to obtain a dc output sweep.

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SWEEP SUPPLY (Continued)

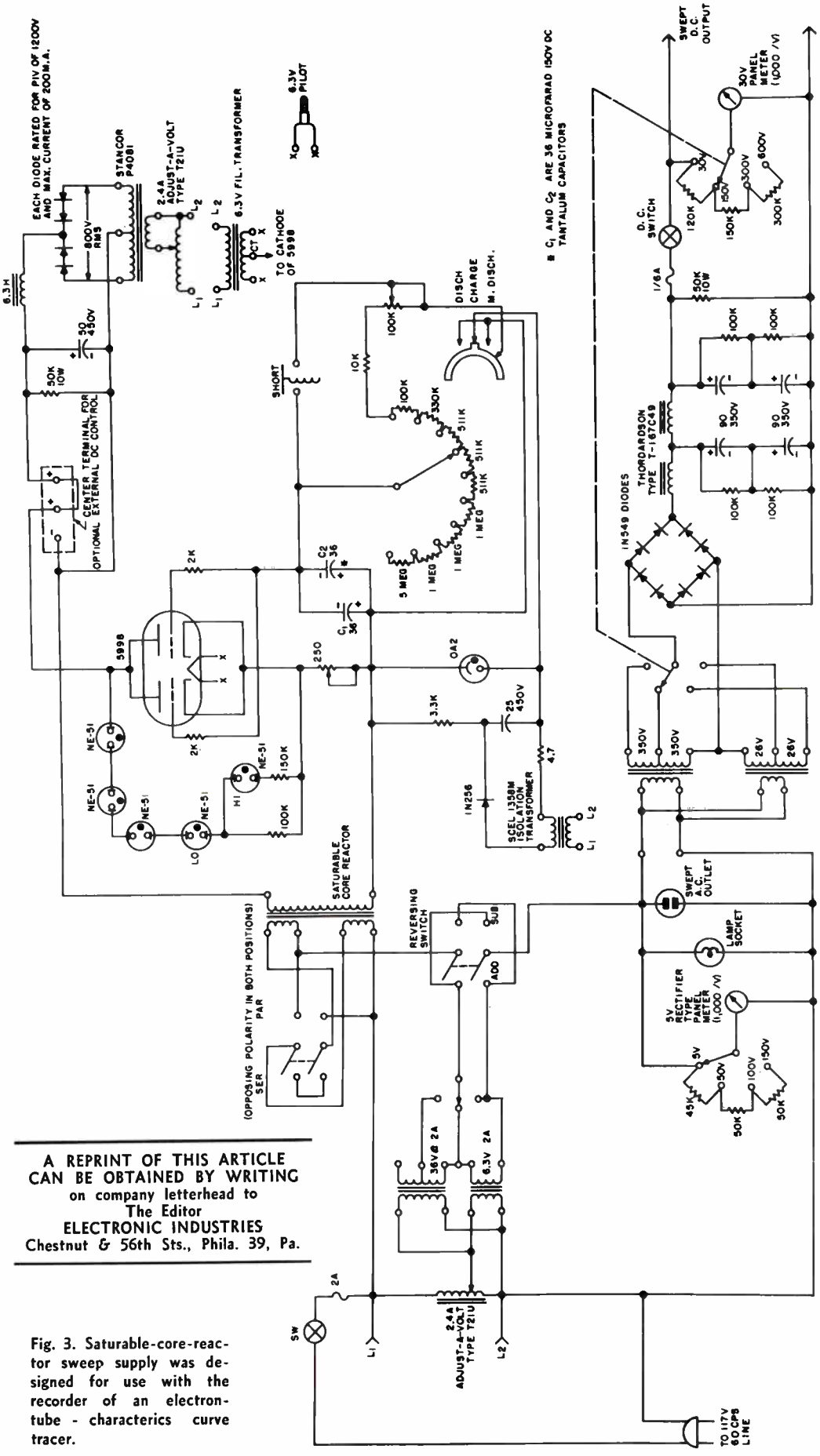

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Fig. 3. Saturable-core-reactor sweep supply was designed for use with the recorder of an electron-tube - characterics curve tracer.

range switch will provide adjustable sweep times from seconds to one hour.

Circuitry

Fig. 3 shows the complete saturable core reactor sweep supply. The reactor was designed for a maximum dc control current of 100 ma, and each ac coil is rated for a maximum of 1a. These ac coils always oppose each other so as not to induce a high voltage in the dc control winding. A series-parallel switch connects the coils for 2a. operation while preserving the relative ac coil opposition. The plate supply voltage auto-transformer controls the maximum sweep excursion. Another auto-transformer and a reversing switch also adjust the minimum and maximum sweep levels.

Warning Indication

A neon-lamp warning circuit is used to caution the operator when the region of maximum plate voltage (275 v.) for the 5998 is approached. The NE51, marked Low, fires when the plate to cathode potential rises within 20 v. of this maximum. The NE51, marked Hi, fires when the voltage exceeds the plate rating. In use, adjustment of the supply voltage to exceed this value is not harmful, for as the tube is swept and cathode current rises, plate voltage drops below 275 v. High plate voltage (Ib cut-off) is not maintained for long time periods, thus tube damage is avoided. An improved supply would eliminate the need for Hi-Low indicators by means of a reactor designed to match the characteristics of a tube chosen for the voltage required. Actual component availability dictated the circuit arrangement shown in Fig. 3. A transistorized version of this circuit would improve the size and weight factor.

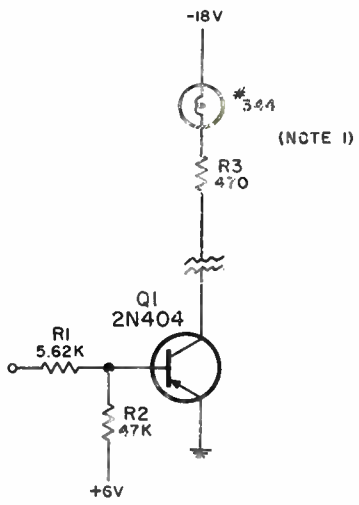
Three-Way Switch

The three-way switch, marked "Discharge, Charge, and Momentary Discharge," starts the sweep rise or fall. The short button is used when it is desired to charge or discharge the cut-off capacitance quickly before initiating a sweep trace. The discharge position starts a rising output-voltage sweep and the charge position starts the decay sweep. The momentary discharge position is used to prevent continued increase of sweep output when the operator is distracted from his duties.

CIRCUIT-WISE

INDICATOR

THIS IS USED AS AN INDICATOR in digital logic circuits. The circuit is designed for a nominal drive of 15 ma at 10 volts to insure conservative operation of the type 344 bulb under limit conditions. It can be used to drive electromechanical devices which operate within the same power limits, or to drive devices with 6v ratings, in which case a −6v source is used for the collector supply.



Unless otherwise stated: R in ohms

NOTES:

1. The indicator and the amplifier may be in different locations.
2. These are the maximum powers dissipated in the resistors. In determining these values, allowance has been made for variations in component values, power supply voltages, and transistor characteristics.
3. The performance specifications are based on component values which do not deviate from the nominal by more than the limits specified. Thus the term "limits" includes the initial tolerance plus drifts caused by environmental changes or aging.

Abstracted from "Handbook Preferred Circuits Navy Aeronautical Electronic Equipment" (NAVWEPS 16-1-519-2), Volume II.

Components:
Max. power dissipation (note 2): R1: 8 mw; R2: 5 mw; R3: 180 mw
Limits (these are not tolerances; see note 3): R1, R2: ±5%; R3: ±20%.

Operating characteristics:
Temp. range: −54°C to +71°C.
Input signal:

	Indicator action
Logical "0" (ground potential)	No light
Logical "1" (−6.2 volts ±10% at 1.2 ma)	Lamp lights

Power requirements:
−18 volts ±10% at 15 ma.
+6 volts ±10% at 0.16 ma.

Last month we presented a State-of-the-Art report called "MICROELECTRONICS TODAY." With that report was a chart reflecting activity but not actual products. Here, as promised, are the specifications of commercially available components and circuits using the latest microelectronic advances.

A STAFF REPORT

PACKAGED MICROELECTRONIC CIRCUITS

LAST MONTH, *Electronic Industries* PUBLISHED PART I of its industry-wide Microelectronics survey—a comprehensive chart identifying 59 manufacturers active in the development of microelectronics, and documenting the methods explored by each in the processing and packaging of eight basic electronic circuits and seven component functions. EI's December chart should serve for some time to come as a ready and quick reference for those seeking sources of experience and capability in any one of the presently known microelectronic techniques.

Part II in this issue presents specifications and package configurations supplied by 27 of the 59 manufacturers for several basic devices, plus a few component arrays which can be interconnected either by the user or by the supplier to form the desired circuit.

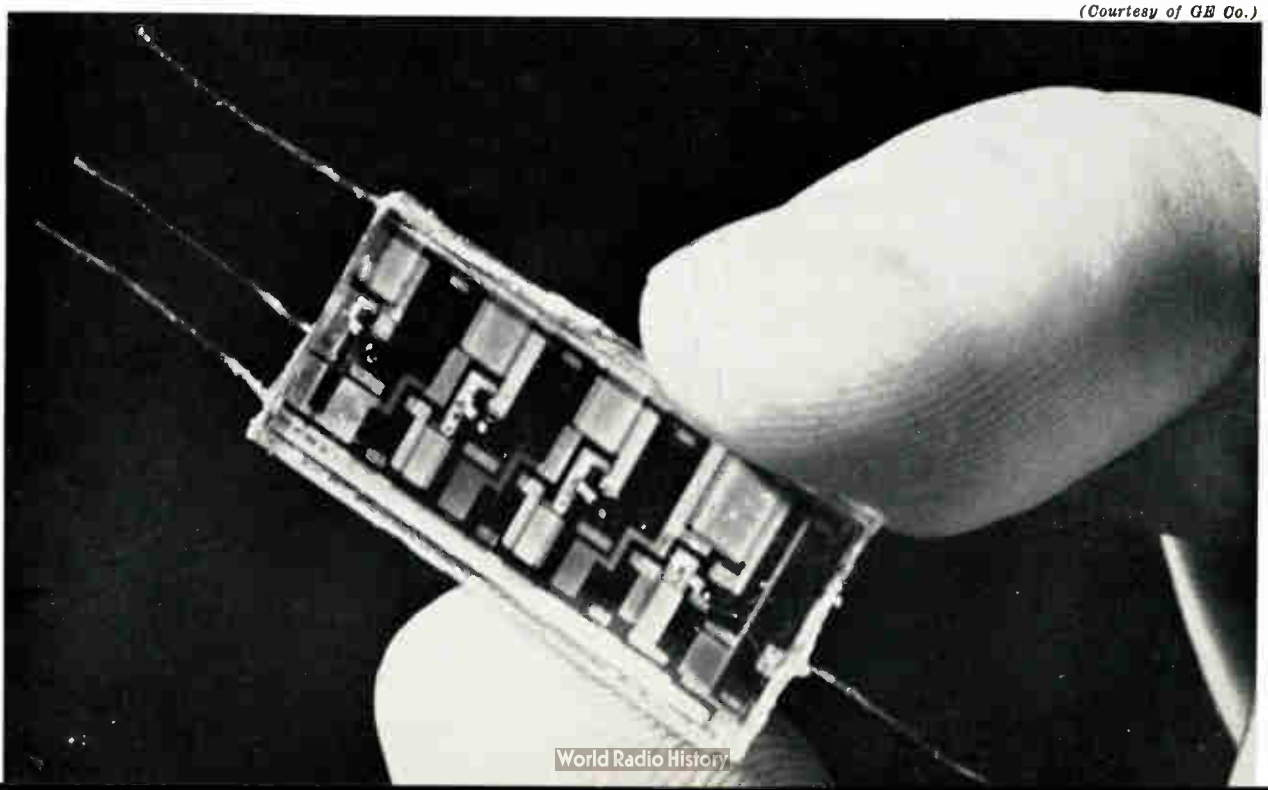
Availability of each product is indicated in the last column of the tabulation. Those labeled as "stock" were said to be available "off-the-shelf," although no delivery time was given. Items identified as "samples" are available in small quantities to the specifications shown. The term "custom" indicates a device that has been produced and is presented as an example of the manufacturer's capability in soliciting a customer's breadboard design.

Most of these packages employ one or more advanced techniques, such as thin film deposition, passivation and multiple-element diffusion. However, some products containing conventional micro components and achieving parts densities that were thought to be of special interest were also included.

It should be noted that there is much more activity by the semiconductor manufacturers in promoting the use of diffused, multiple element networks for custom circuits than shown by our "Semiconductor Arrays" and "Resistor, Capacitor Arrays" listings. A glance at the linear and digital circuit listings in this issue will give some idea of the number of manufacturers with a capability in this area.

* EI's listings include what were considered salient specifications to enable the reader to properly identify the product. Detailed specifications are available, however, in the manufacturers' published literature.

This thin-film, four-stage i-f amplifier measures ½ x 1 in., weighs less than 1½ grams, and operates on a bandwidth of 500 KC. *(Courtesy of GE Co.)*



AMPLIFIERS, OSCILLATORS, DETECTORS

Type No.	App	Freq kc	Gain	Output	Z_i	Z_o	Pwr Req v;ma	Pwr Diss mw	Pkg (Fig)	Wt	Temp Range °C	Avail
CENTRALAB, Electronics Div., 900 E. Keefe Ave., Milwaukee 1, Wisc.												
	Gen.	1							.2 x .28 in			custom
	4-stage Ampl	audio	78db						45			custom
HALEX, INC., 310 E. Imperial Hwy., El Segundo, Calif.												
1001DT	DT	dc-100	10	1v	2K	60	18,7		1		-40+100	4-6 wks.
1002DT	DT	dc-100	30	1v	600	60	18,7		1			4-6 wks.
1003DT	DT	dc-100	100	1v	200	60	18,7		1			4-6 wks.
1004DT	DT	.15-100	300	1v	2K	60	25,15		2			4-6 wks.
1005DT	DT	.05-100	300	1v	600	60	25,15		2			4-6 wks.
1006DT	DT	.15-100	1K	1v	2K	60	25,15		2			4-6 wks.
1007DT	DT	.05-100	1K	1v	600	60	25,15		2			4-6 wks.
1008DT	DT	.015-100	1K	1v	200	60	25,15		2			4-6 wks.
1009DT	DT	.15-100	3K	1v	600	60	25,15		2			4-6 wks.
1010DT	DT	.05-100	3K	1v	200	60	25,15		2			4-6 wks.
1011DT	DT	.15-100	10K	1v	200	60	25, 15		2			4-6 wks.
	Preamp	.2-200	54db	1mw		600			*			
	Audio	.2-1	5-35	2.5v	6meg	14K	20		**			
	Servo	.32-.48	50v/v	4w	10K		45		***			

* *Pkg: .55 x .4 x .18 in.* ** *Pkg: .94 x .81 x .51 in.* *** *Pkg: 1.56 x 1.16 x .66 in.*

LEAR SIEGLER, INC., 3171 S. Bundy Drive, Santa Monica, Calif.												
PN403302	3-stage ampl	.05-4	34db	33mw	75	1K	28-50		*	5gm	-55+125	samples
PN421880	BB	.01-100	51db	.5v	10K	1.5K	6		**			samples
	Servo	.4	200	2w	5K		28		***			samples

* *Pkg: .5 x .5 x .5 in.* ** *Pkg: 1 x 1 x .35 in.* *** *Pkg: .5 x .5 x .3 in.*

Type No.	App	Freq kc	Gain	Output	Z_i	Z_o	Pwr Req v;ma	Pwr Diss mw	Pkg (Fig)	Wt	Temp Range °C	Avail
MINNEAPOLIS-HONEYWELL, Semiconductor Div., Riviera Beach, Fla.												
MHM1001	DARL	to 60mc	1000				V_{cb}:60	.4w	TO5			stock
MHM1101	DARL	to 60mc	1000				V_{cb}:60	.26w	TO18			stock
MOTOROLA, Semiconductor Prods, Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.												
	2-stage ampl	.1-50mc	30db						TO5			custom
	DARL								TO5			custom
	Ampl	Audio							TO5			custom
	Osc	11.5mc							TO5			custom
	Mixer	120mc							TO5			custom
	Ampl	12mc							TO5			custom
TRANSISTRON, Electronic Corp., Wakefield, Mass.												
	V. Ampl	dc-100	20	5μv*	500K	3K	+18		**			custom
	PA(p/p)	.02-20		5w	3K	20	18		**			custom
	vid ampl dblt.	.02-7mc	20				22		**			custom

* *Equivalent input noise voltage.* ** *Variety of 3-dimensional Pkgs.*

WESTINGHOUSE ELECTRIC CORP., Semiconductor Div., Youngwood, Pa.												
WX001	PA	audio	35db	300mw	100	200	22,60		36*	MIL202B		4 wks
WX002	BB	455-3K	25db		300	1K	12,3		36*	MIL202B		4 wks
WX003	**	455-3K	25	8v	1K	1K	12	24	37*	MIL202B		4 wks
WX006	det(2)	455-3K	(detects and filters audio from A-M carrier) (Fig 37*)									4 wks
WX007	DARL	audio	30db	2mw	5K	100-1K	12	80	37*	MIL202B		4 wks
WX027	p/p PA	audio		20w			200		38	MIL202B		4 wks
WX030	DARL	audio	100K		1meg	750	45	.5w	37*	MIL202B		4 wks
WX031	osc/mix	7K-30K	15db		300	2.5K	12	50	37*	MIL202B		4 wks

* *Available in other pkgs and lead arrangements.* ** *Designed for external tuning element.*

LOGIC CIRCUITS

Type No.	App	Function (Fig)	Circuit (Elements)	Freq	Fan-Out	Average Delay	Supply V	Pwr Diss mw	Pkg (Fig)	Wt	Temp Range °C	Avail
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N.Y.												
B892000		F		0-100kc		±6	60		46	.7oz	-20+60	stock
B893000	AND	3-in G*	D,R						46	.7oz	-20+60	stock
B893001	AND	2-in G*	D,R						46	.7oz	-20+60	stock

* *Twin ckts in each unit.*

Type No.	App	Function (Fig)	Circuit (Elements)	Freq	Fan-Out	Average Delay	Supply V	Pwr Diss mw	Pkg (Fig)	Wt	Temp Range °C	Avail
AMPEREX ELECTRONIC CORP. – *(Continued)*												
B893002	OR	3-in G*	D,R						46	.7oz	-20+60	stock
B893003	OR	2-in G*	D,R						46	.7oz	-20+60	stock
B893004		pulse G*	D,R,C						46	.7oz	-20+60	stock

* *Twin cks in each unit.*

ABBREVIATIONS

A – full adder
ADC – analog-to-digital converter
B – buffer
BB – broad band ampl
BCD – binary-to-decimal converter
C – counter
CA – Common anode
CC – common cathode
D – diode
DARL – Darlington ampl
DCT – direct-coupled transistor logic
DL – diode logic
DT – data transmission
E – "exclusive OR" circuit
ECL – emitter-coupled logic
EF – emitter-follower
F – flip-flop
G – gate
H – half adder
HS – high speed
I – inverter
O – OR circuit
PA – power ampl
PI – power inverter
R – resistor
RCT – resistor-capacitor-transistor logic
S – shift register
T – transistor
TCL – transistor-coupled logic

LOGIC CIRCUITS – *(Continued)*

Type No.	App	Function (Fig)	Circuit (Elements)	Freq	Fan-Out	Average Delay	Supply V	Pwr Diss mw	Pkg (Fig)	Wt	Temp Range °C	Avail
AMPEREX ELECTRONIC CORP. – *(Continued)*												
B894000		EF/I	T,R,C	0-100kc			±6		46	.7oz	–20+60	stock
B894001		EF*	T,R	0-100kc			±6		46	.7oz	–20+60	stock
B894002	NOT	I*	T,R,C	0-100kc			±6		46	.7oz	–20+60	stock
B894003		EF/B*	T,R,C,D	0-100kc			±6		46	.7oz	–20+60	stock
B895000		pulse shap.	T,R,C				±6		46	.7oz	–20+60	stock
B895001		S/S MV					±6		46	.7oz	–20+60	stock
B885000		4F/C					±6		p/w bd		–20+60	stock
* *Twin ckts in each unit.*												
BURROUGHS CORP., Electronic Components Div., Plainfield, N.J.												
BIP5500	DL	BCD(25)	40D					500	27		–65+65	stock
BIP5501	DL	BCD(25)*	40D					500	27		–65+65	stock
BIP5502	DL	BCD(26)	40D					500	27		–65+65	stock
BIP5503	DL	BCD(26)*	40D					500	27		–65+65	stock
BIP8000	DL	C(28)		dc-110kc					29	2.3oz		stock
BIP80001	DL	C(30)		dc-110kc					31	2.5oz		stock
* *See NOTE in Fig. Other packages include alpha-numeric decoders, encoders and distributors.*												
CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass.												
A01	AND	5 input G	D,R						*	7.6gm	–55+55	stock
BA1		B	D,T,R	10mc		20ns	–12		*	9.5gm	–55+55	stock
BM1	Bist.	MV		10M		30ns	–12		*	9.5gm	–55+55	stock
IN1		I	T,C,R	10mc		20ns	–12		*	9.5gm	–55+55	stock
IN3		I	T,C,R	10mc		10ns	–12		*	9.5gm	–55+55	stock
LT1		Trig	T,C,R,D	10mc			–12		*	9.5gm	–55+55	stock
NA1	NAND	G	T,C,R	10mc		20ns	–12		*	9.5gm	–55+55	stock
NO1	NOR	G	T,C,R	10mc		20ns	–12		*	9.5gm	–55+55	stock
OA1	OR	G	D,R						*	7.6gm	–55+55	stock
* *Pkg std min 7-pin, 3/4 x 5/8 x 3/4 in.*												
CENTRALAB, Electronics Div., 900 E. Keefe Ave., Milwaukee 1, Wisc.												
	NOR	G,F,MV	R,T	10mc								custom
		mix G	5R, 1C						44			custom
COMPUTER CONTROL CO., INC., 2251 Barry Ave., Los Angeles 64, Calif.												
LE61	NOR/NAND			dc-2mc	9		+8	43	*	30gm	–10+80	120dys
PL61	NOR/NAND	PA		dc-2mc	22			70	*	30gm	–10+80	120dys
FF61	NOR/NAND	R/S F		dc-2mc	9		+8	43	*	30gm	–10+80	120dys
AD61	NOR/NAND	del. MV		dc-2mc	9			19	*		–10+80	120dys
SN61		synch.						62	*			120dys
WS61		word stg		2 mc	9			150	*		0+70	120dys
SM61		ser. memory		1 mc				150				
AN61		ADC						450				
* *Module 1/2 x 1/2 x 7/8 in. with flying leads. Other pkgs available.*												
CORNELL-DUBILIER ELECTRONICS, 50 Paris St., Newark 1, N.J.												
1MCA1	NAND	I	T,D,C,R	1mc	7	.05μs	–18		*		–15+55	custom
1MCA2	NAND	non I	T,D,C,R	1mc	7	.05μs	–18		*		–15+55	custom
1MCA3	NAND	PA	T,D,C,R	1mc	30	.05μs	–18		*		–15+55	custom
1MCB1	NAND	F		1mc	6	.05μs	–18		*		–15+55	custom
1MCC1	NAND	MV, PA, G		.1c-1mc	30	.05μs	–18		*		–15+55	custom
* *Pkgd to customer order.*												

Type No.	App	Function (Fig)	Circuit (Elements)	Freq	Fan-Out	Average Delay	Supply V	Pwr Diss mw	Pkg (Fig)	Wt	Temp Range °C	Avail
CORNELL-DUBILIER ELECTRONICS – *(Continued)*												
1MCD1	NAND	S/S MV		1mc	6	.05μs	–18		*		–15+55	custom
1MCG1	NAND	7-G	D						*			custom
* *Pkgd to customer order.*												
DELCO RADIO DIV., General Motors Corp., Kokomo, Ind.												
DM100	DL	I		175kc	5	.3ms	6		39*		–60+71	30 dys
DM101	DL	3-G		175kc	5	.3ms	6		39*		–60+71	30 dys
DM130	DL	I		175kc	20	.3ms	6		39*		–60+71	30 dys
DM200		F		175kc	5	.3ms	6		39*		–60+71	30 dys
DM210		MV		175kc	5	.3ms	6		39*		–60+71	30 dys
DM221		S/S MV			5				39*		–60+71	30 dys
DM240		Trig		175kc			6		39*		–60+71	30 dys
SM133	DL	Dual G		100kc	4			4mw	40		–40+100	30 dys
SM200		F		100kc	3	2μs		10mw	40		–40+100	30 dys
SM220		S/S MV			6	20μs			40		–40+100	30 dys
SM240		MV		25-125kc	4				40		–40+100	30 dys
* *Width limits of pkg: .2" to .8".*												
ELECTRA MFG. CO., 800 N. 21st St., Independence, Kansas												
CM1	NOR	G(33)	T,R				5		33			stock
MM1	NOR	G(34)	T,R				5		34			custom
FAIRCHILD Semiconductor, 545 Whisman Rd., Mountain View, Calif.												
μLF	NOR	F(3)	DCT	1mc	5	50ns	3	30	TO-5*		–55+125	stock
μLG	NOR	G(4)	DCT	1mc	5	50ns	3	15	TO-5*		–55+125	stock
μLS	NOR	S(5)	DCT	1mc	5	100ns	3	75	TO-5*		–55+125	stock
μLB	NOR	B(6)	DCT	1mc	25	60ns	3	25	TO-5*		–55+125	stock
μLC	NOR	C(7)	DCT	1mc	5	100ns	3	75	TO-5*		–55+125	stock
μLH	NOR	H(8)	DCT	1mc	5	50ns	3	45	TO-5*		–55+125	stock
* *Available also in TO-47 and Type 00 packages.*												
GENERAL ELECTRIC CO., Semiconductor Dept., Syracuse, N.Y.												
M1	ECL	S	R,T	2mc				6mw	TO5			samples
M1	ECL	G	R,T						TO5			samples
M1	ECL	G*							TO5			samples
M1	ECL	AND G							TO5			samples
M1	ECL	F	R,T						TO5			samples
M1	ECL	4-I	R,T						TO5			samples
M1	ECL	AND/OR G	R,T						TO5			samples
* *3 double pair gate circuit.*												
INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa.												
	NOR	G	R,T	100kc	8		2.5	6.5mw	*	.22gm	+50	samples
* *Flat, hermetically sealed pkg .4 x .4 x .05 in.*												
KEARFOTT SEMICONDUCTOR CORP., General Precision, Inc., West Newton, Mass.												
21NRLSB	NOR	(23)	T*,R	1mc		60ns	–10		TO5		–65+125	6 wks
21NRLGB	NOR	(23)	T**,R	1mc		60ns	–10		TO5		–65+70	6 wks
21ORS		0(24)	T*,R	1mc		30ns	–10		TO5		–65+125	6 wks
21ORLGA		0(24)	T**,R	1mc		20ns	–10		TO5		–65+70	6 wks
* *Silicon* ** *Germanium*												

LOGIC CIRCUITS – *(Continued)*

Type No.	App	Function (Fig)	Circuit (Elements)	Freq	Fan-Out	Average Delay	Supply V	Pwr Diss mw	Pkg (Fig)	Wt	Temp Range °C	Avail
LEAR SIEGLER, INC., 3171 S. Bundy Drive, Santa Monica, Calif.												
		RST F		5mc			6		*		+125	samples
	AND	dual G					6		*		+125	samples
	OR	dual G					6		*		+125	samples
		Trig	Schmidt				6-28		*		+125	samples
	NOT	dual I					6		*		+125	samples
* *Pkg size: .5 x .5 x .3 in.*												
P. R. MALLORY & CO., Indianapolis 6, Ind.												
6928FA**		R/S F	T,D,C,R	10kc					.179 cu in			samples
6928KB*	DL	AND G	D,R									samples
* *In kit form; also includes OR Gate, F–F, M–V, Amplifier, Bridge Rect.* ** *Available in kit form.*												
MINNEAPOLIS-HONEYWELL, Semiconductor Prods., Riviera Beach, Fla.												
	NOR	G	DCT	1mc					TO5*			stock
		F	DCT	1mc					TO5*			stock
* *Available also in TO18 and rectangular pkgs.*												
MOTOROLA, Semiconductor Prods, Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.												
MECL	NOR/NAND	ECL(47)			6	4ns	5.2	35	TO5		–55+125	custom
MECL		R/S F	T,R						TO5		–55+125	custom
MECL		H(48)				4ns	5.2		TO5		–55+125	custom
PACIFIC SEMICONDUCTORS, Subsidiary of TRW Electronics, 12955 Chadron Ave., Hawthorne, Calif.												
PS1910		Dual E		2mc	5F				15		–55+110	stock
PS1911		Dual I		2mc	5F				16		–55+110	stock
PS1912		F		2mc	5				17		–55+110	stock
PS1913	AND	G		2mc	5F		+12		18		–55+110	stock
PS1914	OR	G		2mc	5F		+12		19		–55+110	stock
PCF101		F(20)	TCL	dc-3mc	4		3		TO5*		–55+125	2 wks
PCG101	NAND	G(21)	TCL	dc-5mc	4		3		TO5		–55+125	2 wks
PCH101		H(22)	TCL	dc-5mc	4		3		TO5*		–55+125	2 wks
* *Also available in TO18 case.*												
PHILCO CORP., Lansdale Div., Lansdale, Pa.												
μ7004	NOR	G	R,T		3		11	110mw	TO5		–25+100	samples
μ7005		R/S F	R,T		2		11	100mw	TO5		–25+100	samples

Type No.	App	Function (Fig)	Circuit (Elements)	Freq	Fan-Out	Average Delay	Supply V	Pwr Diss mw	Pkg (Fig)	Wt	Temp Range °C	Avail
RADIO CORP. OF AMERICA, Semiconductor and Materials Div., Somerville, N.J.												
DMC100	NOR/NAND	*	D,T,R(41)	10mc		18ns	+7.5	14mw	42		–55+125	samples
CMO911		S/S M	D,T,R		8	.3-3ms	+18		43		–30+90	samples
CMO912		R/S F	D,T,R		3		+18		43		–30+90	samples
CMO913		G/I	D,T,R				+18		43		–30+90	samples
CMO914		G	7D						43		–30+90	samples
CMO915		S/C	D,T,R,C		3		+18		43		–30+90	samples
* *Performs all logic functions by interconnection of units.*												
TEXAS INSTRUMENTS, P.O. Box 5012, Dallas 22, Tex.												
SN510	NOR/NAND	F/C(9a)	RCT	1mc	4	75ns	3-6	2	14	.05gm	–55+125	stock
SN511*	NOR/NAND	F/C(9b)	RCT	1mc		75ns	3-6	3	14	.05gm	–55+125	stock
SN512	NOR/NAND	G(10)	RCT		5		3-6	2	14	.05gm	–55+125	stock
SN513*	NOR/NAND	G(11)	RCT				3-6	3	14	.05gm	–55+125	stock
SN514	NOR/NAND	G(12)	RCT		5		3-6	2	14	.05gm	–55+125	stock
SN515	NOR/NAND	E(13)	RCT				3-6	4	14	.05gm	–55+125	stock
* *With emitter-follower output.*												
TRANSITRON, Electronic Corp., Wakefield, Mass.												
		F		3.5mc			12	150	*			custom
		C		2mc+			12	150	*			custom
* *Variety of 3-dimensional configurations, assembled, encapsulated.*												
WALKIRT, 10321 La Cienga Blvd., Los Angeles 45, Calif.												
MM10333	Bist. MV	bin. C		10mc			+18		32	4gm	–54+125	4 wks
MM10343		trig.		10mc	1		+18		32	4gm	–54+125	4 wks
MM10353*		B	EF	10mc	3		+18		32	4gm	–54+125	4 wks
MM10383*	DL	AND G	EF	10mc			+18		32	4gm	–54+125	4 wks
MM10413*	NOT	I		10mc			+18		32	4gm	–54+125	4 wks
MM10423*	DL	OR G	EF	10mc			+6		32	4gm	–54+125	4 wks
MM10433	Mono MV			5mc		.25μs	+18		32	4gm	–54+125	4 wks
MM10443		F		10mc			+18		32	4gm	–54+125	4 wks
MM14433	Indicator driver; will drive #327 bulb						+24					4 wks
* *For dual units add "D" to Type No.*												
WESTINGHOUSE ELECTRIC CORP., Semiconductor Div., Youngwood, Pa.												
AED2355A	NAND	G(35)	R,T,D		5		+6	25	TO5			4 wks

SEMICONDUCTOR ARRAYS

Type No.	App	Circuit (Fig)	BV	V_{CB}	I_o	h_{FE}	C_o	t_r	Pwr Diss mw	Pkg (Fig)	Temp Range °C	Avail
			(Per unit characteristics)									
CLEVITE CORP., 200 Smith St., Waltham 54, Mass.												
	4D	G	15		25ma		1.5μμf		20	(56)	–65+90	custom
	D	Quad*	90		10ma		4μμf	4μs				custom
* *Matched pairs and ring and bridge modulators also available*												
FAIRCHILD Semiconductor, 545 Whisman Rd., Mountain View, Calif.												
μET1*	HS T	(49)		20		80	5pf	20ns	500	TO5	+125	samples

Type No.	App	Circuit (Fig)	BV	V_{CB}	I_o	h_{FE}	C_o	t_r	Pwr Diss mw	Pkg (Fig)	Temp Range °C	Avail
			(Per unit characteristics)									
FAIRCHILD – *(Continued)*												
μED1*	CC	(50)	30		15ma		4pf	7ns	500	TO5	+125	samples
μEO2*	CA	(51)	30		16ma		4pf	7ns	500	TO5	+125	samples
* *Diffused, for integrated ckt applications.*												
RAYTHEON CO., Semiconductor Div., Lowell, Mass.												
PAK	D	Quad	35-100		65ma				80	(55)	–60+90	stock

SEMICONDUCTOR ARRAYS – *(Continued)*

Type No.	App	Circuit (Fig)	BV	V_{CB}	I_o	h_{FE}	C_o	t_r	Pwr Diss mw	Pkg (Fig)	Temp Range °C	Avail
			(Per unit characteristics)									
RAYTHEON CO. – *(Continued)*												
PAK	D	Quad	25-180		200ma				250	(55)	–60+150	stock
MP200	D	Pair*	175		1ma							stock
MQ400	D	Quad*	175		1ma							stock

Type No.	App	Circuit (Fig)	BV	V_{CB}	I_o	h_{FE}	C_o	t_r	Pwr Diss mw	Pkg (Fig)	Temp Range °C	Avail
			(Per unit characteristics)									
RAYTHEON CO. – *(Continued)*												
MP203	D	Pair*	200		10ma							stock
MQ403	D	Quad*	200		10ma							stock

* *Matched*

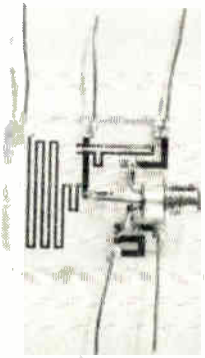
T–F RESISTOR AND CAPACITOR ARRAYS

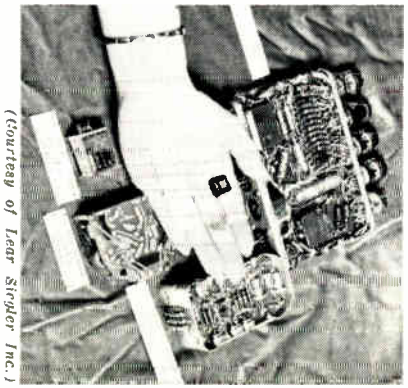
Type No.	App Funct	Circuit (Fig)	Value Range (ohms/pf)	BV	Ohms/ Sq	Tol %	Temp Coeff ppm/°C	Temp Range °C	Pwr Diss mw	Mil Spec	Pkg (Fig)	Avail
CORNING, Electronic Components, Corning, N.Y.												
	R		25-150K			2,5,10	150	+165			•	custom
• *Metal oxide on alumina to customer requirement.*												
ELECTRA MFG. CO., 800 N. 21st St., Independence, Kansas												
	R		10-100K	300	300	1,2,5	100		500		•	custom
	R		100K-200K	300	300	1,2,5	200		500		•	custom
	R		200K-800K	300	300	1,2,5	300		500		•	custom
• *Normally glass or alumina .31 x .31 x .01 in. Other sizes, shapes available.*												
FAIRCHILD Semiconductor, 545 Whisman Rd., Mountain View, Calif.												
μER1*	R	(52)	90-6K	30			.1-.2%	+125	500		TO5	samples
• *Diffused silicon.*												

Type No.	App Funct	Circuit (Fig)	Value Range (ohms/pf)	BV	Ohms/ Sq	Tol %	Temp Coeff ppm/°C	Temp Range °C	Pwr Diss mw	Mil Spec	Pkg (Fig)	Avail
FAIRCHILD – *(Continued)*												
μER2*	R	(53)	1.5K-16K	30			.1-.2%	+125	500		TO5	samples
• *Diffused silicon.*												
INTELLUX, INC., 30 S. Salsipuedes St., Santa Barbara, Calif.												
	R		50+		100	1,10	50	•	–55+150	5w/sq in.	10509D	.1" x .2" custom
MICROLECTRON, INC., 1547 18th St., Santa Monica, Calif.												
	R		10-100K*			1,5,10	200	+97	500		10509D	(54) 30 dys
• *per resistor; 2 resistors per wafer side; 500K total for 4 in series. Other size substrates available to order.*												

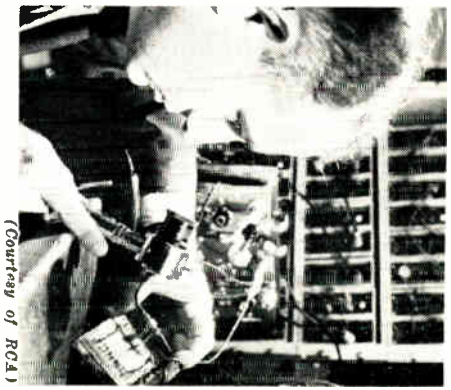
(Above) Relative size of an inverter. (Below) Physicist uses high vacuum apparatus for deposition of thin films. *(Courtesy of Sprague Electric Co.)*

(Courtesy of ITT Federal Labs)





Comparison of micromodule circuit with older units performing similar functions. *(Courtesy of Lear Siegler Inc.)*



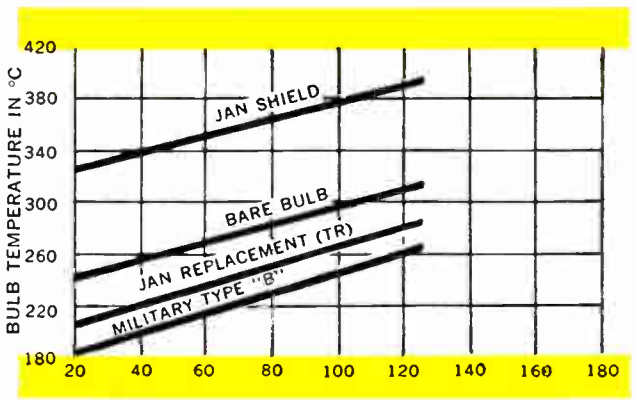
Researcher examines microferrite memory which is held in complex test apparatus. *(Courtesy of RCA)*

Cinch ELECTRONIC COMPONENTS

COMPONENTS ENGINEERED FOR **SPECIFIC** RELIABILITY REQUIREMENTS

For greater MTBF ★*

increase tube life up to 1200%* with Cinch heat dissipating tube shields



6005/6AQ5 Operating at Maximum Plate Dissipation

★ Mean Time Between Failures is a result of many factors, but tube failure due primarily to high bulb temperature is generally acknowledged to be responsible for at least 70% of equipment breakdown.

These Cinch tube shields are designed to provide a substantially cooler tube operating environment, reducing tube temperatures more than 50°C below bare bulb temperatures.

*Tube life increases up to 1200% have been recorded in equipment using these tube shields, under actual operating conditions. This will naturally vary with tube type and operating temperature, ambient temperature, air circulation, etc.

MILITARY TYPE "B"—Cinch T5 and T6 Series are designed for new equipment applications. Each shield locks into a flanged base that mounts to the chassis through the tube socket mounting holes.

Cinch T5 and T6 Series meet or exceed all physical and environmental specifications of MIL-S-9372C and SCL-6307/2, including for vibration (15 g, 10-2000 cps), heat resistance (200°C), heat dissipation (required 20°C actual 50°C at sea level and 50,000 ft.) and salt spray (50 hour).

JAN-TYPE REPLACEMENTS—Cinch TR Series are designed as direct replacements for obsolete JAN shields (now specifically prohibited by all military services). Actual heat dissipation under MIL-S-9372C is 40°C.

They meet all physical and environmental requirements of MIL-S-9372C, MIL-S-19786, SCL-6307/2 and FAA-R-777.

FAST DELIVERY—Shields for all standard 7 and 9 pin miniature tubes are carried in stock. Most orders can be shipped immediately. Contact your Cinch representative or write us directly for detailed information.

Manufactured under license agreement with International Electronic Research Corporation.

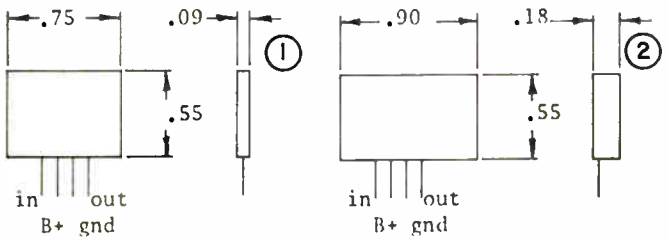
Circle 71 on Inquiry Card

CINCH MANUFACTURING COMPANY

1026 South Homan Avenue, Chicago 24, Illinois

Plants located in Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; and St. Louis, Missouri.

DOT A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS



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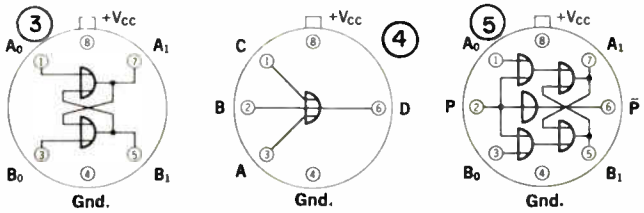
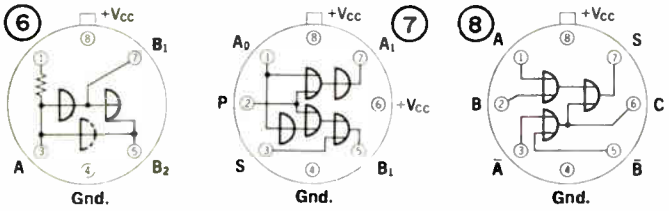


$\bar{A}_1 = A_0 + B_1$
$\bar{B}_1 = B_0 + A_1$

$D = \overline{A + B + C} = \bar{A}\,\bar{B}\,\bar{C}$

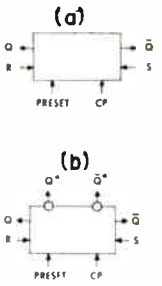
$\bar{A}_1 = B_1 + \bar{A}_0\,\bar{P}$
$\bar{B}_1 = A_1 + \bar{B}_0\,\bar{P}$



$B_1, B_2 = \bar{A}$

$\bar{A}_1 = \bar{A}_0\,\bar{P}$
$\bar{B}_1 = A_0\,\bar{P} + S$

$S = A\bar{B} + \bar{A}B$
$C = AB$

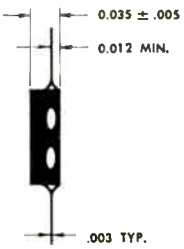


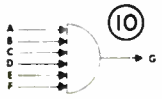
9

Truth Table

t_n		t_{n+1}
R	S	Q
0	0	Q_n
0	1	1
1	0	0
1	1	Indeterminate

Fan-out
Terminal Q and $\bar{Q}$ – 4 max
Terminal Q* and $\bar{Q}$* – 20 max

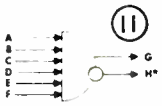




10

Logic

	NAND	NOR
G	$\overline{ABCDEF}$	$\overline{A+B+C+D+E+F}$

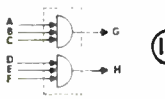


11

Logic

	NAND	NOR
G	$\overline{ABCDEF}$	$\overline{A+B+C+D+E+F}$
H	$\overline{ABCDEF}$	$\overline{A+B+C+D+E+F}$

Fan-out
Terminal G – 5 max
Terminal H – 25 max



12

Logic

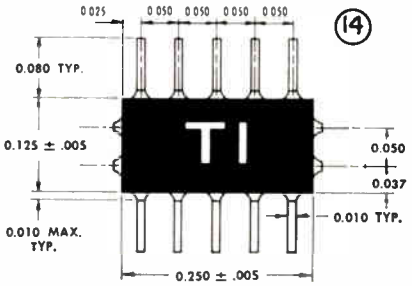
	NAND	NOR
G	$\overline{ABC}$	$\overline{A+B+C}$
H	$\overline{DEF}$	$\overline{D+E+F}$

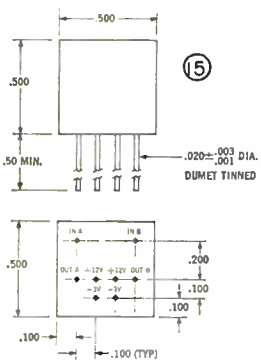
13

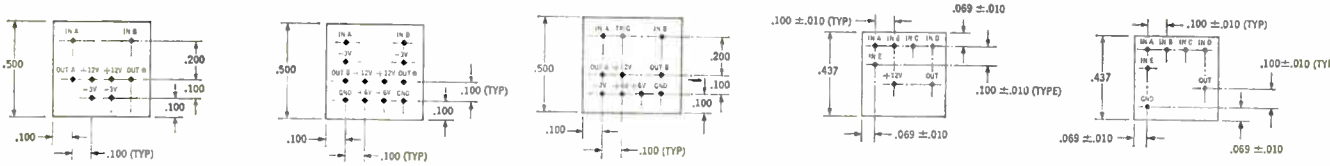
Logic

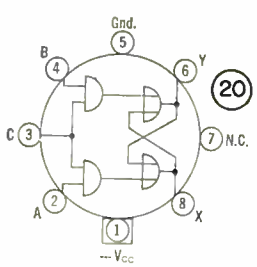
	NAND	NOR
C	$\bar{A}+B$	$\bar{A}\,\bar{B}$
D	$A\bar{B}+\bar{B}A$	$A\bar{B}+\bar{B}A$
E	$A+\bar{B}$	AB

Fan-out
Terminal C and E – 4 max
Terminal D – 5 max



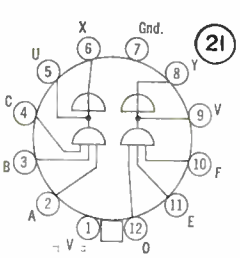






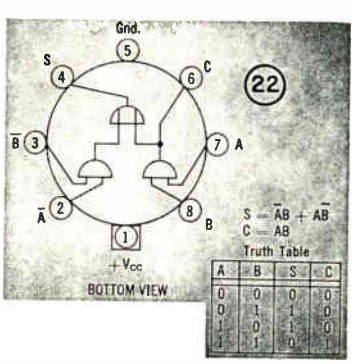
20

$\bar{X} = AC + Y$
$\bar{Y} = BC + X$



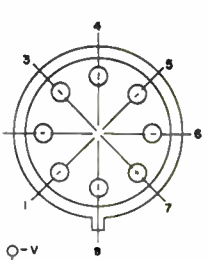
21

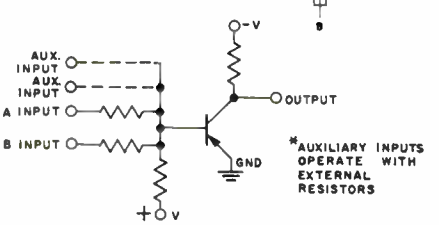
$X = \overline{ABC} + \bar{U}$
$Y = \overline{DEF} + \bar{V}$
$U = ABC$
$V = DEF$



PIN 1 –VOLTAGE
PIN 2 OUTPUT
PIN 3 INPUT
PIN 4 *AUXILIARY INPUT
PIN 5 +VOLTAGE
PIN 6 GROUND
PIN 7 INPUT
PIN 8 *AUXILIARY INPUT

23





(More Diagrams on page 135)

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THAT SET NEW STANDARDS OF RELIABILITY!

Here's a "twist-tab" electrolytic capacitor designed specifically for the rigorous requirements of instrument manufacturers. Check this list of advantages over conventional "twist-tab" electrolytics.

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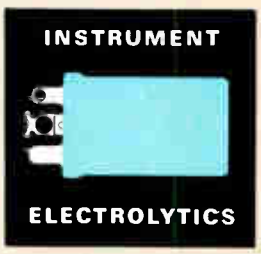

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ELECTRONIC COMPONENTS

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

EC62-5

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ELECTRONIC COMPONENTS

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SPRINGFIELD, ILLINOIS

EC62-2

A new class of logic circuits that are far simpler than anything being used today has been made possible through use of multi-aperture ferrite cores. A new digital telemetering system which makes use of these cores is described.

A NEW DIGITAL TELEMETERING SYSTEM

UNTIL RECENTLY, there have been no basic changes in the methods for electrically implementing complicated logic functions. Although transistor and diode logic are more advanced than relay logic, their logic circuits operate on much the same basic principles. The first commercial application of a new class of logic circuits has been announced by the Solid State Systems Div. of Motorola Inc. of Phoenix, Ariz.

It has developed a new pulse-operated, digital-type telemetric control system that uses multiaperture-core logic circuits. The system, named Telememory, is designed for remote operation of pipelines, power-dispatch systems, water-distribution networks and bulk-loading terminal facilities. It enables a man at a central station to monitor and control the flow of fluids or electric power at as many remote stations as system dynamics require. The remote stations contain measuring instruments, control devices, and equipment for monitoring their own operation. The central station contains a control console and displays for remote-station quantitative data and equipment-status reports.

All the logic functions in this system are implemented magnetically with multiaperture ferrite cores. Each core, about the size of a dime, is an integrated logic circuit capable

By H. H. GEORGENS and L. I. DUTHIE
Solid State Systems Div.
Motorola Inc.
Phoenix, Ariz.

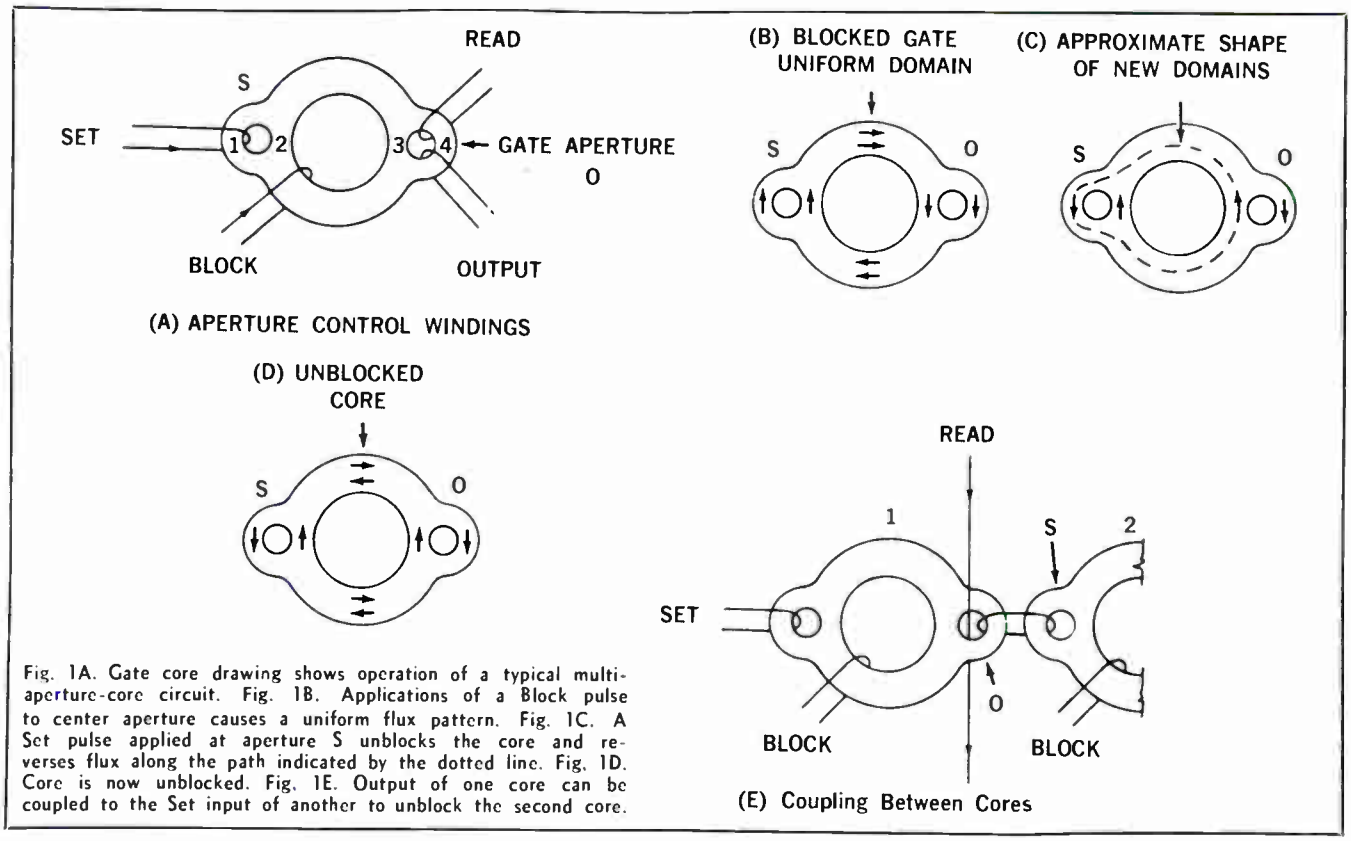


Fig. 1A. Gate core drawing shows operation of a typical multi-aperture-core circuit. Fig. 1B. Applications of a Block pulse to center aperture causes a uniform flux pattern. Fig. 1C. A Set pulse applied at aperture S unblocks the core and reverses flux along the path indicated by the dotted line. Fig. 1D. Core is now unblocked. Fig. 1E. Output of one core can be coupled to the Set input of another to unblock the second core.

of performing a stated logic function. The core circuits, therefore, reduce both the number of components in the system and the size of the equipment package.

More important than the reduction in equipment size is the increase in reliability achieved through simplification of the logic circuitry.

Overall system reliability is further increased by the properties of the cores themselves. They are made of a stable, homogeneous ferrite material that is immune to environmental effects and aging. Logic functions are implemented by changing the direction of magnetic flux, around the various apertures of the core. A feature of this type of circuit is that the flux density established in the core is retained after removal of power. Thus, a power interruption cannot cause the cores to produce an unwanted control action. Moreover, as information is stored in the remanent magnetization of the core, readout is non-destructive and no standby power is needed for the logic circuitry; power is required only to change or read the magnetic state of the cores. This reduces the amount of standby power needed at remote stations.

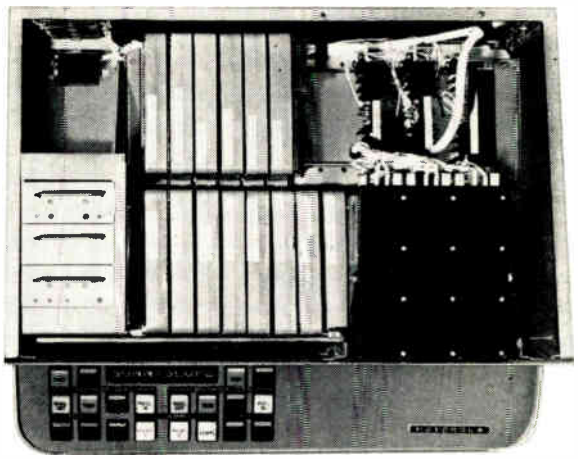


Fig. 2. Typical control console contains all the modules for central-station functions and pushbuttons for manual system operation. Quantitative data and status conditions can be displayed on the control console or on separate panels.

System Flexibility

The flexibility inherent in the simplicity and small size of the core circuits is fully realized by using the logic cores as the basis of a number of modular equipment packages. Each package is an integral subassembly containing all the logic cores (and, where required, power transistors) needed to perform one of the system's basic operations. Any combination of monitoring and control capabilities can be provided by selecting and interwiring the appropriate modules. The generic-module packaging method also makes it easier to alter or expand the system at a later date.

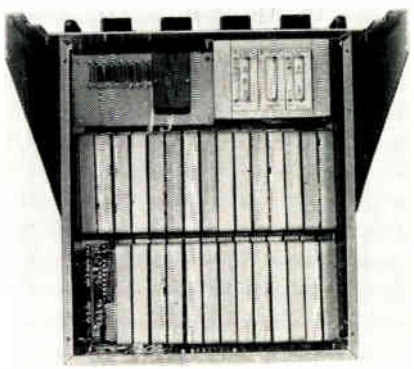
Telememory can vary from a system that measures a single variable at one remote location to one that performs a variety of supervisory and control functions at as many remote locations as the dynamics of the application permit. Standard control options available with the system are stop/start, raise/lower, and open/close. These options can be used to operate pumps, gates, valves, circuit breakers, or other final control devices. The system can also include provision for the digital adjustment of set-points in remote control loops.

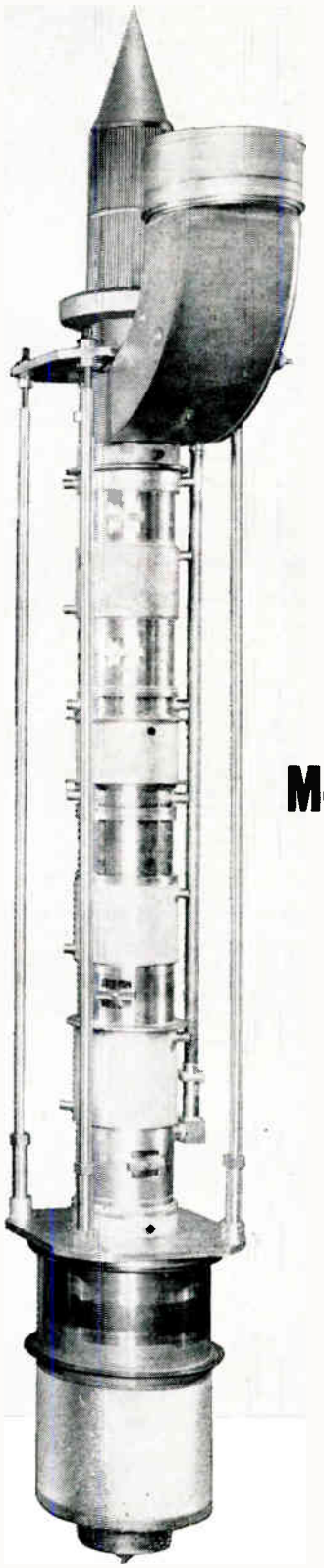
The system's supervisory capabilities consist of reporting quantitative measurements, equipment status, and alarm conditions. Standard subsystems, compatible with all common types of primary transducing devices, can be provided for the measurement of simple variables (amperes, level, pressure, flow, etc.) and such complex variables as mass flow. Subsystems can include computing elements for totalizing quantitative data.

System operation may be manual, semi-automatic, or fully automatic. In the manual mode the operator selects and interrogates remote stations individually. In the semi-automatic mode the operator initiates a program in which all remote stations are automatically interrogated in sequence. A fully automatic system interrogates all remote stations in sequence at regularly scheduled time intervals; no operator action is required.

Systems with either of the two automatic modes include data-log-

Fig. 3. Typical remote-station unit consists of generic-function modules mounted in standard relay rack. Modules measure only 4.4 x 6.3 x 1.0 inches. They are interconnected by taper pins.





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Megawatts at L band . . .

A megawatt or more at X band . . .

or in between

TYPICAL TUBES FROM SPERRY'S MEGAWATT LINE						
Type	Frequency Mc	Bandwidth Mc (1 db)	Peak Po MW	Avg Po kW	Gain db	Joules/ Pulse
SAL-305	1215-1365	150	12.5	60	36	375
SAL-320	1300	*	20	60	50	600
SAS-159	2856	*	25	24	50	62.5
SAC-167	5400-5800	100	1.25	8	47	37.5
SAX-151	9000-9500	500	1.0	10	40	30
SAX-191	8830-9200	370	1.25	6	50	37.5

*Fixed-tuned—optimized for linear accelerator service.

For details on Sperry's broadband, high average power, phase linear, high pulse energy megawatt klystrons, write Section 170. Information about a wide selection of classified Sperry microwave tubes is available with proper security clearance and "need to know." Sperry is represented nationally by Cain & Co.

SPERRY ELECTRONIC TUBE DIVISION

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

ging and data-processing equipment in the central-station unit. They also include provision for operator interrupt of the programmed cycle to insert corrective control action at one or more remotes.

System Transmission

Another aspect of the system's flexibility is its compatibility with all communications media. It can operate over 15-cycle telemetering lines, teletype lines, microwave, VHF or UHF radio, wire lines, or power-line carriers.

Telememory transmits information between the central and remote stations in either binary-coded or binary-coded-decimal (BCD) form, depending upon the quantity and type of data involved. Either of two methods of pulse keying can be used: frequency-shift keying (FSK) or pulse-duration keying.

Both methods are based on a return-to-zero (RTZ) transmission structure in which the regular recurrence of neuter pulses makes the clock rate implicit in the message. As a result, the transmitting and receiving stations are always synchronized, and there is no possibility of errors due to out-of-sync operation.

The FSK method uses three discrete audio frequencies to key constant-duration pulses with identities of binary One, binary Zero, and Neuter. Neuter is the center frequency and is spaced between the binary-bit pulses in a bit-Neuter-bit-Neuter pattern.

The pulse-duration keying method represents binary One and Zero with constant-amplitude pulses of different (x and y) durations. Neuter is the "off" interval between pulses. Messages consist of a given number of bits or pulses arranged in constant-duration time slots. Each time slot contains a binary One or Zero bit (pulse) and a Neuter (nonpulse). Binary One and Zero are recognized by comparing the length of the pulse with the constant length of the time slot in which it appears.

Regardless of the keying method employed, or the communication medium used, Telememory is a quiescent system; unlike continuous-interrogation systems it is normally at rest. Remote stations, therefore, can report alarm conditions and changes in equipment status as soon as they occur. Quiescent operation also permits the system to time-share a communications channel with other transmissions without impairing reception quality. Consequently the system is able to accommodate a greater number of remotes within a narrower bandwidth than is possible with continuous-scanning systems.

Message Security

The system has automatic error-detection provisions to prevent incorrect readouts and control actions in the event of equipment failure or disturbance in the communication channel. Remote-to-central messages

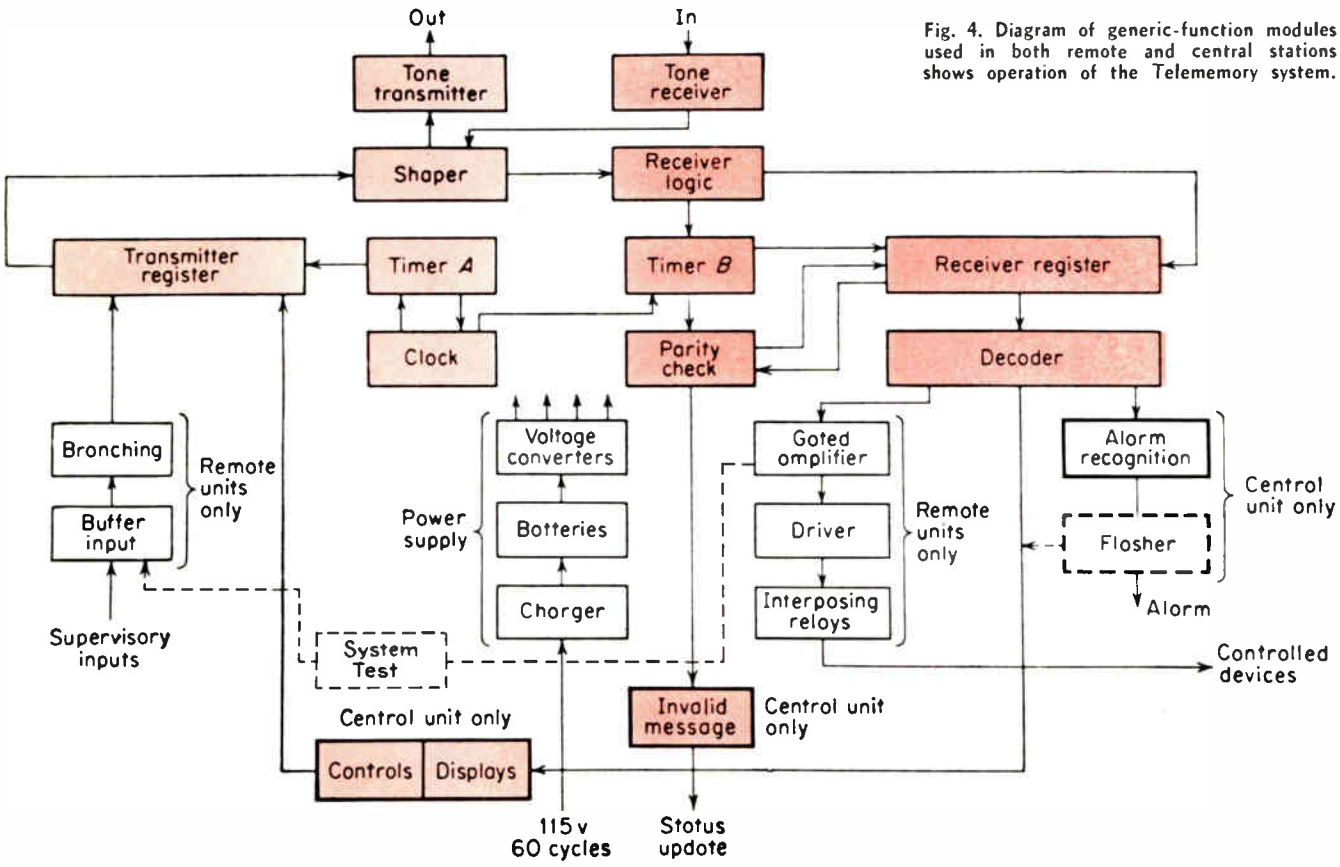


Fig. 4. Diagram of generic-function modules used in both remote and central stations shows operation of the Telememory system.

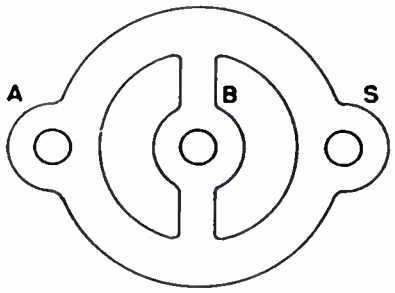


Fig. 5. Core shape shown may be used to perform logical function S = B + A B (i.e., B or Not A and Not B) and to store the result. To implement this function, the core would require four windings: a clock winding and windings at apertures A, B and S.

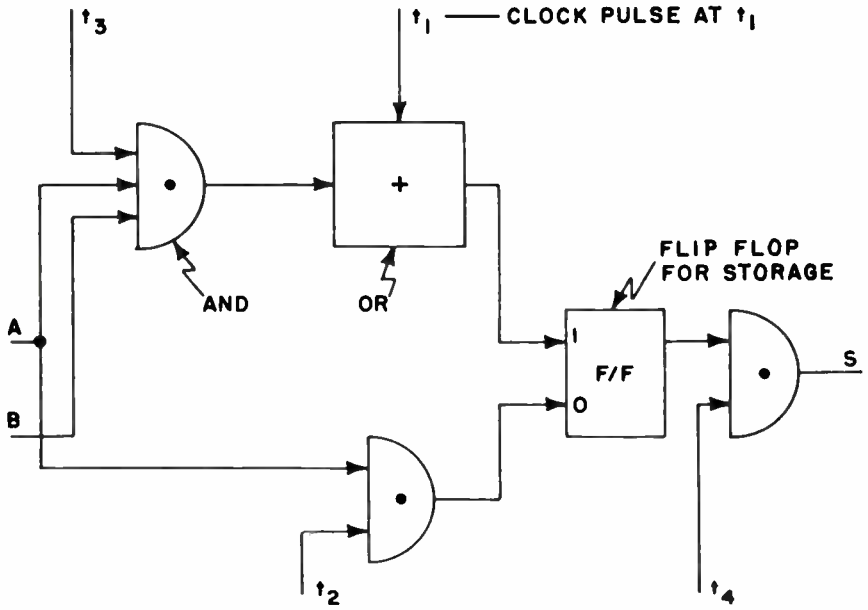


Fig. 6. The circuitry necessary to implement the equation of Fig. 5 with conventional clocked logic is shown in the diagram.

go through a two-part parity check; central-to-remote messages may go through as many as three parity checks.

The remote-to-central parity check consists of counting the code pulses within a fixed time period. A message that does not contain the correct number of code pulses and/or is not completed within the specified time period is rejected as invalid. The message is then retransmitted, either manually or automatically.

Central - to - remote messages are subjected to the same parity check as described above. In addition, the message is checked for an m-ones-out-of-n-bits code. Still further security may be provided by using a redundant code structure and bit-by-bit comparison.

A supplementary form of message security is carried out on all central-to-remote command messages. All system commands are coded by the position of two binary One bits; the bits appear in different message slots in each command. The remote station decoder scans each message to determine if the binary One bits are present in the proper slots. If the message scan shows that the command is not one of those assigned to the remote, the message is rejected. This security measure precludes the possibility of a control action being carried out at the wrong remote because of interference-caused ambiguity in the message address.

Confirmation that command messages have been properly effected is automatic. All command - actuate buttons on the control console contain lamps which light when the command has been carried out at the remote.

A separate provision for detecting trouble in the communications link and remote-station receiving/transmitting equipment is optional. This consists of an automatic interchange of test messages between the central station and all the remote stations. This self-exercising provision is generally used where communication between central and remote stations is infrequent.

Logic Circuits

The integrated multiaperture-core logic circuits used in the system operate on small electrical pulses (applied to the apertures through copper windings) that switch the local magnetic flux around one or more of the apertures. Basic principles of core design are based on two factors: (1) the effect that geometry has on the core's magnetic fields and (2) the location, magnitude, and direction of the magnetic forces that are necessary to establish and control these fields. Core shape determines the magnetic paths that can be reliably established within the core. It also permits the local flux around an aperture to be switched without changing the remaining flux pattern in the core. Essentially, therefore, the function performed by the core is determined by the shape of the core and the windings placed in the core.

Implementation of a logic function is accomplished by establishing and controlling the domains (well-defined volumes within which the magnetic state of the material is essentially uniform) around the core apertures. The core has a square hysteresis characteristic with a sharply-defined threshold level. Below the threshold, the domain walls are stationary, and the core acts as a linear device. Above the threshold, the domain walls move, and the core's behavior is non-linear. The spread between the threshold level of the hysteresis curve and the amount of magnetic force required to move all the domain walls is a small one. Therefore, large sections of the core can be forced into the same magnetic state by a magnetic

TELEMETERING SYSTEM (Concluded)

force that exceeds the threshold level by a relatively small amount. Removal of excitation from the core leaves the newly established domains substantially unchanged; the core remains magnetized to some flux density and, thus, is capable of remembering its most recent history.

Circuit Operation

Operation of a typical multiaperture-core circuit is shown in the drawings of a simple gate core (drawing A). The core has no external components. It has three apertures and four separate windings for Block, Set, Read, and Gate (the output) functions. A Block pulse will close the gate and a Set pulse will open it, when certain conditions are met.

Application of a Block pulse to the large center aperture saturates the core and causes its flux pattern to become uniform (drawing B). The Block-pulse current level is enough to produce a coercive force of about twice the magnetization threshold of the core's ferrite material.

A Read pulse introduced into aperture O of the blocked core (drawing B) is unable to produce a usable output signal across the output winding. This is because the two available legs around aperture O are already saturated by flux established in opposite directions. Opposition of the flux paths acts, in effect, as an air gap that minimizes transformer coupling to the output winding.

A Set pulse applied to aperture S unblocks the core. The current level of the Set pulse is high enough to reverse flux along the path indicated by the dotted line in drawing C. Since this path includes one leg of aperture O, a new condition is created in which the flux paths around the aperture are in the same direction. In this condition, the simulated air gap between the Read and Output windings no longer exists. The core is now unblocked (drawing D), and the Read pulse is able to induce a signal in the output winding by simple transformer-coupling principles.

The output of one multiaperture gate core can be coupled to the Set input of another (drawing E) to unblock the second core. In this manner, it is possible to propagate flux switching through a long chain of cores without any interposing amplifying devices. This is the method used in the logic modules of the new system.

System Operation

Central Station: The operator initiates transmission of a message by actuating the appropriate pushbuttons on the control console (Fig. 4). Contacts within the pushbutton load the message in parallel form into the Transmitter Register. In response to pulses from the Clock and Timer A, the Transmitter Register shifts out the message serially to the Shaper. The Shaper alters the width and amplitude of the pulses to make them compatible with the communication equipment. (Pulse-duration transmitter and receiver can be substituted for the tone transmitter and receiver shown in the diagram.)

The remote-station reply message begins with a long Neuter, which opens the squelch on the central-station Receiver. Message pulses pass serially through the Shaper and Receiver Logic to the Receiver Register. As the pulse train enters the Receiver Register, the Parity Check and Timer B modules count the pulses and overall time duration of the message. An invalid message will not be routed to the central-station display; failure of a confirmation signal to appear at the central station notifies the operator that the command message must be retransmitted.

Pulses of a valid message are shifted in parallel from the Receiver Register to the Decoder, where the remote-station identity and status- or quantitative-data content is decoded. The message signals are then amplified and routed to the appropriate lamp or digital display. Concurrently, the Alarm Recognition module scans the message for alarm bits. If alarm bits are present, visual and/or audio alarms are actuated.

Remote Station: A command message received at the remote station is fed serially through the Shaper and Receiver Logic to the Receiver Register. It is checked for parity (by the Parity Check module and Timer B) and, if valid, sent in parallel into the Decoder.

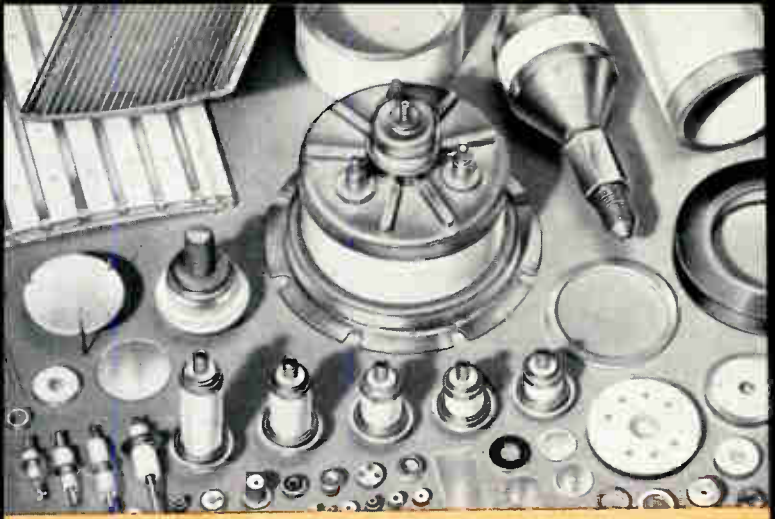
Besides decoding the message, the Decoder checks the message for proper structure. Two binary One bits must be in specific message slots, the location of which is unique for each command in the system. If this message check shows that the command is not one of those assigned to the remote, the message is rejected.

A message that passes the command-code check is decoded and sent through the Gated Amplifier and Driver modules to the relays that operate the appropriate control or readout devices.

After the central-station command has been effected, the reply message is fed from either a measurement subsystem (if quantitative data) or the Buffer Input (if status data) to the Branching module. The Branching module routes the reply messages into the Transmitter Register. The message then goes to the Shaper to be prepared for transmission.

An important feature of remote-station operation is the immediate reporting of any non-commanded change in equipment status. This is done by the Buffer Input, which continuously monitors status-indicating contacts; any change in contact position causes the transmission of a status-update message to the central station.

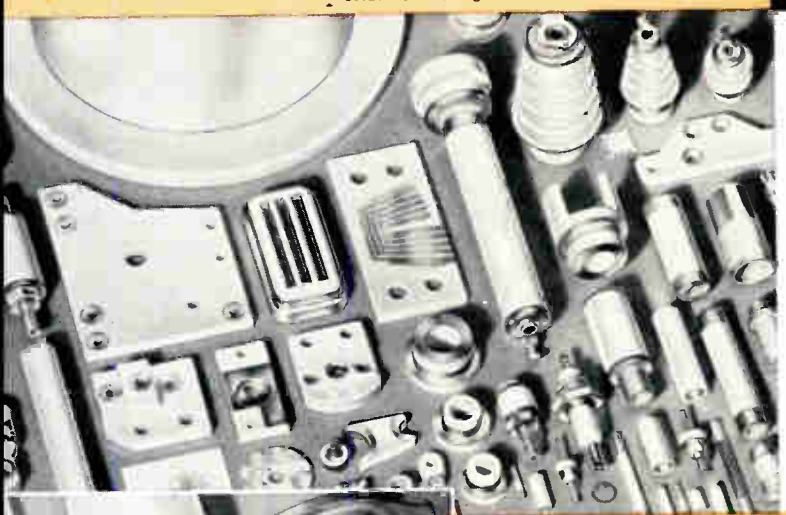
Progress Report on AlSiMag® METALLIZED CERAMICS UNDER A SINGLE RESPONSIBILITY



These high temperature metallized ceramics were produced by both the active metals and the sintered metal powder method. Note the part in the upper left hand corner which is injection molded to close tolerances, with critical dimensions ground and metallized, gold plated finish for soft solder or brazing.

American Lava offers the widest variety of ceramic compositions available from a single source and all present commercial metallizing processes and related finishing processes. Electroplating facilities include copper, tin, nickel, silver, gold and cadmium. Electroless nickel, solder coating, and other special finishes are also available. As a progress report, these items from regular production are shown. They represent volume production, not pilot plant or laboratory developments. If you will outline your requirements, our engineers will be glad to make suggestions. Prototypes for your own testing can be furnished at reasonable cost from a specially expedited department.

Circle 77 on Inquiry Card

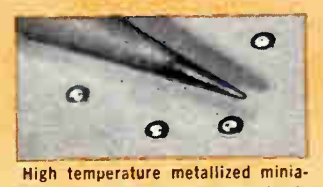


Above: These lower temperature metallized ceramics were produced with silver-glass frit and other processes.

Bulletin No. 612, AlSiMag Metallized Ceramics, will be sent on request.

These ceramics were metallized by attachment through cementing or compression.

Metallized bushings.



High temperature metallized miniature ceramics with O.D. .0815 ± .003 with two holes .017 ± .0015, thickness .016 ± .002 are supplied with gold or other finishes.

Miniature high temperature feed thrus.

Rings up to 1" long can be metallized O.D. and I.D. with no bleed over on ends with tolerances as close as ± .0005 on length by grinding.

Ultra-thin and flat ceramics can be metallized on both faces to close tolerances.

Squares or rectangles as small as .040 ± .002 x .080 ± .002 x .025 ± .002 thick metallized both faces. Maximum bleed over .002 for soft solder or brazing.

A subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
60TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining and Manufacturing Co. in these cities (see your local telephone directory): Boston: Needham Heights, Mass. • Chicago: Bedford Park, Ill. • Cleveland, Ohio. • Farmington, Mich. Laurens, S. C. • Los Angeles, Cal. • Milwaukee, Wis. • Metropolitan New York: Ridgefield, N. J. • Up-State New York: Newark, N. Y. Philadelphia, Pennsylvania • Richardson, Texas • St. Paul, Minnesota • South San Francisco, California • Seattle, Washington
All export except Canada: Minnesota Mining and Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

#65 INDUCTIVE AND CAPACITIVE REACTANCE

THE CHARTS ARE USED to solve the equations for inductive and capacitive reactance:

$$X_L = 2\pi fL$$

$$X_C = \frac{1}{2\pi fC}$$

where: X_L = inductive reactance, ohms
f = frequency, cycles per second
L = inductance, henries
X_C = capacitive reactance, ohms
C = capacitance, farads

Chart A is used to determine the approximate magnitude and decimal point location. Chart B is used to determine the significant figures.

Examples:

(1) Using Chart A, 10 mh at 10 KC is approximately 600 Ω. Using Chart B, the significant figures are shown to be 6.3; therefore the answer is 630 Ω.

(2) Using Chart A, a capacitance of 5μf at 400 MC is in the 10^{-5} decimal range. Using Chart B the significant figure is found to be 8.0. The reactance is thus 8×10^{-5} Ω.

By DAVID P. COSTA
Picatinny Arsenal
Dover, N. J.

Chart A: Use to determine magnitude and decimal location.

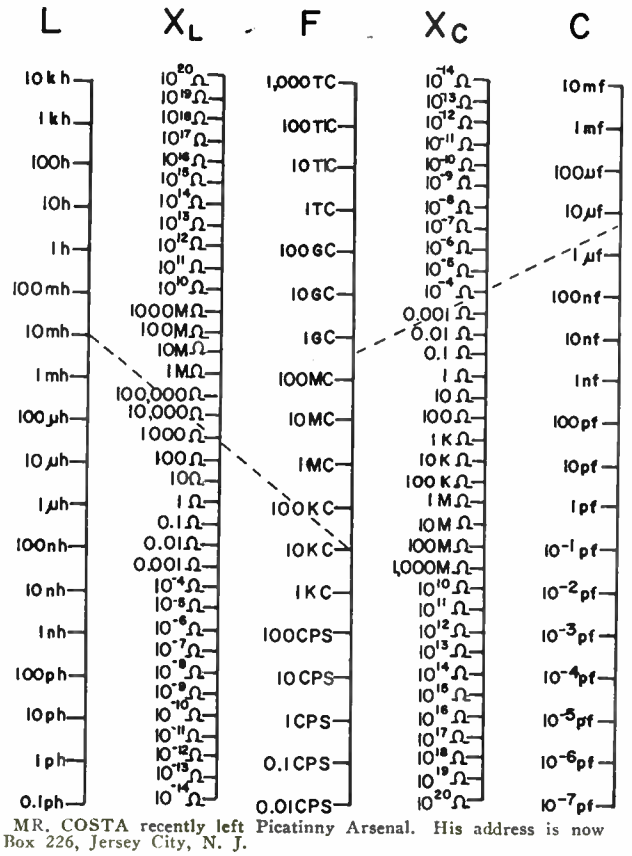
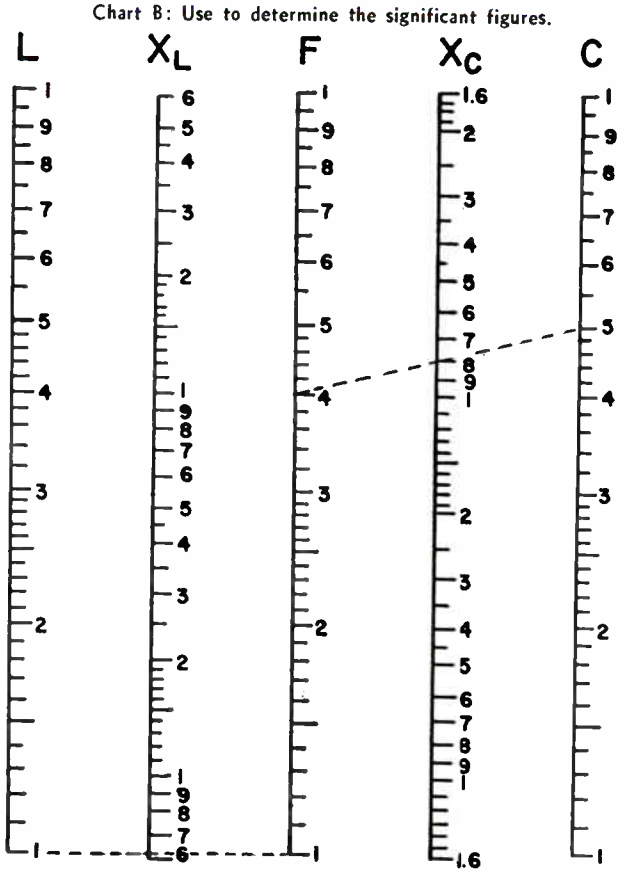
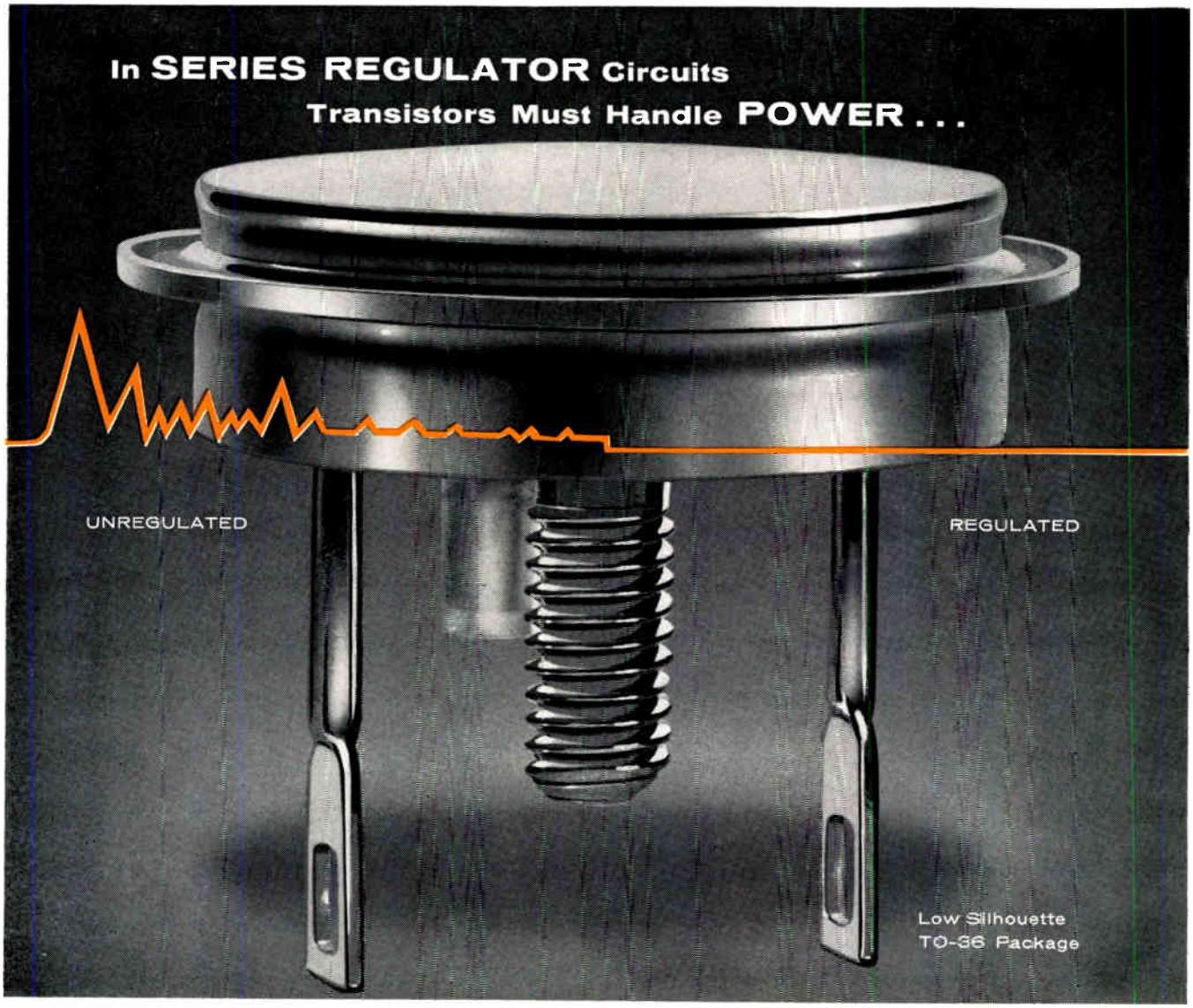


Chart B: Use to determine the significant figures.



MR. COSTA recently left Picatinny Arsenal. His address is now Box 226, Jersey City, N. J.



MOTOROLA 170-WATT POWER TRANSISTORS ARE BUILT TO TAKE IT!

The most important measurement of a power transistor in a series regulator circuit is its ability to absorb power. Motorola's TO-36 germanium power transistors, with 110°C maximum junction temperature and thermal resistance of only .5°C per watt, are rated for 170 watts at 25°C case temperature . . . the greatest power capability of any germanium power transistors today! (The power handling factor of a transistor can be calculated by dividing the difference between its maximum junction temperature, and 25°C, by its thermal resistance rating.)

In high-current applications higher power capability can actually reduce the number of parallel units required for a given set of power conditions. Use of fewer transistors, in turn, eliminates the need for the extra resistors, capacitors, etc. normally used to adapt each device to the circuit and reduces the total heat sink area required.

The result? Simplified, more rugged series regulator designs . . . and excellent cost savings!

MOTOROLA TO-36 POWER TRANSISTORS*

h_{FE} (min) @ I_c (amps)		Type Number
20 35 50 80	5	2N2075 thru 2N2078 2N2079 " 2N2082 2N2152 " 2N2154 2N2156 " 2N2158
25 30 40 50	15	2N2152 thru 2N2154 MP500 " MP502 2N2156 " 2N2158 MP504 " MP506
15	25	2N2152 thru 2N2158
12	50	MP500 thru MP506

*All types have $T_J(max)$=110°C, θ_{JC}=0.5°C/W(max)

Units are available from your local Motorola distributor or your nearest Motorola District Office . . . many types with "Meg-A-Life" reliability data. For complete technical information on any of these devices contact the Technical Information Department, Motorola Semiconductor Products Inc., 5005 East McDowell Road, Phoenix 8, Arizona.

MOTOROLA
Semiconductor Products Inc.
A SUBSIDIARY OF MOTOROLA INC.

E-122-006

5005 EAST McDOWELL ROAD · PHOENIX 8, ARIZONA

WHAT'S NEW

STAIN FREE DRYING

FAST, THOROUGH, AND STAIN FREE DRYING of materials used in the assembly of transistors, crystal holders and other components requiring a glass-to-metal seal has become increasingly important.

In supplying such parts, Isotronics, Inc., Saddle Brook, N. J., found an expensive and delaying bottleneck. This was in the finishing room during drying after the parts were cleaned and rinsed in aqueous solutions. A typical component requires three to four cleaning and drying operations before shipment because before every assembly operation, finger marks, oxides, scale and other contaminants must be removed to insure a proper bond.

Although cleaning or washing in a water and detergent mixture presented no problem, drying with a methanol and acetone dip not only was expensive and time consuming, but inefficient. The product frequently retained residues and other stains. Consumption of 20 to 25 gallons per day of methanol and acetone was regarded as too high.

Through investigation into a better drying process, the firm learned of a "Spotless Dryer" made by Phillips Mfg. Co. of Chicago, a company licensed by Imperial Chemical Industries, Ltd., a British concern that developed the system. The dryer, trade named "Trisec," works on the principal that certain cationic surface-active agents dissolved in a chlorinated solvent are strongly absorbed at the surfaces of metal or glass objects; that these surface-active agents preferentially wet the objects and displace the water. The result is a perfect water free surface on the cleaned object. The displaced water mixes with the Trisec to form an azeotropic mixture with a boiling point nearly 14°C. below that of the solvent by itself, and rapidly boils away.

Cleaning operation: Trisec displaces water; Trisec rinsed.

The Trisec Dryer is a single piece of equipment consisting of two heated chambers. The water wet work is placed in the first chamber where the Trisec displaces the water. Then the work is transferred to the second chamber where the Trisec is rinsed off. Upon removal, the vapor over the immersion chambers dries the work completely, leaving a perfectly clean, stain free surface. The entire operation takes less than 45 seconds.

The uniqueness of the process is the manner in which it is different from other water displacement methods. The removal of water has been accomplished before by immersing wet parts in various commercial water displacing liquids. However, the water displacing liquid then became difficult or expensive to remove from the work. The water displacement bath rapidly ceased to function efficiently and had to be thrown away because of excessive water contamination. Also, the same problem occurred in the following bath where the water displacement liquid was removed from the part.

In the Trisec process, the water displacing agent is inter-mixed and is compatible with the solvent that removes it. Thus only one solvent and a single piece of equipment is required. Also, due to the characteristics of the solvent and the equipment, the water taken from the parts and placed in solution is automatically removed from the solution and discharged from the machine. The solvent is, therefore, used over and over again without water, other contamination or expensive operating difficulties.

With the Trisec Dryer, consumption of solvent dropped from 20 gallons methanol and acetone per day to approximately 5 gallons per week of Trisec. Also, costs of handling were reduced some 15%.

GaAs AS AN INFRARED SOURCE

GALLIUM ARSENIDE (GaAs) is used in a diffused pn junction diode as a promising infrared source. The IR source, SNX-100, is an experimental device developed by Texas Instruments Incorporated and is intended for engineering evaluation. When biased in a forward direction, the device emits light of relatively narrow spectral width in the near infrared.

(*Continued on page 134*)

Continuous Thin Film System

THE FIRST CONTINUOUS PROCESS to make thin film electronic circuits was shown recently to the Navy Panel on Microelectronics at the Naval Avionics Facility in Indianapolis (NAFI), Indianapolis, Ind. The system was developed by International Business Machines Corp. at its Kingston, N. Y., facility. Still in the pilot stage, the equipment produces devices many times faster than the step-by-step methods used until now. Every hour, the equipment can turn out as many as 750 circuits containing a total of over 3000 thin film components.

The system is designed to fabricate passive microminiature thin film networks continuously in a four-stage deposition. Glass substrates are transported mechanically through four interconnected vacuum chambers separated from the loading magazines and source chambers by vacuum locks.

The 2x2x1-½ ft. chambers contain substrate conveyors. substrate heaters, and mask changers. Smaller chambers are attached to each of these main chambers, containing the evaporation sources. The pilot system evaporates four layers of material onto a 3-¾x5-3/16 in. substrate with precise control over evaporation rate, substrate temperature, film thickness, chamber pressure, and transfer mechanism. All pumping components are mounted on transportable platforms. Valves are electro-pneumatically controlled. During deposition, the chamber pressure remains between $5x10^{-5}$ and $5x10^{-6}$ Torr. Commercial vacuum components and fittings are used to facilitate maintenance. The equipment can be operated without the need of a clean room in any non-corrosive manufacturing environment.

The transport mechanism positions masks and substrates inside the vacuum changer with a minimum of operator control. It also handles and stores additional masks and substrates.

In each chamber, up to six masks are stored in a cartridge. A mask changer removes a clean mask from the cartridge, positions it to register with the substrate holder and returns the "dirty" mask to the cartridge. The changer contains a heater to raise the temperature of the mask to that of the substrate. Registration accuracy is better than ±0.002 inches.

The equipment is designed for a flexible refitting for various deposition sequences.

Experience shows that the component density of the deposited pattern can be increased considerably.

Technicians operate the first system that produces thin film circuits continuously.

GaAs As An Infrared Source (Continued)

An interesting aspect of the device is its ability to be modulated by varying the forward current that is applied to the input. Some possible uses for this device are in secured optical communication links, transmission of TV signals, light source for tape or card readers on computers, as a source in IR radar equipment, and for logic circuits.

The unique device consists of a wafer about 50 mil x 50 mil. The emitting junction covers the entire wafer surface. It is packaged in JEDEC TO-18 can with a glass top for light emission. (See Fig. 1).

For uncanned units, the radiation pattern closely follows a cosine law with maximum intensity in a direction normal to the emitting surface. The radiation pattern is independent of temperature down to —195°C. In the can, the radiation is limited to within a 30 degree angle from normal. The wavelength of peak emission is 0.897 micron at 25°C case temperature. Additional emission has been noted with peaks at 0.95 and 1.2 micron. However, this accounts for only a small percentage of total power output.

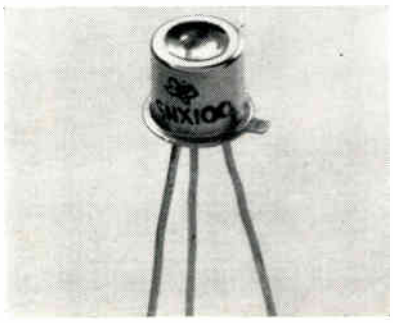


Fig. 1: Gallium arsenide diode shown is an incoherent infrared source. Light is emitted from the top of case which has a window.

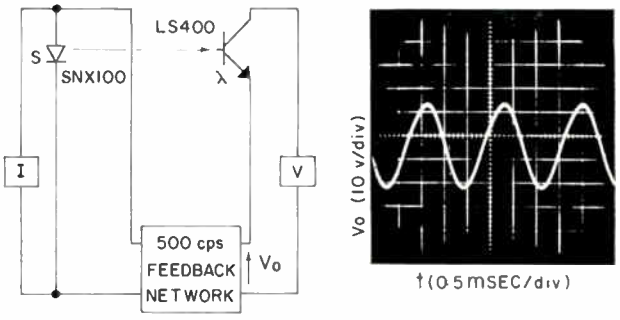


Fig. 2: An active circuit using the GaAs diode is shown.

An active circuit was constructed using an SNX-100 and an LS-400 silicon photo device. This is shown in Fig. 2. The transmission of information by infrared radiation provides electrical isolation between input and output. The spectral output of the SNX-100 is well suited for use with silicon photo detectors. Power gain is demonstrated in Fig. 2 by the presence of oscillations when positive feedback is applied.

Further information is available from Texas Instruments Incorporated, Components Division, 13500 N. Central Expressway, Dallas, Tex.

"SCEPTRON"—FIBER OPTICS PATTERN RECOGNITION

Sperry Gyroscope Co. has developed a minature "brain cell" of optic fibers that can listen to, understand, and react to human commands.

The Sceptron (for *S*pectral *C*omparative *P*attern *Recog*nizer) automatically classifies complex signals or events such as spoken words, spectral signatures of vehicles, advanced sonar and radar returns; any information that can be changed into an electrical signal.

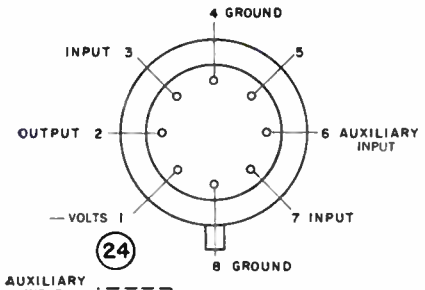
It has great storage and processing capacity. The latest Sceptron is 1/300 of a cubic inch with a package density of 300,000 frequency channels per cubic inch. In many applications this would permit 300 complex signatures to be stored and recognized in a cubic inch. In effect, this makes it possible to process as much information in a match box as would normally require a full-scale computer.

The Sceptron is self-programming. All the steps necessary to prepare a Sceptron to recognize a complex signal can be done automatically using the signal itself without any knowledge of the signal characteristics and without knowledge of exactly how the

(*Continued on page 235*)

L. Balandis of Sperry triggers a Sceptron that has been "taught" to react when the word "five" is spoken into the microphone.

CIRCUIT PACKAGES



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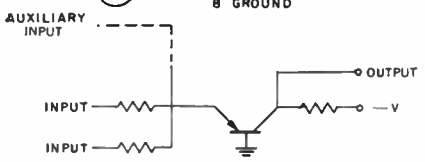

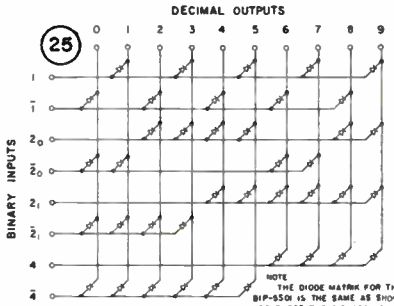

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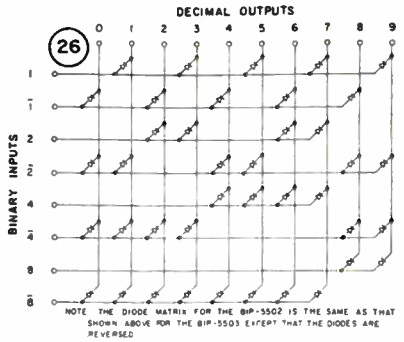

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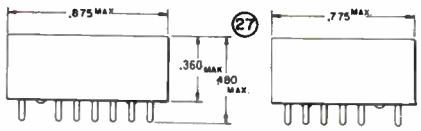

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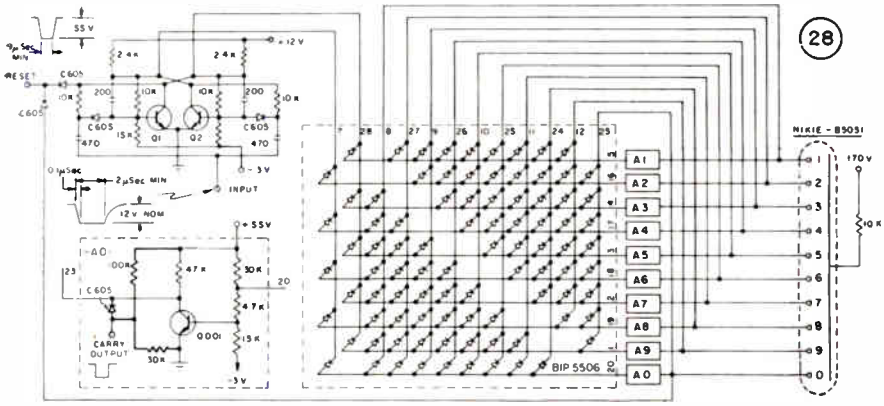
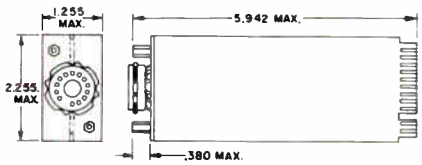


28

NOTES
1 Q1, Q2 & Q101 / Q001 ARE GT 5214 (G I)
2 ALL RESISTORS ARE 1/4 W ± 5% UNLESS OTHERWISE SPECIFIED.
3 ALL CAPACITORS IN μμF UNLESS OTHERWISE SPECIFIED
4 AMPLIFIER "A0" IS AS SHOWN ABOVE WITHIN THE DOTTED BOX. "A1" THROUGH "A9" ARE SIMILAR EXCEPT THAT THE CARRY OUTPUT CIRCUIT INDICATED BY THE HEAVY LINE IS NOT USED.
5 NIXIE® TUBE NOT INCLUDED AS PART OF MODULE.



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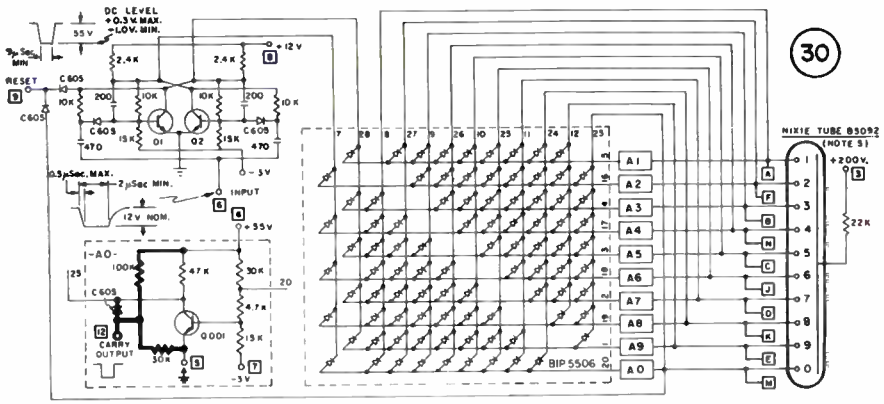

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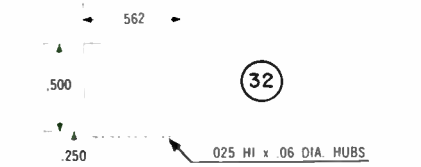
NOTES
1 ALL TRANSISTORS ARE GT 5214 (G I) OR SIMILAR.
2 ALL RESISTORS ARE 1/4 W ± 5% UNLESS OTHERWISE SPECIFIED
3 ALL CAPACITORS IN μμF UNLESS OTHERWISE SPECIFIED
4 AMPLIFIER "A0" IS AS SHOWN ABOVE WITHIN THE DOTTED BOX. "A1" THROUGH "A9" ARE SIMILAR EXCEPT THAT THE CARRY OUTPUT CIRCUIT INDICATED BY THE HEAVY LINE IS NOT USED.
5 NIXIE® TUBE NOT INCLUDED AS PART OF MODULE.



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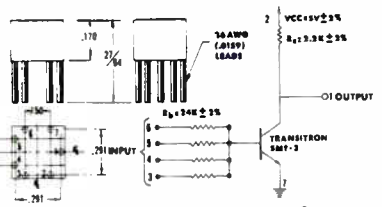

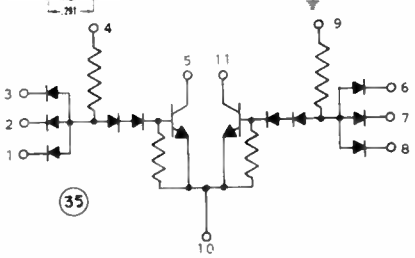

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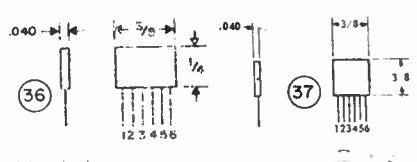

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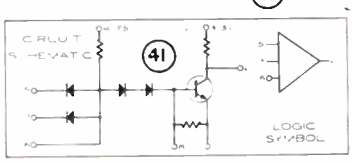

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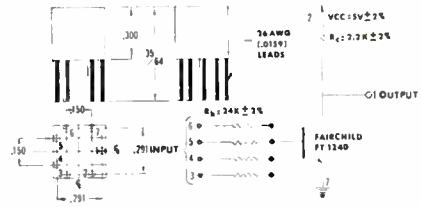

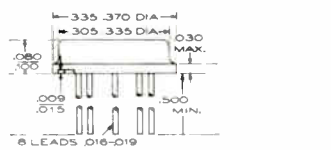

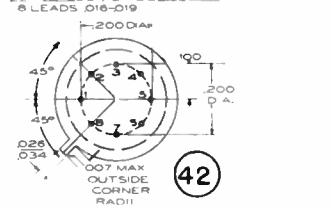

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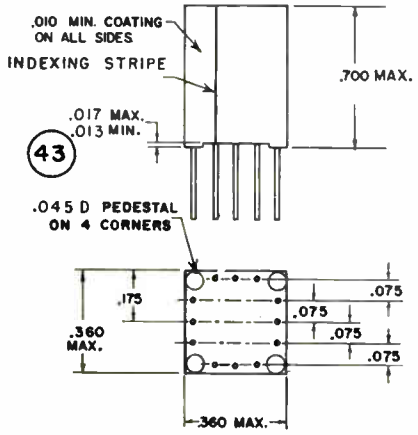
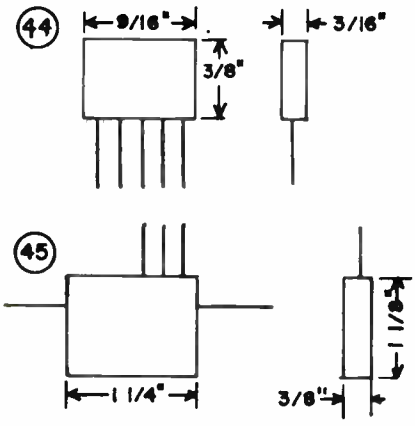
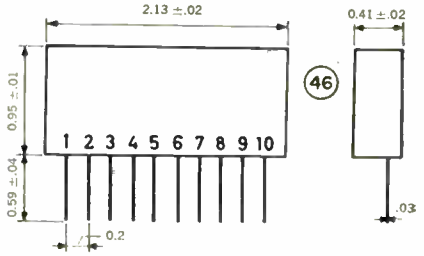
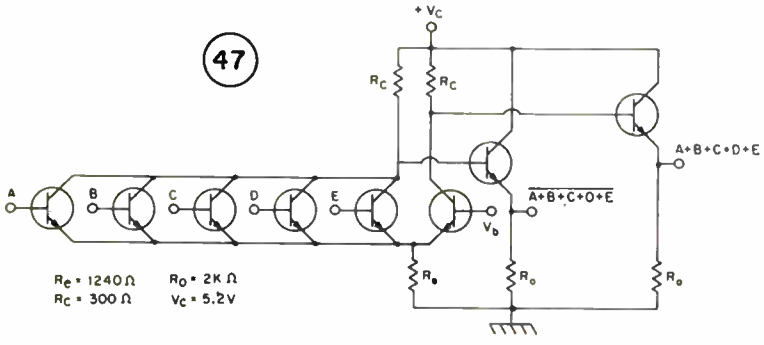
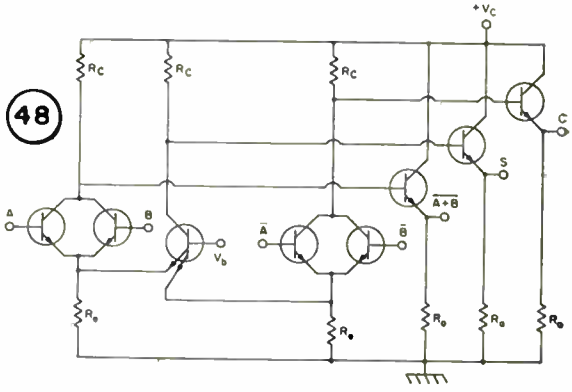
(More Diagrams on page 136)

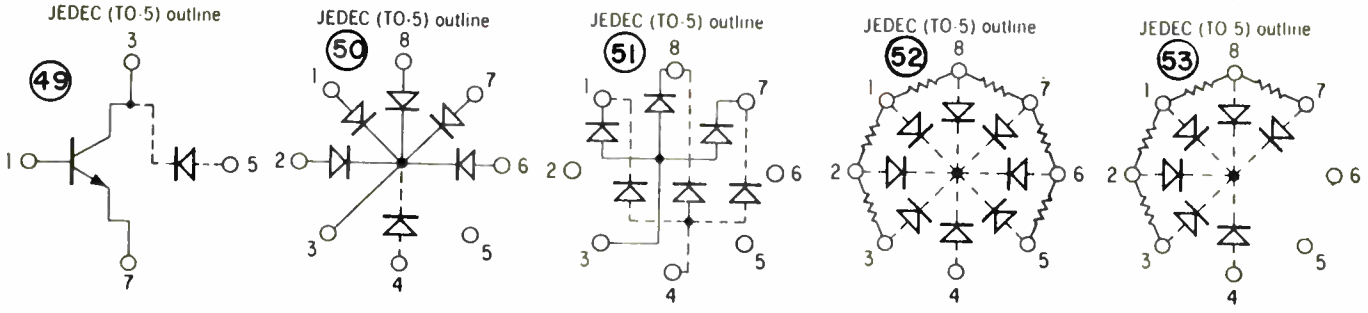


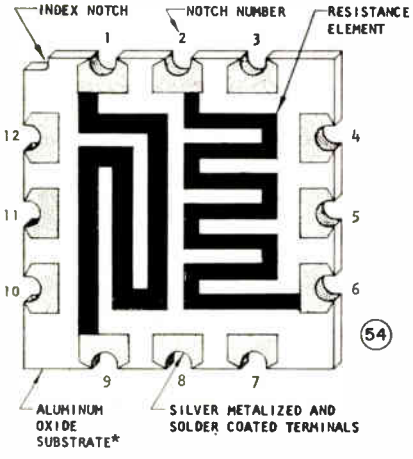


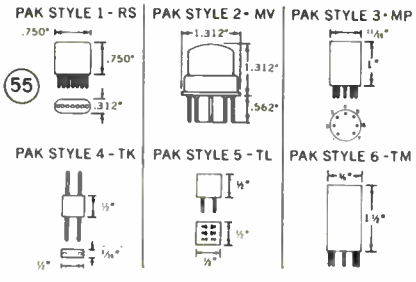


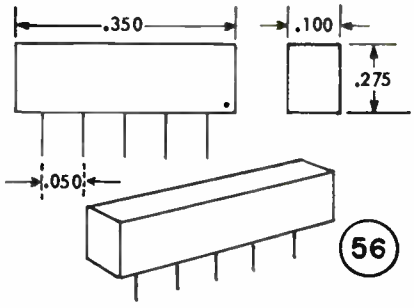












$$$ for Circuit Designs

Have you come up with any simple or unique circuit designs lately? Do you think that they would be useful to fellow engineers? If so. why not send them to us for possible publication? We pay our usual space rates for those accepted. Please keep them as concise as possible and send to: Circuit Design Editor, ELECTRONIC INDUSTRIES, 56th & Chestnut Sts., Philadelphia 39, Pa.

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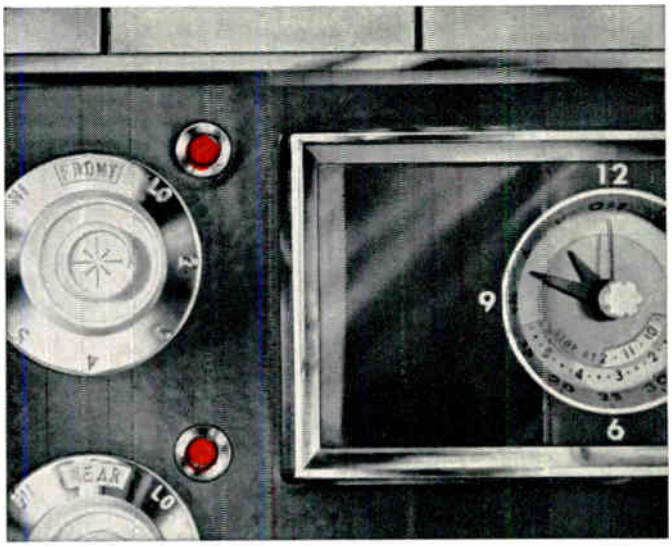

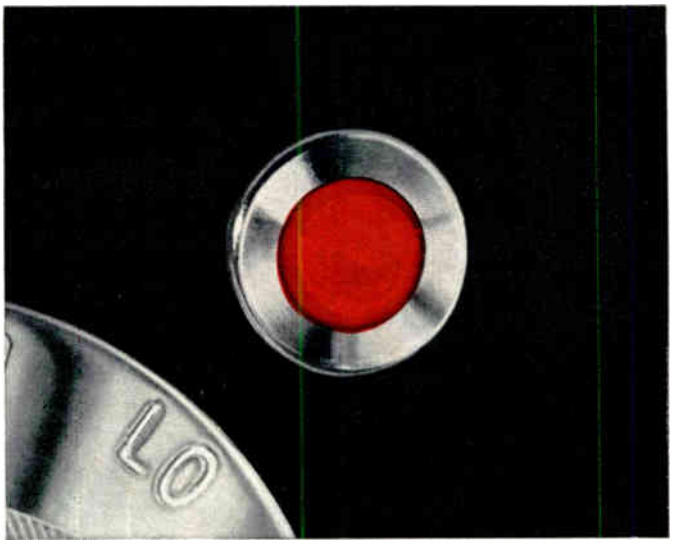

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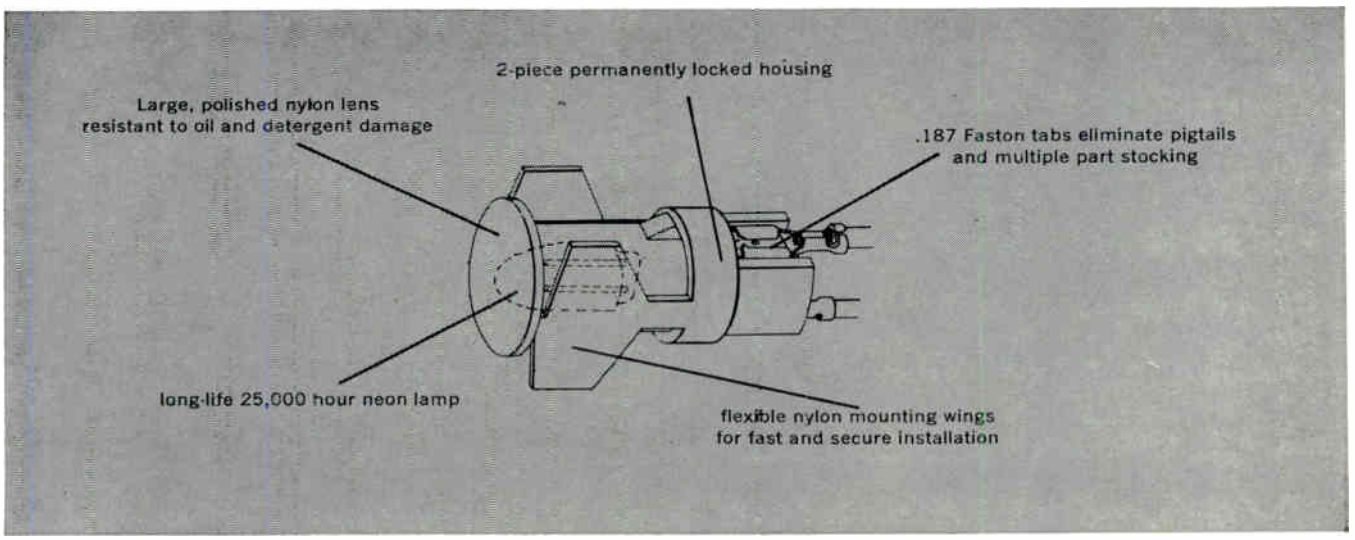

You pay nothing at all for a sample of our new AMPILLUME* Neon Indicator Light. It's yours . . . free!

We've got good reasons, of course. Check it against the features listed below. See for yourself why it's a good buy for you. In addition, while you're considering the low price, have it right there to see the quality that AMP has built into it.

AMPILLUME Neon Indicator Lights give you all these things. Low price—the lowest in the field. Fast delivery—the fastest anywhere. Quality and reliability—right up to AMP standards. And, all the features you see listed here:

● terminated with .187 tabs—standardization—eliminates pigtails and stocking of multiple parts ● self mounting ● mounts in standard .514—.519 mounting hole—no need to retool ● excellent light dispersion and intensity ● large lens area ● all nylon housing and lens—highly resistant to oil and detergent damage ● 25,000 hour bulb operating life ● tabs separated by nylon barrier to prevent shorting.

Send for your free sample of the AMPILLUME Neon Indicator Light today! IDEAL FOR USE in—computers, ground support equipment, aircraft, washers, dryers, ranges, vending machines, freezers, dishwashers and many other applications requiring indicator lights. The AMPILLUME Neon Indicator Light is available in a variety of shapes and sizes. Send us your specifications.

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NEW LINE OF LINEAR INTEGRATED CIRCUITS

A line of linear amplifiers in integrated circuit form is now available as off-the-shelf items from Texas Instruments Incorporated.

This month TI introduces "Series 52" in their "Solid Circuit" line of semiconductor networks consisting of the SN521, a basic d-c operational amplifier; and the SN522, which is essentially the same amplifier with an emitter-follower output.

These two circuits represent the amplifiers most commonly used today in analog to digital converters, feedback amplifiers, integrators and differentiators.

The "Series 52" networks contain two PNP and five NPN transistors diffused into a single block of silicon. Each transistor can be used as a diode if desired.

The circuit bars also contain six tapped resistors, from 5,000 to 50,000 ohms.

S. A. WOOD TO HEAD DE FOREST PIONEERS

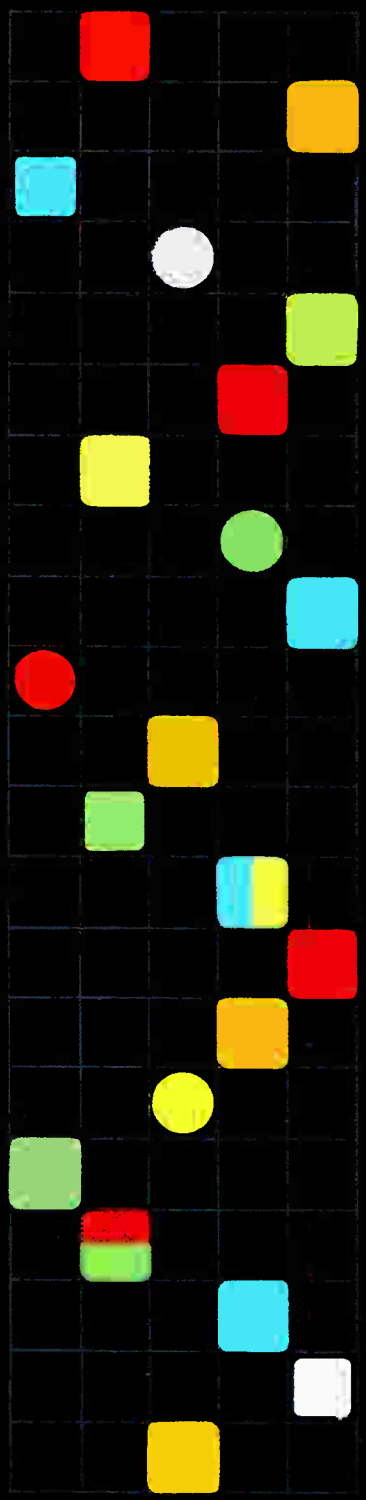
Sidney A. Wood has been elected President of the De Forest Pioneers for 1963. The society was formed in 1952 to bring together men who worked and associated with the late Dr. Lee De Forest, famed electronic pioneer and inventor of the three-element vacuum tube.

Wood is Chairman of the Board of Wilbur B. Driver Co., Newark, N. J., manufacturer of electronic alloys.

COMPUTER TALK

As girl dials phone, computer at North American Aviation's Space & Information Div., Downey, Calif., transmits at 3,000 words per min. to computer at division's Tulsa facility. Data goes from magnetic tape computer (rear) to phone dial equipment where it is converted to tone signal. Tone goes to phone equipment in Tulsa and is converted back to tape.

Circle 144 on Inquiry Card →



IN LIGHTED

PUSHBUTTON SWITCHES

CLICK

CLICK

ONLY

CLICK

CLICK

LICON

CLICK

CLICK

REPEATS

CLICK

CLICK

REPEATS

CLICK

CLICK

REPEATS

CLICK

CLICK

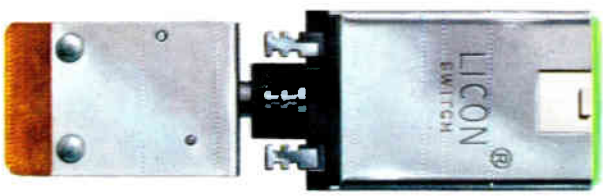
REPEATS

CLICK

CLICK

WHEN IT MUST BE RELIABLE
LICON BUILDS THE SWITCH

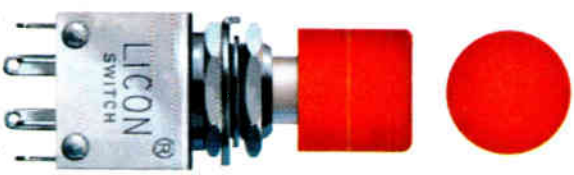
two types



04

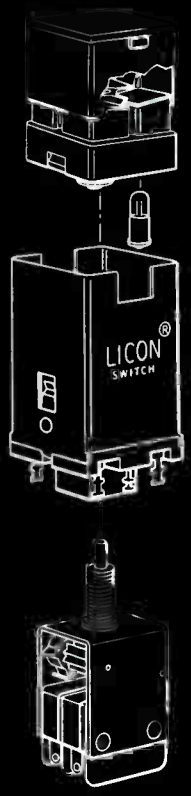
of lighted pushbutton switches...the highest ratings...optimum legibility

Licon has added a new concept of color, combined with the world's finest, most reliable subminiature switch, the Licon® Type 16. Colors are aggressive, intense—projected with complete saturation—provide signals clearly understood even in well-lighted surroundings. MIL quality switching mechanism is simplified, always dependable, lasts over five times as long as conventional subminiature switches. See back of page for complete specifications and additional switch data.



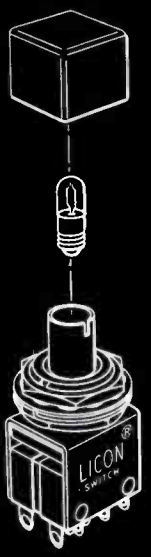
01

04



Four-bulb type for utmost reliability. Light module lifts out and bulbs are replaced quickly without special tools. Unique color clarity and diffusion give complete saturation—color and legend instantly identifiable even in strong ambient light. Standard in three display screen styles—full, vertically split or horizontally split. Engraved or insertable legends. ⅜″ sq. display screen. Less than 3″ long.

01



Single bulb illuminates selected color. Removable operating button, fast bulb replacement. Same dependable switch as the four bulb Model 04. Requires less back-of-panel clearance than a conventional toggle switch; provides twice the rating. An inexpensive combination of panel indicator and control. Available with or without engraved legend. ⅝″ square or round indicator button.

Licon® Lighted Pushbutton

SWITCHES

don't meet standards . . . they set them

RELIABILITY. No other lighted pushbutton switches even resemble Licon's performance, long life, and reliability. Minimum switch life at full 10 Amp rating is 200,000 cycles; at the conventional 5 Amps, 750,000 cycles. All metal parts are corrosion-resistant.

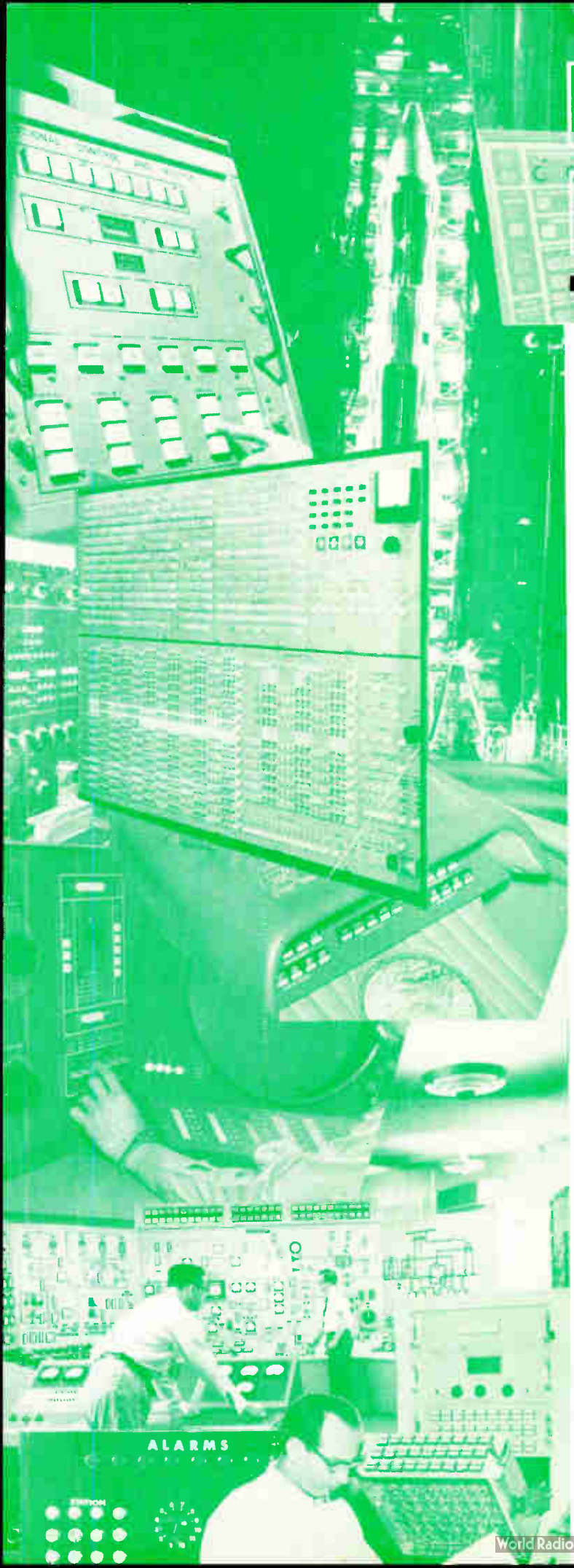
HIGHEST ELECTRICAL RATINGS. 10 Amps, 30 VDC—125/250 VAC—*twice* that of conventional subminiature switches. Exclusive double-break mechanism increases electrical performance, life, and capacity—permits a single switch to handle two isolated circuits rated up to 7 Amps, 30 VDC each.

HUMAN FACTORS ENGINEERED. Momentary-contact units (which reset when button is released) and maintained-contact type (requiring one push to actuate, a second push to release) give the operator the *positive* feel required by Human Factors engineers. Lighted pushbuttons eliminate potential human error in relating a separate signal light to its corresponding switch.

EXCLUSIVE SWITCH FEATURES. Model 04 provides intense, selective pushbutton colors; red, green, yellow, amber, blue, white—without hot spots or dimly lit button edges—for maximum visibility. With Licon's unique *canted* filters, one bulb is sufficient for screen illumination of projected colors—but two bulbs for each color provide a margin of safety against bulb failure. Also available with colored screens for "color-on/color-off" display. ⅞″ square shape is ideal for horizontal or vertical ganging. Model 01 offers single bulb illumination and economy while providing quality panel appearance. Buttons available in red, white, blue, green or yellow; plain or engraved, ⅝″ square or round.

SIMPLIFIED INSTALLATION AND MAINTENANCE. In both series a single, compact component replaces conventional systems of separate panel lights and switches—cuts panel size, installation time, and wiring by half. For complete product information on the Licon 04 and 01 pushbutton switch series, write for descriptive brochures.

LICON
DIVISION ILLINOIS TOOL WORKS INC.
6615 WEST IRVING PARK ROAD • CHICAGO 34, ILLINOIS



ELECTRONIC INDUSTRIES

DESIGNER'S GUIDE TO:
LAMPS
INDICATOR LIGHTS
ILLUMINATED SWITCHES

The increase in computers, data processing equipment, instrumentation and automation has created a vast demand for indication devices. The most widely used are indicator lights and illuminated switches.

Their basic component is the lamp—either incandescent or neon. What are the parameters that will determine what kind of a lamp you can use in your project?

The major factors in using indicator lights are discussed in the second article of this 3 part series. A thorough study of the transistor-controlled indicator light, now coming into increased usage, is also included.

Illuminated pushbutton switches are simple--when you're looking at the lighted screen. Behind the panel is where the complications start. What kind of switching action, how many poles, and what reliability do you want?

Check-lists for specifying and buying, comparison charts, and human factors information are included in all 3 articles of this designer's series.

By LOUIS S. GOMOLAK
Assistant Editor
ELECTRONIC INDUSTRIES

Part One of Three Parts

DESIGNER'S GUIDE TO LAMP SELECTION

How do reliability and miniaturization affect your choice of a lamp? The 3 classes of lamps for indicating devices: large, miniature, and sub-miniature are thoroughly discussed. Data on micro-miniature types is also given. Handy check-lists for specifying and buying, along with comparison charts are included.

THE LINK BETWEEN MAN AND MACHINE is most frequently light. Lights—indicating lights and illuminated switches—tell man just what his machine is doing. The reliability of any piece of equipment is no better than the reliableness of its indicating unit. The following example should bring this point home.

Flight 424, in-bound to Philadelphia International, approaches the landing pattern. The co-pilot runs through the check-list.

"Gear down."

"Handle in the down position." Replies the pilot. Suddenly, the darkened cockpit is lit by a flashing red light.

"Got a red one on the gear. Might be down, but its not locked. Let's run it through again."

They re-cycle the landing gear. Minutes go by and still nothing they do turns off the blinking red light. The crew uses every trick in the book. Finally, the red light goes out—a green one takes its place.

"Gear down and locked."

A tiny light, one among many in the instrument crammed cockpit, has given its warning; another its reliable O. K. The multi-million dollar jet lands safely.

Lamps for indicating use come in 2 types, incandescent and neon glow. They have their advantages and dis-advantages. Each is suitable for specific jobs. Let's talk about the incandescent types first.

Incandescent Lamps

Under this heading there are 2 divisions—high voltage and low voltage. The high voltage (105-125 and 210-250v) are usually called "Large Lamps." This is not because of size, but determined by the voltage rating. The low voltage (1-55v) are grouped under "Miniature" and "Sub-Miniature" headings. A miniature lamp measures under an inch in diameter. As the lamps become smaller, under ¼ inch, they are known as sub-miniature. When they are so small that it's difficult to even see them, they are called "Micro-Miniature."

Large, miniature, and sub-miniature lamps are used for indicating devices on computer consoles, instruments, machinery and panels. The micro-miniatures are finding use in dry-circuit applications, as readout devices, and as optical point sources.

Incandescent lamps are made of a filament, an evacuated bulb, and usually a base. The filament is a thin diameter wire, enclosed within the glass bulb. The base is for support of the bulb, and for electrical connection of the filament.

Filaments are usually strung on supports within the bulb. The universal filament material is tungsten. This is because of its high melting point and low evaporating rate.

Incandescent lamps work on the resistance heating principle. When the design voltage is applied, current flows through the filament. It offers resistance. The tungsten heats to operating temps. of 2000°K and higher. Power is given off in the forms of heat and light. The Candle Power (C.P.) is determined by filament temp. and power input.

Lamps are generally operated at design voltage. Therefore you get the designed result in terms of power input and C.P. output. This is because at designed filament temp. you get designed efficiency. If the voltage is raised, more power is put into the lamp. You raise the filament temp. The result is higher efficiency (C.P./watt).

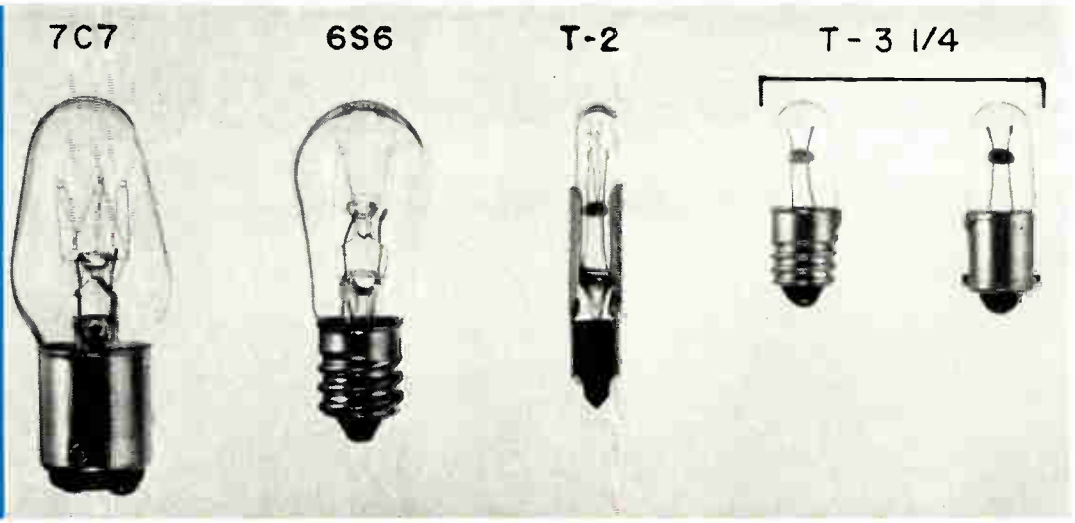
The length and diameter of the filament determines the resistance it will offer. The length is determined by the voltage to be applied. Long for high voltages; short for low voltages. Current determines the wire diameter. Thick for high current; thin for low current. For high voltage lamps, the filament will be long. It will also be thin. Thin, long filaments are susceptible to shock and vibration. This is the prime dis-advantage of large lamps—low reliability in rugged environments.

Lamps are usually rated on the basis of their operating in open air, at room temp. Anything that causes the temp. to rise (increasing ambient; radiant heat from other components; over-voltage) will raise the temp. of the bulb wall. The bulb will already be at a higher than room temp. A number of things could happen, the worst of which being an increase in the evaporating rate of the filament. This causes the blackening effect. As long as the temps. affecting the lamp are kept within normal limits (below 350°F), the lamps will work reliably.

A word on interpreting specs. People often phone lamp manufacturers, asking for the formula for converting the watt rating in the catalogs into C.P. Don't waste your time. There isn't any formula. There is no constant relationship between Candle Power and wattage. Large lamps are rated in watts and some-

Light at his fingertips. Astronaut John H. Glenn, Jr., holds up hands, during pre-launch check-out, to show the miniature lamps, on the index and middle fingers of each hand, which he used to read instruments and charts. Battery operated, the lamps produced 5 candlepower, directed through fixed-focus lens in each lamp end. Lamps measured ½ in. long and were designed into suit after sub-orbital flights of Alan B. Shepard and Virgil Grissom.
(Courtesy B. F. Goodrich)

LAMP SELECTION (Continued)



Most popular lamps for indicating use, shown actual size. The 7C7, conical bulb, double contact bayonet base, recommended in 10w type—strongest large lamp on 120v. The 6S6 is 6w, straight-sided bulb, candelabra screw base, for use on 120v. T-2, tubular bulb, telephone-slide base, usually used on about 48v. The T-3¼ lamps are miniature types, miniature screw and bayonet based. Bayonet base always recommended. Designed for use on from 6 to 28v supplies.

times in C.P. Miniatures are usually rated in C.P. The reason you can't convert one to the other is, light output depends on the temp. of the filament, *not* the wattage.

A comment on service life. Service life differs from rated life in that, service is under actual operating conditions and rated is in the laboratory. Rated life is what is stated in the catalogs. For the present, it is the best method of comparison available (the lamp manufacturers have to have some base line to work from). To find out what the service life of a particular lamp is, you will have to give the manufacturer *all* the parameters under which the lamp will be operating. In most cases, he'll come up with a reliable figure. In others he won't have the information you want, or you won't be able to give him the data he needs. There are too many factors affecting service life for a manufacturer to come out with blank statements. They'll make good "gues-timates," but it can only be that. Service life will always depend on the specific conditions of your particular project.

Large Lamps

If you have a high voltage source and also a space available problem, and must use a large lamp for its

GLOSSARY OF LIGHTING TERMS

AMBIENT TEMPERATURE — That range of maximum temps. over which the lamp or indicating unit will perform as specified.

BASE—Component, usually metal, cemented to the bulb for support and to provide electrical connections. Main types include: midget screw, flanged and grooved; miniature screw and bayonet; candelabra screw; and bayonet single contact (S.C.) and double contact (D.C.).

BRIGHTNESS—That attribute of visual sight by which an area appears to emit more or less light.

BULB—Glass enclosure, evacuated, containing the filament or electrodes of a lamp. Lamp identification is by letter and number.

G—Globe shape C—Conical
S—Straight-sided T—Tubular shape

Number is the diameter of the bulb at its maximum; measured in eighths of an inch. Example: G-6 is globe shaped, measuring 6/8 (¾) inches.

CANDLE POWER—The unit of measurement of light intensity in terms of Mean Spherical Candle Power: 1 candle power (C.P.) equals approximately 12 lumens. Large lamps are usually rated in lumens. Miniature lamps are usually rated in C.P. Micro-miniature lamps are rated in milli-lumens.

CURRENT—The amount of amperes the lamp will draw at design voltage.

DESIGN VOLTAGE—Voltage at the socket of the lamp, for which the lamp is designed, giving best over-all characteristics of light output and life time.

EFFICIENCY—The measure of a lamp's ability to convert power into light. Formulas are: C.P./watt and lumens/watt.

EXTINGUISHING VOLTAGE—That voltage level at which a neon glow lamp will not produce light.

FILAMENT—Standard material is tungsten wire, arranged on supports within the bulb. May be straight (S), or a coil (C), or a coiled-coil (CC). Filament designation consists of a letter and a number. The number tells the arrangement of the wire on the supports.

FOOT LAMBERTS—The unit of measurement of brightness for indicating lights and illuminated switches.

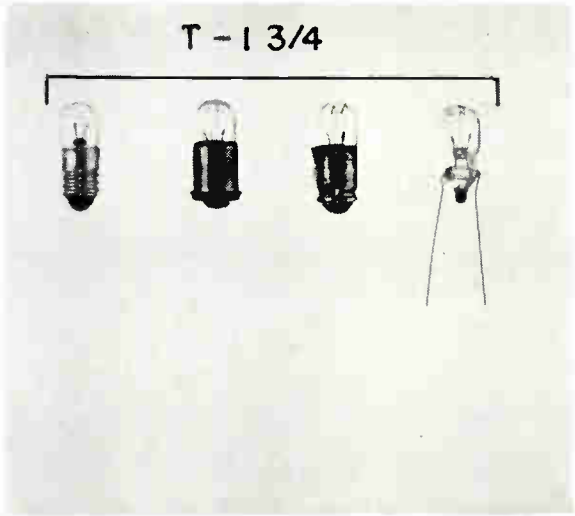
LAMP, LARGE—Any incandescent lamp, usually of the 6 to 10 watt type, operating on from 60 to 120 or 210 to 250v. Most popular measures approximately ¾ inch in diameter.

LAMP, MINIATURE—Any incandescent lamp, usually below 6 watts, operating on from 2 to 55v. Most popular measures approximately ⅜ inch in diameter.

LAMP, MICRO-MINIATURE—Any incandescent lamp, usually in the milli-watt range, operating on up to 3v. Diameter size ranges from 0.01 to 0.06 inches.

LAMP, GLOW—Lamp with electrodes sealed inside a bulb filled with a gas, usually neon. Can be based or unbased.

LAMP, INCANDESCENT—Lamp with supports and a fila-



(Courtesy G. E. Miniature Lamp Dept.)

The T-1¾ lamps, with tubular bulb shape, are midget screw, midget flanged, and midget grooved base respectively. Lamp at end is wire-terminal type. Designed to operate on 1 to 28v.

high light output, try to use a 6w instead of a 10w lamp. The 6w will be smaller. It will also be more rugged. The 6w, 110v lamp is not rated at 6w because 6w of light is needed. It is the smallest practical lamp for that voltage and wattage. This is because of the fragility of the filament. At 6w, the wire is as thin as possible, but still able to withstand minor shock or vibration.

If you must use a large lamp in a rugged environment, be sure to specify to the manufacturer that the filament must be clamped at every support. Large lamps have their long filament strung back and forth on a number of supports. Clamping at each support can raise the strength factor to near that of the low voltage lamps. The strength of a filament is measured between supports. The low voltage lamps usually have only 2 supports, if any. Clamping, on these large lamp filaments, reduces the stresses to only those applied between any 2 supports. Clamping also has one other affect in these lamps. It will reduce the light output somewhat, because the clamps act as heat sinks, drawing heat out of the filament. Remember, light output depends on filament temp. The light will be reduced, but with the high power input, this decrease can be lived with. There is still plenty of light left for indicating.

The smallest lamp (6S6) for use on 120v measures approximately ¾ inch in diameter, and 1⅝ inch in length.

Miniature and Sub-Miniature Lamps

In contrast, a lamp designed for the lower voltages (below 55v) usually measures about ⅜ inch (down to ¼ inch) in diameter. Overall length can be as small as ⅝ inch. Two typical lamps are the No. 44 (T-3¼, miniature bayonet base) and the smaller 327 (T-1¾, midget flanged base).

The small size is because the low voltage lamps generally have a lower power input. In most cases the filament will be shorter and thicker than those in large lamps. These miniature and sub-miniature lamps may not even need supports, outside of their lead-in wires. They produce less heat. Because of these factors, service life can be longer.

ment, sealed in an evacuated bulb. Can be based or unbased.

LAMP, SUB-MINIATURE—Any incandescent lamp, usually below 4 watts, operating on from 1 to 28v. There is a very hazy line between miniature and sub-miniature lamps as far as definitions go. They may be based or unbased.

LIFE TIME—Average rated laboratory life, usually in hours, that can be expected of lamps operating on stationary racks, with regulated voltage. At rated life time, 50% of the lamps will have failed. Life time varies inversely to the 12th power of the applied voltage in incandescent lamps. For standard brightness glow lamps it is inversely proportional to the cube of the current. For high brightness glow lamps it is inversely proportional to the 6th power of the current.

LIFE, SERVICE—Actual time, usually in hours, that a lamp will perform under operating conditions.

LIGHT, INDICATOR—Unit used to show some action is completed, must be preformed, or for warning. Includes a lamp socket, bushing for housing lamp and socket, and a lens cap.

LIGHT OUTPUT—Amount of emitted light as measured in C.P. and lumens.

LUMENS—A unit of measurement of emitted light.

OVERVOLTAGE—Any voltage exceeding design voltage, giving increased light output, but reduced life time.

RUN-AWAY—Characteristic of glow lamps, which will destroy them. Proper selection and use of current limiting resistor determines lamp current and life time.

SPECTRAL QUALITY—A measure of relative emission through the visible spectrum.

SWITCH, ILLUMINATED—In its simplest form an indicator light with a switch attached. Highly developed components having single or multiple (up to 4 usually) lamps, able to display one or more messages. Switching can either control the lamps or other associated functions in different parts of system.

TRANSMISSION—The manner in which light passes through the bulb, lens cap, legend screen, or translucent button. Clear glass passes 80 to 90% of the available light, with 8 to 10% reflected and the rest absorbed. Plastic is somewhat lower. Light through translucent materials is an example of diffuse transmission.

TRANSLUCENT—Capable of passing light, but not an image. Good example is frosted glass.

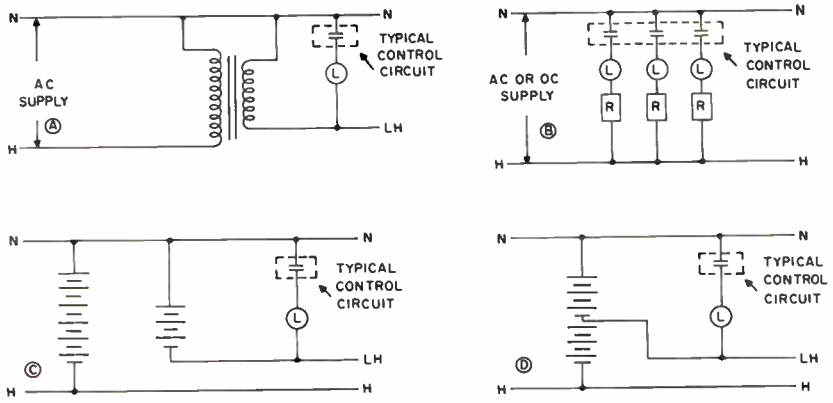
TRANSPARENT—Capable of passing light undistortedly. A good example is window glass.

VIBRATION & SHOCK—Mechanical conditions having adverse effects on incandescent lamp filaments and indicating units. High voltage, low current filaments are most susceptible because of length and diameter. Low voltage, high current filaments are thicker, shorter, and stronger.

VOLTAGE, BREAKDOWN—Also known as firing, starting, igniting, or ionizing voltage. That voltage required to completely ionize the gas in a glow lamp and conduct current.

Low voltage lamps on high voltage. A. and B. circuits are for miniature and sub-miniature lamps on high voltage lines. R in B. are dropping resistors. Control circuits are left to user's choice. C. and D. are high voltage batteries—the first using a separate battery for the lamp; the second circuit using a tap-off.

(Courtesy Panellite)



LAMP SELECTION (Continued)

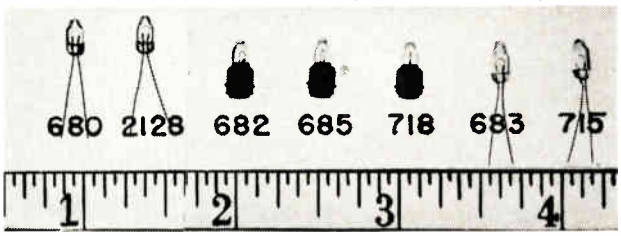
These miniatures (also holds true for sub-miniatures) offer increased reliability. But they do have their dis-advantages—the lower design voltages required, and the decrease in light, as compared to the larger lamps. They may be operated on 120 or even 250v lines, but here a step-down transformer is needed. In most cases this is both uneconomical and impractical. But, if you do have to use them (6, 12, 24, and 28v types) on the higher voltages—because of limited panel space or for the increased ruggedness they offer—the series of schematics captioned "Low Voltage Lamps On High Voltage" should be of help. These circuits are in wide use and have proven their value.

Temps. have another effect on both miniature and large lamps. The lamp bulbs are cemented to the base. The filament leads are soldered to the base. Temps. approaching 350°F will soften both cement and solder. This leads to early failure. Temp. maximums must be observed. Lamps are available, with no base or soldered connections, for use up to 600°F. This is about the top limit for lamps, as water is evolved from the bulb wall, combines with the tungsten of the filament, and causes increased blackening on the bulb wall. These wire terminal (un-based) lamps use only their sturdy leads for support in the circuit. Their one dis-advantage is that of replacement. They are normally wired into the circuit, not fitted into sockets or lamp holders. Hudson Lamp Co., General Electric Miniature Lamp Dept., Sylvania Electric's Lighting Products Div., and Tung-Sol Electric Inc., all offer these lamps in a wide variety of voltages and sizes.

Life time, for incandescent lamps, varies inversely to the 12th power of the applied voltage. Light output is directly proportional to the 3.6 power of the voltage. The accompanying Characteristics Chart gives a graphic picture of this. What it all means is that if you raise the voltage to the lamp 10%, light output is increased some 40%, but life time drops some 60%. On the other hand, if you decrease the voltage 10%, light output drops some 30%, but life time almost doubles.

High reliability T-1 lamps approximately actual size. Brass based measure 3/16 in. dia. by 3/8 in. long. Wire terminals are 1/8 in. dia. and 1/4 in. long.

(Courtesy G. E. Miniature Lamp Dept.)



NO.	VOLT	AMP	DESIGN LIFE	CAND. POWER
682	5.0	.060 ± 10%	100,000+	.029 ± 25%
685	5.0	.060 ± 10%	100,000+	.048 ± 25%
718	5.0	.115 ± 10%	40,000+	.132 ± 25%
680	5.0	.060 ± 10%	100,000+	.032 ± 25%
683	5.0	.060 ± 10%	100,000+	.053 ± 25%
715	5.0	.115 ± 10%	40,000+	.147 ± 25%
2128	3.0	.0125 ± 20%	100,000+	.001 approx.

Reliability

Most incandescent lamps now on the market have a high efficiency (C.P./watt), by today's standards, but only a moderate life time. During the time this article was in preparation, this editor talked with numerous designers who use lamps daily. More and more of them feel that reliability or long service life is the main consideration today. Whether in missile control equipment or coffee pots.

To get this longer reliability/service life you can do one of 2 things. The first would be to use the new, longer life, General Electric High Reliability Lamps. They are designed for the lower voltages, operate the filament at a lower temp., and give life times of from 40,000 to 100,000+ hours. Using these lamps, your

problem is reduced to designing the circuit around the lamp. You should be doing this anyway. This approach saves you time, trouble, and money. Of course their light output can't be used to attract the attention of an operator if his head's turned; but for console use, with the operator looking at the lights, they'll give all the light you'll need for any indicating function.

The other approach is to take one of the lamps now on the market. Run it at some figure below its design voltage—greatly prolonging its service life. A typical figure (using the Characteristics Chart) would be an increase from 1000 to 4000 hours. And you don't have any circuitry changes. Using a 28v lamp in a 24v circuit affects nothing.

In the case of this under-voltage operation, you sacrifice light output from the rated C.P. But, you *really* increase life time. Let's take the 327 previously mentioned. It is one of the "work-horses" of the indicator light and illuminated switch industry.

	RATED VALUE	10% UNDER-VOLTAGE
Voltage	28v	25.2v
Current	0.04a	0.038a
C.P.	0.34	0.20
Life Time	1000 hrs.	4000 hrs.

The necessary compromise is clear. When using lamps, always note carefully your requirements. Are they a logical combination? Or, are you asking for more life time than is possible at the available power? The accompanying Incandescent Lamp Check-List will aid in your selection of a lamp. There is such a wide variety of lamps available now, that with the help of a manufacturer you'll quickly be able to find one for your needs. And the word is *needs*. Don't over-specify: ask for a reasonable combination of life time and light output at your available voltage.

The lower voltage lamps (6, 12, 24, and 28v) are generally more rugged than the 120 or 250v types. Also, a 6v will be more rugged than a 12v, the 12v more than the 24v, etc. If you can manage the lower power source—you'll get the advantages of longer service life and smaller size.

Concerning mechanical reliability, here is something to watch during selection. For dependability, always choose a bayonet base over a screw base, if possible You get positive locking and contact. You avoid the danger of the lamp accidentally unscrewing —for a false failure indication.

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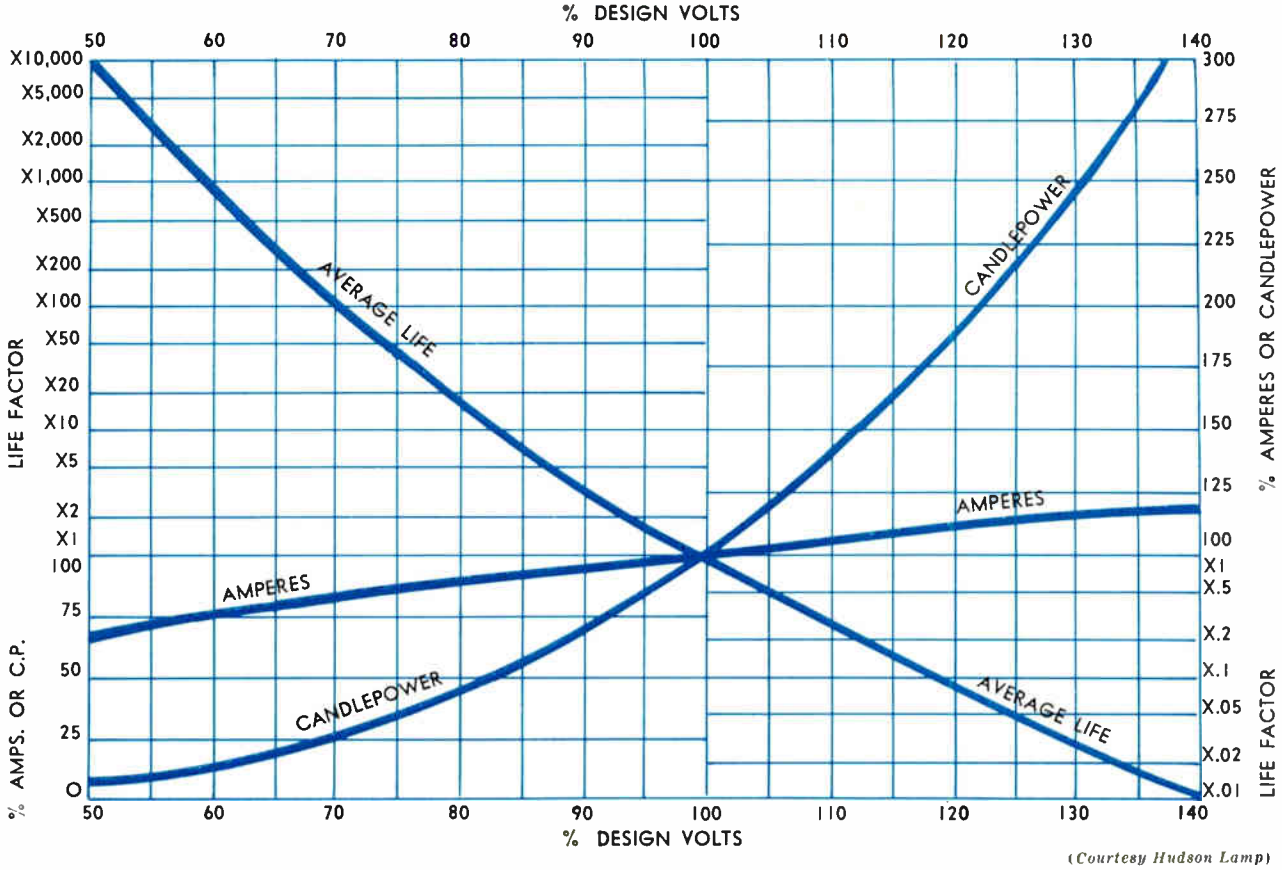
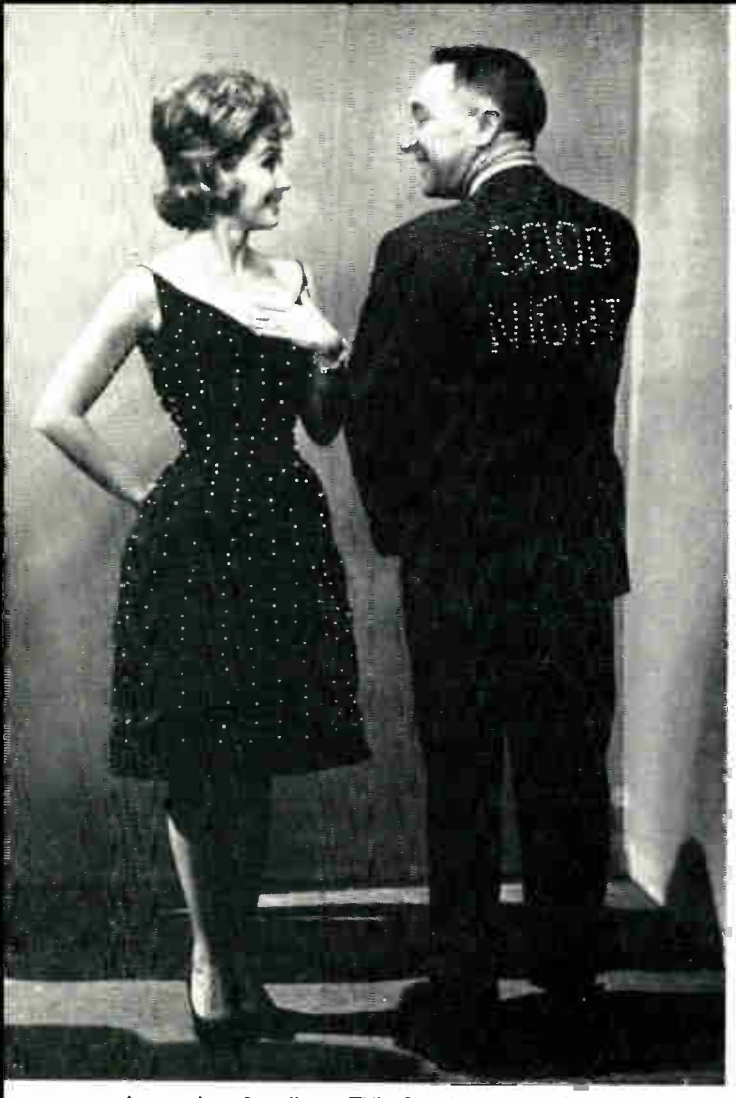
CHARACTERISTIC CURVES FOR MINIATURE LAMPS



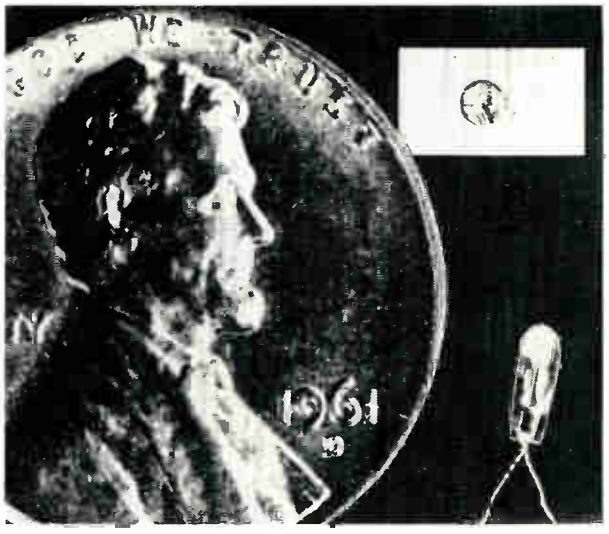
(Courtesy Hudson Lamp)



Actress Jane Powell and TV's Gary Moore on "I've Got a Secret" show. The secret—over 500 Mite-T-Lites in Jane's dress, about 150 in Gary's sign. *(Courtesy Sylvania)*

INCANDESCENT LAMP CHECK-LIST

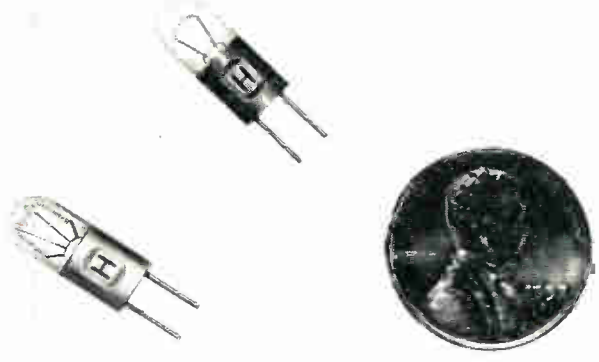
1. Application
2. Environment:
   - A. Ambient light
   - B. Shock & vibration
   - C. Ambient temp.
3. Voltage
4. Current
5. Light Output
6. Life Time
7. Size: diameter ; length
8. Base
9. Bulb Shape
10. Notes



Micro-Miniature Lamp Co.'s Micro Lamps measure from 0.0315 to 0.0630 in. dia. by 0.118 to 0.146 in. long.

LAMP SELECTION (Continued)

A dozen of these sub-miniature incandescent lamps fit within a one inch square. Named "Tu-Pin," they operate on 1.35 to 28v Max. diameter is 0.230 in. by 37/64 in. (plus pins) in length. Bases are epoxy and color coded (one color for each set of different electrical characteristics) for fast identification of the 12 lamps in the 2300 series The pins are spaced to fit in transistor sockets, fast plug-in on printed circuit boards, and for sockets with soldered connections. *(Courtesy Hudson Lamp)*



TYPICAL INCANDESCENT CONSIDERATIONS

VOLTAGE	HIGH (120/250v)	LOW (6, 12, 24, 28)
Filament	thin/weak	thick/strong
Current	50–85 ma	15–250 ma
Wattage	6–10 w	4 w & below
Bulb Dia.	3/4 inch	3/8 inch
C. P.	4	1
Life Time	1500	200–10,000

Micro-Miniature Lamps

For real micro-miniaturization these lamps are the thing. They are reliable, withstand shock and vibration well, and consume little power. The one dis-advantage is their light output. It ranges from 20 to 250 millilumens.

Originally developed by the Diamond Ordnance Fuse Laboratories, Washington, D. C., for use in the timing circuits of close-proximity exploding shells, they are now available from 3 manufacturers in the United States—Kay Electric Co., Pinlite Div., Pine Brook, N. J.; Micro-Miniature Lamp Co., New York, N. Y.; and Sylvania Electric Products, Inc., Sylvania Lighting Products Div., Salem, Mass.

Voltage required varies from 1.0 to 3v. at currents of from 5 to 45 ma. These micro-miniatures are subject to the same restrictions as any other incandescent lamp. Raise the voltage and current and you get increased light output, but, again, the life time will be shortened. Burn them at their design voltage and current, and life times will range from 500 to 5000 hours.

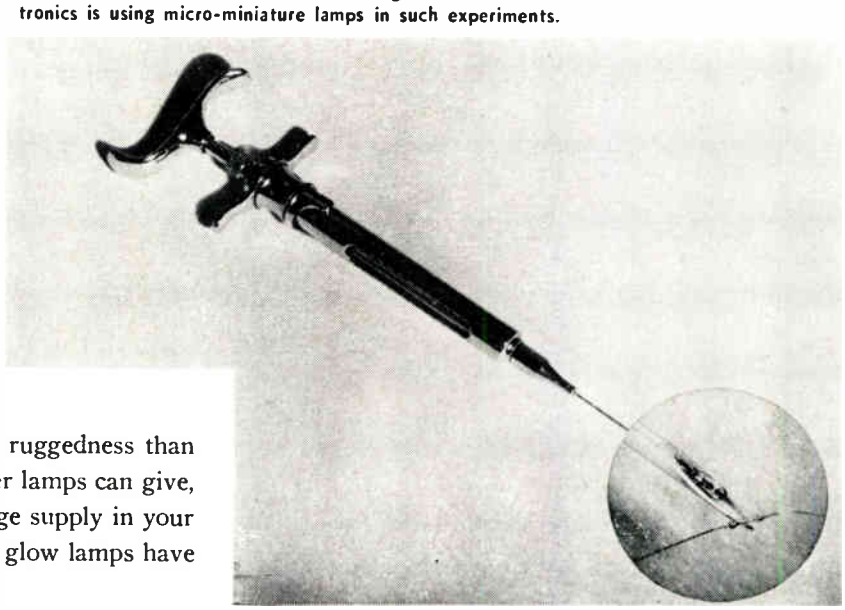
Measuring from 0.016 to 0.0630 inches in diameter and 0.065 to 0.146 inches in length, they have been, and are, used in a wide variety of applications, including: high-speed punch-card readers; computer tape readouts; compact matrix displays; photoelectric logic system; on/off indicators in transistorized circuitry; in the recording systems in airborne radars; microwave bolometers and as noise sources; and as optical point sources.

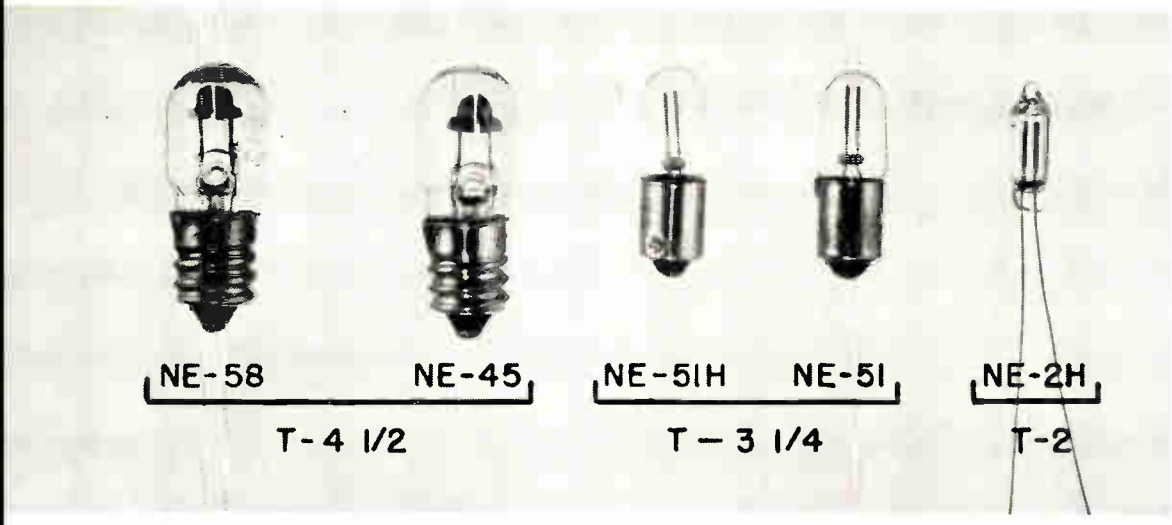
If you are looking for even more ruggedness than the low voltage miniature and smaller lamps can give, or, you can't include the lower voltage supply in your design, take a look at what the neon glow lamps have to offer.

TABLE OF MICRO-MINIATURE LAMPS

Type	Voltage (v)	Current (ma)	Diameter (inches)	Length (inches)	Millilumens	Life Time (hours)	Axial leads	Leads from same end
Kay Electric Co., Pinlite Div., Pine Brook, N. J. PINLITES								
L12-12	1.2	12	0.030	0.080	50	1000		X
13-7	1.35	6.75	0.016	0.065	20	500	X	
15-15	1.5	15	0.016	0.065	60	1000	X	
15-45	1.5	45	0.030	0.100	220	1000	X	
L15-30	1.5	30	0.030	0.080	160	1000		X
L15-45	1.5	45	0.030	0.080	220	1000		X
30-30	3	30	0.030	0.100	250	2000	X	
Micro-Miniature Lamp Co., New York, N. Y. MICRO LAMPS								
M 1A	1.0–1.2	5–7	0.0315	0.118	30–35	1000		X
M 1	1.2–1.5	8–10	0.0433	0.1378	35–40	700–1000		X
M 2	1.2–1.5	8–10	0.0512	0.146	35–40	700–1000		X
M 2A	1.2–1.5	10–15	0.0512	0.146	40–45	700–1000		X
M 2B	1.2–1.5	20–25	0.0512	0.146	45–50	700–1000		X
M 2C	1.2–1.5	25–30	0.0512	0.146	50–60	700–1000		X
HM 3	1.2–1.5	10–15	0.0630	0.146	45–50	700–1000		X
HM 4	1.2–1.5	20–25	0.0630	0.146	50–55	700–1000		X
Sylvania Electric Products, Inc., Lighting Products Div., Salem, Mass.								
MITE-T-LITE	1.0–1.5	35(max.)	0.045	0.125	100	500–5000	X	

Kay Electric's "Pinlites" are small enough to fit within a blood vessel. Medical electronics is using micro-miniature lamps in such experiments.





Real rugged lamps. T-4½ are standard brightness types with candelabra screw bases having integral current limiting resistors. T-3¼ glow lamps are miniature bayonet based, without integral resistor. NE-51H and NE-2H are high brightness types for 210-250-vac. Light output is 8 to 10 times that of standard brightness lamps. *(Courtesy G. E. Miniature Lamp Dept.)*

LAMP SELECTION (Continued)

Neon Glow Lamps

Glow lamps are rugged. They consist of a sturdy pair of electrodes, a gas (usually neon), and a glass bulb. A base may be attached if desired. There is no filament to fail.

Operation is simple. A voltage is applied, either ac or dc (the lamps work both ways). Current flows between the electrodes. The gas ionizes. Light is produced in the luminous gas surrounding the electrodes. The electrodes are nickel-iron, with an emission mix on them similar to the oxide emission mixes on vacuum tube cathodes.

When used in dc circuits, the light is produced only around the cathode electrode. This is because glow lamps are negative glow devices. When used in ac circuits, the glow appears to be around both electrodes (actually only around one at a time). But it appears to be, because of the rapidly changing ac cycle.

Glow lamps are for use on line voltages (105-125 and 210-250v). They are high reliability, long lived lamps. But they do have their dis-advantages. The first is a lower range of light output than the incandescent lamps. The second is limited colors. Neon lamps produce the red and yellow wavelengths of the light spectrum (the combination of the two is orange).

RUGGEDNESS CHOICE

1. **Glow lamps.**
2. **Low voltage, high current incandescent.**
3. **High voltage, low current incandescent.**

Thus, in indicator uses, only lens caps and indicator screens of red, yellow, or clear material can be fitted over the lamps.

There is no voltage-life time compromise with glow lamps. For standard brightness lamps life time is inversely proportional to the cube of the current. For the high brightness types life time is inversely proportional to the 6th power of the current. Light output in both types is directly proportional to the current. If the voltage rises (and the current rises also); the light output increases, and the life time in standard brightness lamps is barely affected. In the high brightness types if the voltage increases (and the current rises also), the light output increases, but life time is drastically shortened.

Glow lamps use low wattage. They operate at cooler temps. than incandescent lamps. Upon ionization, the resistance inside the bulb, between the electrodes, drops. Glow lamps have a negative resistance characteristic. If some resistance is not included outside of the bulb, either in the base (screw type only), or in the external circuit, the current will "run-away," destroying the lamp. The current must be controlled. This is done with a series limiting resistor.

For all practical purposes, the voltage across a neon lamp is constant. Neon lamps are widely used as constant voltage devices (e.g. one used as a 60v regulator in a critical power supply). No current will flow in the circuit until the breakdown voltage is reached. Then the lamp "fires". Current flows, and the applied voltage divides between the lamp and the series resistor.

This point must be stressed and remembered. *The voltage across the glow lamp is, for all practical purposes, independent of the current flowing in the circuit.*

Changes in applied voltage are reflected mainly in

increases across the series resistor. The voltage on the lamp remains substantially constant. This means that with a given resistor value, and an increase in line voltage from say 120 to 130v, there will be the lamp's constant 60v drop, the remaining 70v will be across the resistor. In other words, the increase in current that results, is for all practical effects, proportional to the increase in the voltage across the resistor. Remember, there is no current flow until the breakdown voltage is reached.

In cases where the voltage is mis-applied, example 240v to a device with a resistor rated for 120v operation, the current becomes not twice its normal value (as the voltage is), but 3 times. This is important where the wattage rating of the series resistor is concerned. It is primarily the voltage applied to this resistor that determines the current flow in the circuit. In the case of 120 to 130v, the voltage drop across the resistor went from 60 to 70v. In the example of 240v, the drop goes from 60 to 180v (240 − 60 = 180). If the current was 1ma at 120v, it will be not 2ma at 240v, but 3ma.

Standard and High Brightness Lamps

There are, as mentioned above, 2 basic types of glow lamps. The first is the standard type, of which the NE-2 and NE-51 are examples. The second type is the high brightness lamp, examples of which are the NE-2H and NE-51H. The differences between the types are 2 major ones.

1. The breakdown voltage needed to fire: standard types need a min. of about 90vdc or 65vac to glow; the high brightness need a min. of around 160vdc or 90-95vac to glow.

2. The light output is vastly different. If the standard brightness are given a factor of 1, the high brightness factor would be around 8 to 10.

Neon lamps are similar to incandescent lamps in one respect. They blacken with time, but in a different manner. In the standard brightness glow lamps this blackening is caused by ionic bombardment—positively charged particles knocking off electrode material. This material deposits on the bulb wall—slowly cutting-off the light output. The rate of blackening is determined by the current flow.

If the limiting resistor was 56kΩ for example, blackening would result (using an NE-51) in 50% reduced light output at 5000 hours. This is the end of life figure for a glow lamp. This is what decides when you replace the lamp—insufficient light out. If the resistor is of such a value (220kΩ) that the cur-

GLOW LAMP CHECK-LIST

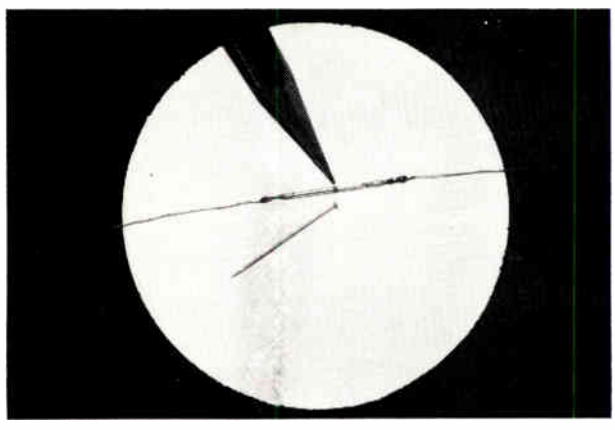
1. Application .....
2. Voltage:
   - A. Circuit ..... (standard—90vdc, 65vac) (Hi-brite—160vdc, 95vac)
   - B. Breakdown .....
3. Must lamp start in darkness .....
4. Size: diameter .....; length .....
5. Base:
   - A. Unbased (wire terminal) .....
   - B. Miniature bayonet .....
   - C. Candelabra screw (resistor built-in) .....
   - D. D.C. bayonet .....
6. Bulb Shape .....
7. Light Output .....
8. Lens Cap Color: red ...; yellow ...; clear ...
9. Notes .....

INCANDESCENT vs. GLOW LAMPS

	INCANDESCENT	GLOW
Brightness	high	lower
Watts/Temp.	high/high	low/cool
Lens Cap Colors	any	clear, yellow, red
Overvoltage Effects	shorten life	unaffected
Strength	low	very rugged

World's smallest glow lamp, for use in missile tests, is no larger than head of a pin. Supplies 1/40th watt from trace of neon gas enclosed in tube about 1 in. long and 1/20th in. in dia.

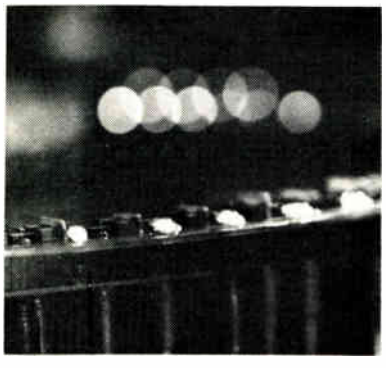
(Courtesy Westinghouse Lamp Div.)



LAMP SELECTION (Concluded

rent is reduced to 0.3ma, the 50% end of life point would occur at 200,000 hours. Of course, to get this figure you have to sacrifice light output (which is directly proportional to current). This 50% point is a big factor in the use of standard brightness glow lamps. These lamps fail slowly, or are "Fail-Safe". Light gradually diminishes. When you're not satisfied with the amount of light you're getting, you just replace the lamp. To quote a pioneer in the uses of neon glow lamps, Warren Walker of Dialight Corp., "It's hard to find anything else in the way of a light indicator device that will give you that kind of reliability."

With the high brightness lamps, using them on 105-125v, there is no blackening—no fail-safe feature. The voltage needed to fire these high brightness types is relatively constant throughout most of rated life, with an abrupt rise in the breakdown voltage required at the end of life. Thus, high brightness lamps fail suddenly, when used on 105-125v lines. The standard brightness lamps are always recommended for use at these voltages.



Glow lamp processing and testing line at Signalite, Inc., Neptune, N. J.

The reason for the high brightness sudden failure is the gas used. It is a mixture. This mixture is responsible for 2 very important features of the high brightness types:

1. They are able to operate on high current levels for a given number of hours of operation (say 4 times that of the standard lamps).

2. Because of this high current, they give greatly increased light output, about 8 to 10 times that of the standard types, per given number of operation hours.

These lamps are especially suited to the higher voltages (210-250v). This is where they really "shine." To go back for a moment. Glow lamps need a specific breakdown voltage. These high brightness types need minimums of 160vdc or 90-95vac. Operating them on 105-125v lines leaves an operating margin (till the rise) of only 35v (125 — 90 = 35v). Operating them, on the other hand, on a 210-250v line leaves a margin (till rise) of 160v (250 — 90 = 160v). Life time is increased so much, in fact, that it will only be limited, in most cases, by bulb blackening (which does occur in these lamps at the higher currents and higher voltages). But, since you have such a wide margin, the number of hours you'll get sufficient light is very long, as compared to the standard types.

At high voltages the high brightness glow lamps are high reliability and fail-safe devices. They are always recommended for use on 210-250v sources.

Neon screw based glow lamps have the series limiting resistor built into the base. It is an integral part of the over-all lamp. Glow lamps with the more dependable (from a mechanical view-point) bayonet base *do not* have this integral resistor. *Note Well: it must be included in the external circuit.* This can be in the actual circuit, or in the indicator unit housing the lamp. Such complete indicating units are widely available. You save time and money with this kind of unit. If the lamp has to be thrown away because of low light output, then only the lamp is replaced, the resistor stays with the unit.

Another point to watch. When glow lamps, used as indicators, are placed in unusually darkened environments, their breakdown voltages can rise appreciably. This is what's known as the Dark Effect.

The solution is to order lamps with a mild radioactive additive in either the gas or on the electrodes. The additive will keep the breakdown voltage from being affected too much. These lamps are already in wide-spread use in indicating devices today (most indicator manufacturers prefer them). The point is that *you must consider all the parameters when designing with lamps.*

Temp. will not affect glow lamps. If it is kept within normal limits, that is. Glow lamps will operate satisfactorily up to around 250°F. Here it is not a question of cement or solder softening. With neon lamps it is a poisoning of the gas in the lamp, by other gas evolved off the bulb wall, along with some water vapor.

Life time for these very dependable lamps can and does range up to 50,000 hours of service life. To wind-up, a quote from Jim Tuttle, G.E.'s expert on glow lamps, "Glow lamps are the most reliable, low cost, 120/250v light source available."

The author wishes to thank Mr. Warren Walker, Director of Research and Development, Dialight Corp., for his patient effort and technical assistance in the preparation of this article.

DESIGNER'S GUIDE TO INDICATOR LIGHTS

Indicator lights are the perfect means of conveying information on equipment condition and functions. The major factors involved in their use are discussed in this article. A thorough study of the transistor controlled indicators now coming into widespread use is also included.

Part Two of Three Parts

THE FIRST FACTOR IN USING INDICATING DEVICES is the light source. How much brightness or light output do you want? This will be limited by your power supply—what voltage and current is available?

Your next step is to decide what information must be conveyed from the indicator to the operator. From now on you're working with human factor, optical and mechanical considerations.

An indicator is built around a lamp. Thus, any condition that affects the lamp will naturally affect the indicator. How much shock and vibration will the unit have to withstand (if any)? If the environment is rugged your best choice is the smaller low voltage miniature lamps or the neon glow lamps. If it is really rugged, or the application is very critical you will probably want the indicator to have 2 lamps. If one fails, the other will give enough light until replacement is possible.

Cockpit of Boeing 707 series jet airliner. Designers used 150 indicator lights, approximately 70 illuminated switches, and 300 to 500 lights on pilot, communications, navigation, and engineering panels. *(Courtesy The Boeing Co.)*

INDICATOR LIGHTS (Continued)

How well do you want the indicator to show up? What are the ambient light conditions? The contrast of the indicator light to its panel surroundings increases as the ambient light level decreases. Where you will really notice this is when you are using lamps with a low light output, such as the neons. Another point to watch is the angle of the panel to the dominant light source. If the panel is angled or approaching the horizontal, and you have strong light from overhead, or, if you have, say, some angle above 45° across from a large window, this ambient light will be an important factor where you're concerned with contrast and visibility of the indicators. If there is a bright light source above the panel, operator fatigue and consequent system inefficiency can result from glare. If you don't have these high ambients to contend with, then your problems are that much simpler. If you do, the easiest way around them is to make a panel mockup. A little close study will reveal any trouble, and proper selection of lamps, lens caps or indicator screens, or a different angle for the panel, should minimize the problem.

If you're using just 1 or 2 indicators the heat generated by the lamps themselves should not be a serious problem. But with the uses of indicators multiplying with a speed comparable to our rabbit friends, more than likely you had better give some thought to the heat generated by the indicator lights. Every indicator gives off heat. Using 10, 20, 50, or 100 of them on one panel multiples a single heat factor in direct proportion. A number of things could go awry. The first could be the lens caps or screens if they are made of plastic. Plastics will only withstand up to about 200°F.

Heat can cause trouble in the lamp, if the combined (lamp plus surroundings) temp. approaches 350°F. The insulation on the lead-in wires might melt or shrink, and if you are using high voltages there could be insulation breakdown of the socket, etc. Make sure there is some means of heat dissipation, either by moving air or by spacing the indicators farther apart.

Do you want the lamps replaceable from the front or the rear of the panel? Is it O.K. to use a tool to remove the lamp, or do you want finger access for quick replacement? In critical applications, where time is the governing factor, you'll probably want the lamps replaceable without tools. The operator or maintenance man might misplace the tool (they are small in size), and critical time might be "chewed-up" while he tries to find it.

As far as space is concerned, the number of indicators you use will determine and be determined by a number of things. The first will be, of all things, the amount of light you want available. The higher wattage large lamps and the larger miniature lamps are fairly large in size. Their housings will have to

Typical selection of lens caps for indicator lights. Glass types recommended for use with the larger miniature and large lamps because of the heat they generate. Plastic caps used with most miniature, and all neon glow, lamped indicators. Reading l-r. top row: friction mounting, convex glass; screw-on, convex glass; screw-on, plastic dome; screw-on, faceted glass; and screw-on, flat plastic. 2nd row: screw-in, cylindrical plastic; screw-in, long stovepipe, 'halo' effect plastic; screw-in, long stovepipe, fluted plastic; friction, convex glass; friction, faceted glass; friction, flat plastic. 3rd row; screw-in, flat plastic; screw-in, faceted glass; screw-in, convex glass; screw-in, long stovepipe, plain plastic; screw-in, stovepipe, fluted glass; screw-in, short stovepipe, 'halo' effect plastic. Row 4: screw-in, convex glass; screw-in, faceted glass; screw-in, flat plastic; screw-in, short stovepipe, plain plastic; screw-in, stovepipe, plain glass; and screw-in, short stovepipe, fluted plastic.
(Courtesy Dialight)

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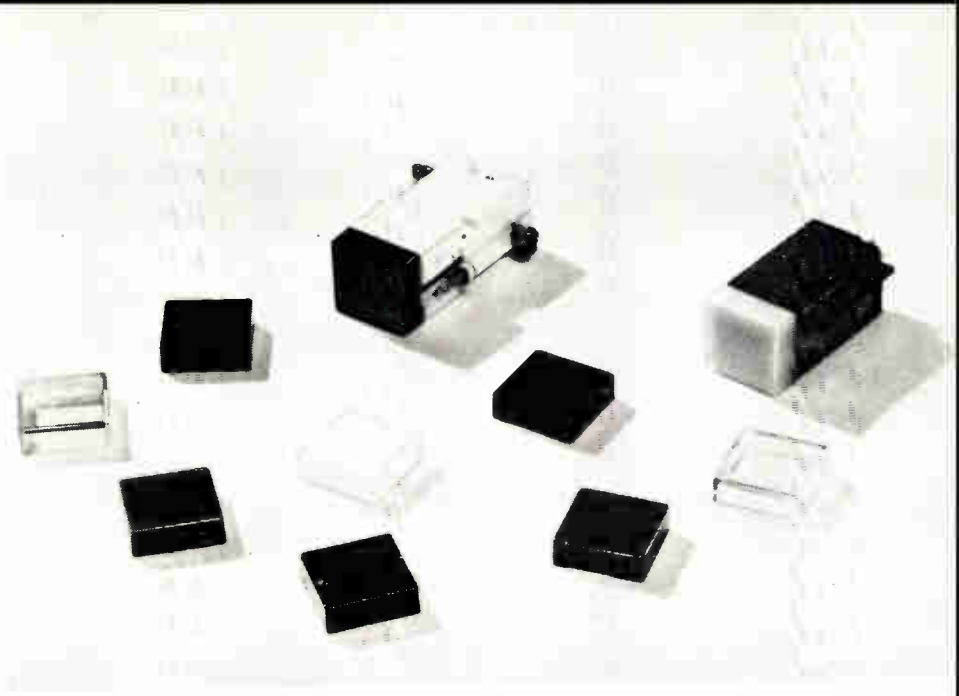


Square indicating lights display information either lit or unlit, or both. The CR103 Type C features a 1 sq. in. screen, complete back-of-panel mounting, in either single or gang mountings. For 110vac and dc and transformer forms for 220-, 440-, or 550vac ratings. Screens snap-on. Diffuser, easily inserted behind transparent screens, is offered in frosted, fine cross-hatch and coarse cross-hatch. Legends for transparent lenses may be on photographic film, mylar[T.M.], or any material suitable for 120°C operation. Colored screens are also available. Standard legends for both are available from factory.
(Courtesy G. E. General Purpose Control Dept.)

be large, and only a few will fit in a limited space. And again, heat must be considered. Putting them too close, without some means of controlling the temperature, will have adverse affects. Size is also important in another way. If the indicators are large, their center-to-center spacing will be greater than if you used lamps of lower light output, but smaller size. When panel space is limited, the most widely accepted solution is to take a reduction in light output, trading that for the required number of indicators.

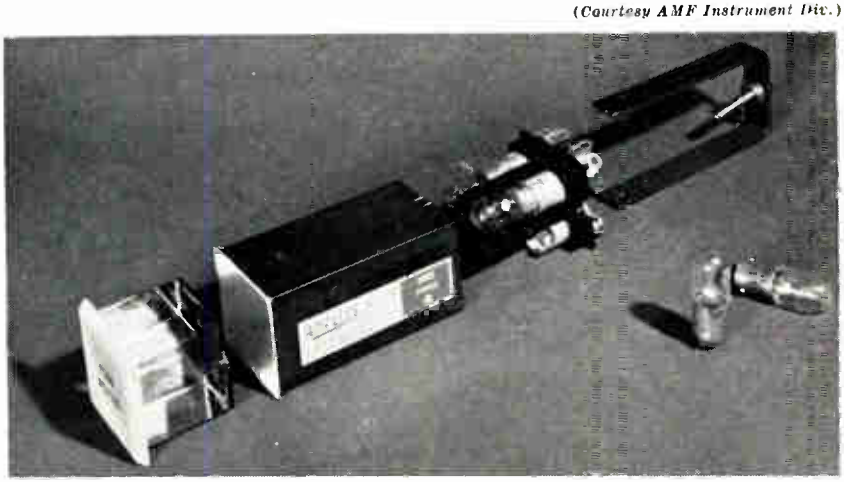
The wide choice of terminals available makes it simply a question of—what type would you like? Some of the more popular types include: binding screw; solder lug/taper tab; solder turret; wire-wrap; taper pin receptacle; and wire lead-in. They are available in stainless steel, brass, etc., with gold plate, hard plate, or hot tin dipped (most widely used) coverings.

Lens Caps and Legend Screens

After the lamp, the most important component of an indicator is the lens cap and indicating screen. Maybe you only need an indicator for a simple "on" or "off" indication. A translucent, possibly colored lens cap should suit your purpose. Maybe your project requires some simple legend such as a number, for example a 1, showing that the first phase of the condition being monitored is completed. Here a numeral, either hot stamped or engraved (and filled) onto a flat lens cap, is sufficient. If you need to show a long word a rectangular screen is what you want.

On the other hand your project might be more complicated. You may have many conditions to

One to 4 colors can be displayed consecutively over entire screen. Re-lamping is from the front. Two lamps may be used in parallel for reliability. A sectionalized face is available for displays of various color combinations. Mount on 1½ in. centers, adaptable to 0.032 to 0.250 in. panels. AMFlite Series 7000 operates on 6, 14 or 28v.
(Courtesy AMF Instrument Div.)



Neon indicator light, the AMPILLUME mounts in 0.514 to 0.519 in. hole, push-in mounting. High resistant nylon housing and lens. Lamp is 25,000 hr. type.
(Courtesy AMP, Inc.)

INDICATOR LIGHTS (Continued)

monitor and display. Here you need a large number of indicators, either of the pilot light size or with rectangular screens, for either numbers, words or symbols. The amount of panel space available will determine the number of units you can use. You can't line-up 3 one-inch diameter lens caps on an area 2½ inches in length.

For rectangular screens 2 lamps are recommended. Reliability is the first consideration. Usually one lamp will always work. The second point is a more even distribution of light. There will be no "hot-spots"—some portions of the screen brightly lit up and others dimmer.

What kind of lens cap do you need? The typical shapes are: flat, both long and short; convex; faceted (jewel); torpedo; dome; and stovepipe. The material may be either glass or plastic. The plastic is usually used with neon indicators and the lower wattage miniature lamps. For high wattage miniatures and the large lamps, choose glass lens caps; they withstand temperatures to 600°F. If the indicator is to be used in high ambient temperatures, then glass is again the best choice.

The inside surfaces of lens caps and indicator screens can be matted or frosted for better diffusion of light.

The lens caps are also available with diffusing rings and in fluted configurations. Take an indicator light with a plain transparent, either colored or uncolored, lens cap and note the amount of light (how bright it looks). Change that ordinary cap for one with fluted rings. With the same light output from the lamp, the indicator will now appear to have increased brightness. This is one way of making a low voltage miniature or neon lamped indicator look like a higher powered, brighter unit.

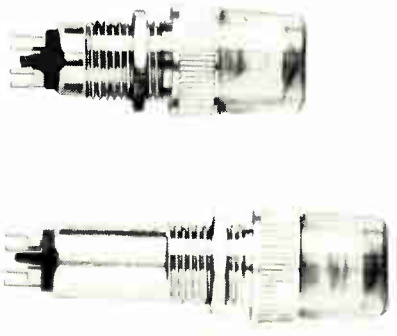
For wide angle viewing, a stovepipe type lens cap is recommended. If you don't need wide-angle light, then choose a flat end; faceted; or dome type cap. There is less chance for breakage or of having the lens cap knocked off the indicator.

The outside surface may also be frosted. This will prevent any ambient light reflections which could make an operator think the indicator is "on" when it is actually "off". When choosing lens caps, screens, panels, etc., do everything possible to eliminate any future operator confusion. Constructions are also available which make the message invisible, until the unit is lighted. Then and only then will the number, word, or symbol appear. In critical or emergency applications these types of surfaces are widely preferred. The operator will see the legend only when it actually comes on—it will really catch his attention. (The opposite is also available: when the lamp is lit, the number, word, etc.—which can be read in ambient light—becomes invisible due to washout by a screen of the same color as the letter, etc.)

Where high brightness is needed during daytime and low brightness during night, or, where the indicator is in a darkened environment (but you must use the incandescent lamp for brightness requirements) use a polaroid disk or lens shutter to "dim" the indicator. But make sure that the light can not be completely obliterated. Murphy's Law For Indi-

Offered in both incandescent and neon lamped units, Pan-i-Lite's are front re-lampable. Operate on from 6 to 220v. Snap-in mounting. Measure ⅜ in. in dia.
(Courtesy Alden Products)

Neon lamped Model 857 offered with and without resistor. Measure 1 11/16 in. long with resistor, mount in ⅜ in. dia. hole. Legend area ⅜ in., visibility 180°.
(Courtesy The Sloan Co.)



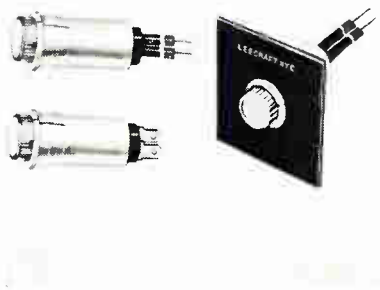
Use the new flat-tip T-2 telephone slide base lamp in rugged phenolic housing. Designed for 6, 12, 24, 28 and 48v supplies. Metal parts nickel-plated.
(Courtesy Sylvania Lighting Products)

cator Devices reads, "If the device can be completely dimmed, someone *will* do it."

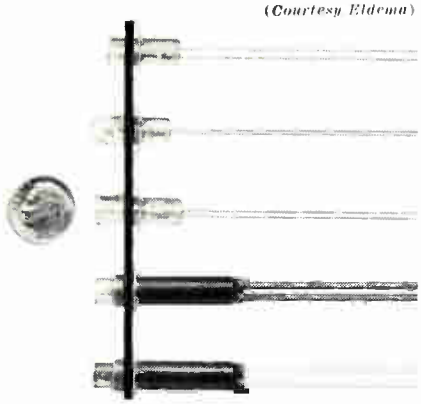
What kind of lettering, numbering, or symbology do you want on the indicator lens cap or screen? Some of the materials available include: legends on photographic film, or mylar[T.M.]; color film transparencies (for use with clear, transparent caps or screens); type printed on clear acetate, parchment, etc. (for use with colored caps or screens); type printed on cellophane; characters hot stamped on plastic and filled with a desired paint; plain printing on smooth or frosted surfaces; and etched metal disks.

Remember size is important. You can't fit a 1 inch letter on a ¾ inch surface. Also, the style must be considered. If you want the operator to react immediately when the indicator comes on, don't have the letter or word in Old Style English. Another point: There is only so much room—any word or legend should be short and to the point.

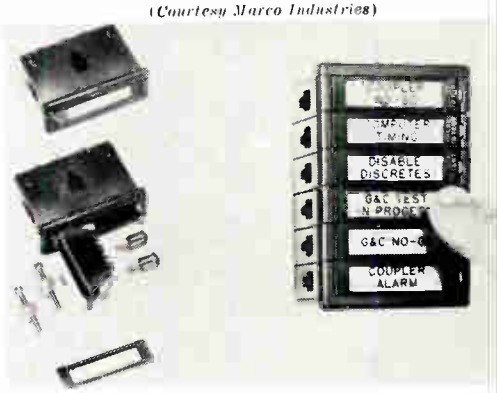
Snaplites mount in ½ in. dia. hole, use high brightness neon lamp, on 125 to 250 v. Snap-in mounting, no additional hardware needed. Butyrate lens caps.
(Courtesy Leecraft)



B-Lites use NE-2 neon and T-1 ¾ incandescent lamps. Mount in 0.316 in. dia. hole, push-on retainer or snap-in. Inexpensive unit in wide range of colors.
(Courtesy Eldema)



Missilite 400 Series screw together. Can be in r-f shielded assembly. Are 1 15/16 by 1 5/16 by ¾ in. Dual lamp illumination; and front panel re-lamping.
(Courtesy Marco Industries)



Average Brightness

A further word on brightness. Certain colors such as red and yellow show up very well, whether using neon or incandescent lamps. On the other hand, green and blue are less effective. If you are using a variety of colors there are two reasons why you want an Average Brightness. The first is operator comfort. If the brightness varies markedly from one indicator to another, he might miss the blue or green indications. Operator fatigue is increased as his eyes grow tired from constantly adjusting to the different levels of intensity. Controlling the voltage to the individual lamps is about the only way to gain an average brightness (assuming the indicators are single lamped units). Run the red and yellow lamps below voltage—reducing their filament temperature and their light output. Leave the voltages of the green and blue lamps at design

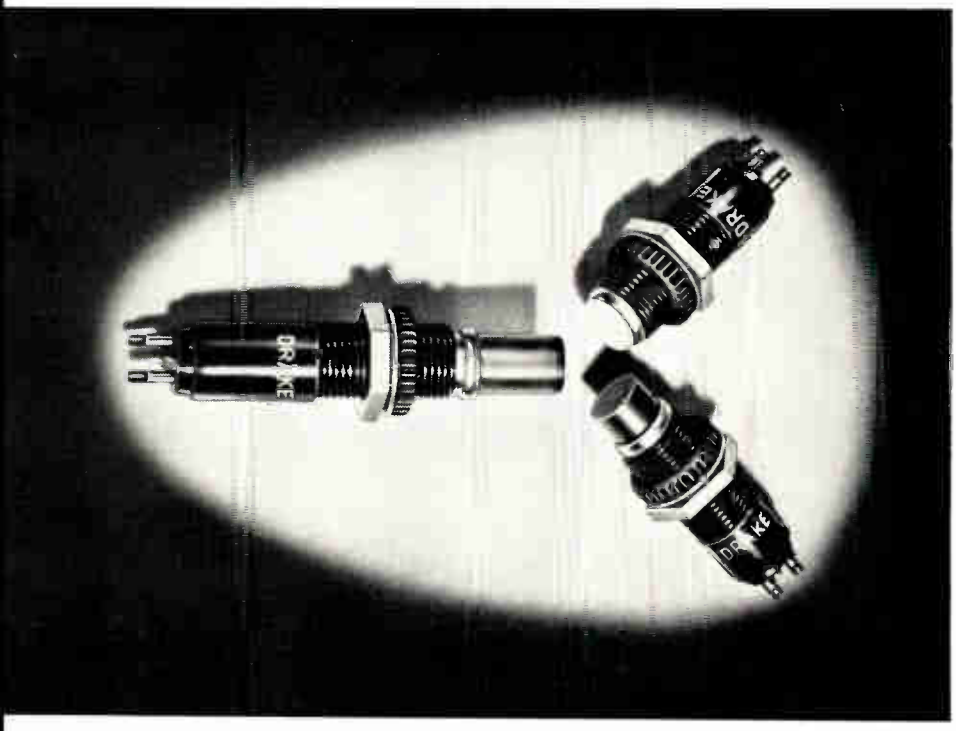
Most indicators are used in corrosive-free atmospheres. But, of course, not all. If your project calls for a protective finish there are a number available, including: cadmium plated; brass nickel-plated; aluminum anodized and dyed in black, grey, and clear colors; and chromate finishes.

Where sealing is specified, what do you want, and what do you actually need? Don't over specify. The more tightness you want, the higher the price. Normal practice uses an O-ring between the lens cap and the indicator housing, with either another O-ring or gasket between the housing flange and the panel.

Lamp Cartridge Indicators

For increased miniaturization in computers, data processing equipment, instrumentation and other areas of automation, the replaceable lamp cartridge indicators are a natural. They are available in both neon glow and incandescent lamped units, so you have a choice (or dilemma) between advantages.

These lamp cartridges are replaceable from the front of the panel. They plug into specially designed cartridge holders, and are secured by lockwasher and a hex nut from the rear and a round, knurled nut from the front of the panel. They mount in ⅜ inch holes. The cartridge indicators come with integral lens caps, available in a full range of colors (red, blue, green, yellow and clear for incandescent; red, yellow and clear for neon). If more lens cap space



(*Courtesy Drake Mfg.*)

Replaceable "Bi-Pin" cartridge lamps and lampholders are shown with flush, short, and long cylindrical lens caps. Neon or incandescent lamps may be used. The legends imprinted on the lens are indexed with the 2 stainless steel pins. Also available without legends. Neon units can have integral resistor, either in cartridge or lampholder. Replaceable from front of panel.

INDICATOR LIGHTS (Continued)

(Approx. actual size)

(*Courtesy Dialight*)

Sub-miniature Indicator Lights use the G. E. T-1 incandescent lamps. Mount in (l-r) 0.193, 0.375, and 0.375 in. hole. Wide range of lens cap colors. Long life makes for permanent installation.

is needed, these units can have an additional lens cap mounted over the lamp cartridges containing incandescent lamps. The legends are normally marked in black, but other colors are available on order.

Their big advantage is their small size. The lamps (unbased types) are housed within a small diameter aluminum cartridge (from which they got their name). The cartridge can be filled with an epoxy compound, which is said to serve a dual purpose. It both supports the lamp; and acts as a protective shield against shock and vibration. Some manufacturers offer their units potted. Others do not; they believe potting leads to early breakage as the thermal coefficients of expansion of the epoxy and the glass lamp bulb are too different.

The neon lamp cartridges can either have the current limiting resistor included within the cartridge, or you can include it in the external circuitry.

The units are offered with stovepipe, flush (flat), and long or short flat lens caps, in a variety of colors. The flat top types can, of course, be stamped with numerals, letters, or symbols.

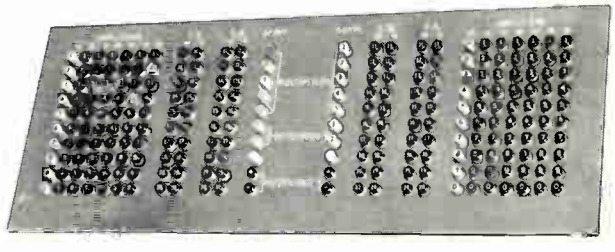
All of these replaceable lamp cartridges have their terminals (2) off-set from center line. This offers advantages of:

1. Any number, letter, or symbol will always be right-side-up.
2. They can only be put into the holder in one way.

No matter what your particular need is, there is a wide assortment to choose from. Dialight Corp.'s, Lamp Cartridges measure 0.330 in. in diameter, by 31/32 to 1 21/64 inches in length. Drake Manufacturing Co.'s, "Bi-Pin" units are 11/32 in. in dia., and from 15/16 to 1 5/16 inches long. Eldema Corp.'s, "C-Lites" measure 0.330 in. in dia., and from 0.93 to 1.30 in. in length. For more detail on these, and all other units in any section of this series see each manufacturer's catalog (they're offered in the Tech Data section this month).

In all cases, consult the indicator manufacturer AS EARLY AS POSSIBLE. He's collected a lot of experience and knowledge from dealing with a variety of designers.

Good example of replaceable lamp cartridge indicators put to work, and cooperation between designer and light manufacturer. Land-Air Corp., provided the panel, 7 by 19 in. and ⅛ in. thick. Dialight Corp. fitted 240 indicators in that space. Panel is now installed at White Sands Proving Grounds. (*Courtesy Dialight*)



INDICATOR LIGHT CHECK-LIST

1. Application . . . . . .
2. Available Voltage . . . . . .
3. Current . . . . . .
4. Lamp rated life . . . . . .
5. Shock & Vibration . . . . . .
6. Ambient light conditions . . . . . .
7. Ambient temp. conditions:
   - A. Air temp. . . . . .
   - B. Air circulation . . . . . .
8. Means of lamp replacement . . . . . .
9. Mounting:
   - A. Space available . . . . . .
   - B. Assembly desired . . . . . .
   - C. Number of indicators . . . . . .
10. Wiring accessibility . . . . . .
11. Terminals . . . . . .
12. Lens Caps or Screens:
    - A. Transparent . . . . . .
    - B. Diffusing . . . . . .
      1. Diffusing rings . . . . . .
      2. Frosted: inside . . . .; outside . . . .
      3. Matte finish . . . . . .
    - C. Clear . . . . . .
    - D. Color . . . . . .
    - E. Shape . . . . . .
    - F. Size . . . . . .
    - G. Lettering, Numbers, Words, or Symbols:
      1. Specify . . . . . .
      2. Style . . . . . .
      3. Size . . . . . .
    - H. Brightness . . . . . .
13. Corrosion protection . . . . . .
14. Water and/or Oil tightness . . . . . .
15. Assembly finish . . . . . .
16. Other information . . . . . .

TRANSISTOR-CONTROLLED INDICATORS

Now that we've talked about standard indicator lights, let's look at a specialized type—the transistor-controlled or transistor-driven indicator light.

The major advantage of these lights is that they can be operated from signals as low as 2v. Types are available that eliminate any high voltage being brought to the console or panel. Within their space saving, small housings they contain everything needed to raise, say, 28v to as high as 150v RMS, for the neon lamp types. The incandescent lamp devices measure as small as 9/16 in. in dia., mount from the rear in 3/8 in. holes, on centers as close as 5/8 in. They project back about 1 3/4 in. The neon types range down to 1/2 in. in dia., mount on 5/8 in. centers, and project back 1 3/4 in.

Another feature is that they keep the high current required to light the incandescent types inside the indicator housing—out of any sensitive logic circuits. Both types offer space savings—the driver circuitry is taken out of the computer and put in the indicator housing. They mount by insertion from the panel rear; secured by a round knurled nut from the front.

Theory

The problem with computers (in which these lights are most widely used), where you are trying to get information visually, becomes one of handling the power that is required for the indicator lamp. Here we are using power in a broad sense—as running either current or voltage type devices. Current types are the incandescent lamps; voltage types are the neon lamps (current is of a relatively lesser consideration).

You need something that is going to respond at the high speeds computers operate at (this precludes relays—even if they could follow the speed, their life time is too short).

The low voltages used extensively in computers pose the main problem. You are usually working with very minute signals, in most cases just milliwatts. You need amplification to run any type of indicator. Also, you need devices that will handle the current or voltage that the lamp requires. Here is where the transistor comes in.

Transistors lend themselves perfectly to indicator use, for 3 reasons:

1. Compatible in size with everything that is being done today.
2. Have the long life (reliability) you are looking for.
3. Cost is competitive with any other device you might use for this purpose.

Neon Indicators—High Voltage

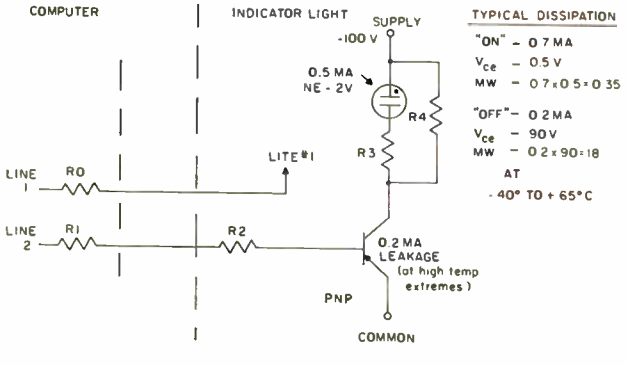
The natural combination in a transistor-controlled indicator light is the neon glow lamp and the transistor (the first units built by the originator of transistor-controlled indicator lights, the TEC-LITE Div. of Transistor Electronics Corp., Minneapolis, Minn., were transistor-controlled neon lamped types). Both of these components are inherently long-lived (at least 25 to 50 thousand hours); there is no need to make either component replaceable. Thus, miniaturization and reliability were extended and improved. They are considered "throw-away" items (customers have found that equipment obsolescence becomes the limiting factor, rather than light emitted).

With these considerations as background, let's discuss the theory, and take a look at some representative circuits.

The transistor acts simply as a high voltage switch (using a neon lamp on 105-125v lines). If you do not want to bring the high voltage to the console, we'll talk about units requiring only low voltages a little later. The transistor can be used in 2 basic circuits. The first is with the neon lamp in series with the transistor (Fig. 1). Resistor R_3 is needed to limit the current through the lamp, after the breakdown voltage is applied. It is not a component of the transistor circuit, but only used because of the neon lamp requirement (see the preceding article *Designer's Guide To Lamp Selection* for more detail).

Let's work from supply to common. In most cases the supply voltage is negative, about 100v. It is negative because of the widespread use of pnp transistors in computers. Most computers work with negative voltage largely because the pnp types are the most economical transistors available.

Fig. 1: Series circuit for transistor-controlled, neon lamped indicator light. Resistance is split, part in computer, part in light housing. For use with—100 volts. *(Courtesy Transistor Electronics)*



Turning "on" the transistor is done through the base circuit. You need to get a current from the computer voltage source. This is done by putting a resistor (R_2) in series with the supply, which gives a certain value of current for the voltage available. The resistor is sometimes put in the indicator, and is sometimes left out. There are good reasons for doing either one. Probably, though, the best circuit is where the resistance is split—part in the computer and part in the indicator light. The lines from the computer to the console, as a rule, are usually quite long. They are run in large diameter cables, with a large amount of cross-talk present. Coupling of signals from one line to another becomes something of a problem. So, if the resistance, which is large in respect to the normal impedances of these lines, is split, the portion in the computer will give a certain amount of isolation. In Figure 1, line 1 goes to another indicator. Resistor R_1 and R_0 are in the computer. Any cross-talk between lines 1 and 2 will be further reduced by resistor R_2 in the indicator.

The Tec-Lite engineers prefer to have part of the resistance included in the indicator light—for testing reasons. When a shipment of indicators arrives at the purchaser's plant, the transistor-controlled units go through in-coming inspection. When a voltage is applied to the unit, and if the purchaser has forgotten to include an external resistor in the test circuit, a resistor-less unit's transistor would be burned out. The inspectors can go through a large number of indicator lights, as has happened, before they realize it is the test set-up that is at fault, not the indicators. This is similar to the problem with neon lamps having no integral resistor; both cases should be noted and avoided.

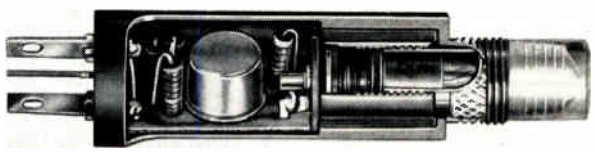
A practical limitation in the design of transistor-driven indicators is the leakage current of the transistors. They are temperature sensitive devices. You have to be careful in your use of them. Tec-Lite uses a rule-of-thumb in their design, that the indicators are made to operate from −40° to +65°C. These are felt to be practical limits, because operators are sitting in front of these lights. They are in the same environment as the indicators, and nobody will want to work beyond the −40° to +65°C limits, as a rule. Storage temperatures, as a problem, are widely appreciated and watched. Also, when the units are in transit, they might go through some severe environmental temperatures. But as far as operating temperatures go, there will be no problem, due to the human factor.

The upper temperature limit, as far as most of the transistor-controlled industry is concerned, is and has

been the plastics used in the lens caps. This is being overcome. There is much development and experimentation—and some new materials are appearing which will stand up to, and above, +65°C.

The basic part of the series circuit then, is due to temperature considerations. The leakage current, the current remaining in the transistor after you turn it "off," is still pretty significant, compared to the normal current going through the neon lamp. A typical design current here is 0.5ma through the lamp. At high temperatures (approaching +65°C) it is possible to get 0.2ma leakage. If you turn the transistor "off," the lamp can still continue to glow dimly. This is taken care of by shunting the lamp with resistor R_4. It has been chosen so as to handle the leakage entirely. When the transistor is turned "off," the voltage across the lamp drops to below the extinction level.

A typical lamp used in this series circuit is the NE-2V, a modernized version of the old reliable NE-2, but with a formed end-tip. Before they are used, they are seasoned (operated at specified voltage for specified periods of time) and selected for



(Courtesy Transistor Electronics)

Cut-away view of a transistor-controlled indicator light. This particular unit uses a No. 327 incandescent lamp. Neon version is same size, with addition of a series limiting resistor and leakage shunting resistor.

their narrow range of breakdown voltages. The gas includes tritium, an isotope of hydrogen (a radioactive material) for minimizing the effects of light (reduces the Dark Effect) and of temperatures. This makes for good, uniform firing characteristics. A typical lamp will fire somewhere on the order of 70v. This voltage can be dropped to about 50v and the lamp will still continue to glow. Under 50v the lamp will be extinguished. The lamps used are the standard brightness type. This gives you the fail-safe operation mentioned in the lamp article.

In some circuits, the logic is such that the designer would like the lamp to go "on" with the opposite signal polarity of that in Fig. 1. (When the transistor is turned "off," in Fig. 1, the lamp is "off," when the transistor is turned "on," the lamp is "on".) In Fig. 2 the neon can be turned "on" or "off" by shunting it on or off.

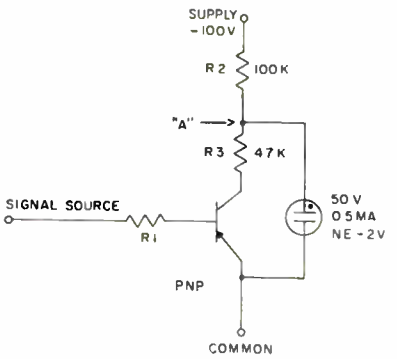


Fig. 2: Shunt circuit of a neon lamped transistor - controlled indicator light. For use on —100v, when transistor "on," lamp is "off" and vice versa.

(Courtesy TEC-LITE)

The neon lamp is across the transistor in effect. There is a resistor in series with the signal source (R_1). This resistor limits the base current. When the transistor is cut-off, the voltage at point A can rise to the breakdown level. The lamp fires; current flowing through resistor R_2, through the lamp to common. When the transistor is "on," the voltage at point A drops to essentially 0v. R_2 and R_3 form a voltage divider, designed to assure that the voltage at point A is below extinction, with the transistor "on". The circuit can be built without R_3, and will perform well. But, by using R_3, the differential in current (between the "on" and "off" conditions) is minimized. R_2 is chosen to limit the current to the neon. If, for example, we had 100v, and a 50v drop across the lamp, then 50v would be dropped across R_2. The current would be, say, 0.5ma, the resistance of R_2 would be 100KΩ. If R_3 were not in the circuit, when the transistor was switched "on," the 100v applied to the 100KΩ resistor would result in a current of 1ma. If R_3 is included, say with a value of 47K, then the voltage divider is formed, dropping approximately ⅔ of the voltage across R_2 and ⅓ across R_3 (transistor "on"). The voltage at point A is then around 33v, a level well below the extinction level. The lamp is effectively turned "off." Another important factor: the current drawn when the transistor is "on" is reduced from 1ma to about 0.66ma. If we multiply the 0.33ma by say 100 lamps, we get a decrease in current drawn of 30ma, no small amount for the circuits we are talking about and dealing with.

These are the 2 basic neon circuits, in which we can control the lamp with opposite signal polarities. In Fig. 1 a negative voltage turns "on" the transistor and the lamp. In Fig. 2 a negative voltage turns "on" the transistor and turns "off" the lamp.

Incandescent Indicators

Incandescent indicator lights pose their own problems. Here you are dealing with a very, very high current (with respect to the neon types). Let us take,

INDICATOR LIGHTS (Concluded)

for example, the 327 lamp of previous examples. It is a 28v, T1¾, incandescent, drawing 40ma. There is roughly an 80-to-1 ratio in current drawn, compared to the neons. That much current makes it impractical to shunt the lamp with the transistor in the "on" state, as in the neon shunt circuit.

What makes an incandescent, transistor-controlled indicator light possible is the fact that with these lamps npn transistors can be used to good advantage. Although high voltage npn transistors are not generally in the price range dictated by the needs of small indicator lights, low voltage npn's are quite reasonably priced.

A typical circuit (Fig. 3) for the incandescent units is similar to the neon circuit. But, we do not have to worry about the current limiting resistor or the leakage shunting resistor. This is because the current the incandescent lamp needs to glow is extremely high with respect to the leakage of the transistor. This leakage now becomes insignificant. As a matter of fact, one thing which extends the life of the lamp tremendously is, to maintain a certain amount of current through the lamp at all times. This is done by using what is called a "keep-alive" resistor (R_1). This resistor by-passes the transistor. It is chosen to continually conduct current through the lamp: either an amount just below the glow level; or an amount that will make the lamp glow a dull cherry. This dull color can serve as a very useful maintenance tool. The service personnel can go to the panel or console and take a close-up look at the indicators. If they see the glow—the lamp is good. If not, they will know just which lamp to replace. There is enough light output for this simple inspection, but not enough to attract an operator's attention.

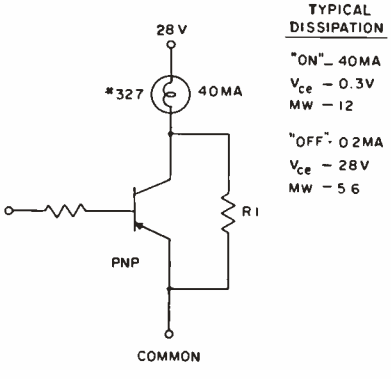


Fig. 3: Series circuit for an incandescent lamped, transistor-controlled indicator light. R_1 is the "keep-alive" resistor, giving longer lamp life. Constant dull glow of lamp can also be used as a helpful servicing tool.

(Courtesy TEC-LITE)

This constant current also results in extended life time, as mentioned above. The reason being that in many cases, the life of a lamp is not ended due to bulb blackening and corrosion of the filament, but by twisting, stress, and friction. The filament length in the 327 is approximately 4¼ inches. The turns are so close together that the heating and cooling cycle (result of turning the lamp on and off) causes the wire to literally rub itself to death. Keeping a certain amount of current flowing reduces the cycle differential; lengthening life time considerably. This "keep-alive" resistor is an integral part of the indicator light.

High temperatures must be considered and dealt with, because of the effect they have on the leakage in the transistors. Low temperatures must also be watched. They affect the drop-off of transistor gain. This is not so much of a problem in the neon circuits. It is a major factor with the incandescent lamped indicators. In these units, the transistor must remain saturated because of the high current being used. If the transistor is not saturated these high currents can increase the dissipation factor to where the transistor will be destroyed.

As the temperature goes up, you have to derate the dissipation factor. At +65°C you are working at the practical limit of germanium units. But with silicon transistors, indicator lights can be made to work efficiently up to 100°C. Also, the silicon leakage factors are down by around 100 under germanium.

The transistors used in these indicators are not high speed (30-40mc) types. High speed is not needed because of one principle of the human eye. It can only distinguish between light flashes, etc., at about 24-30cps. Because of this fact, and as an offshoot of development of the high speed Mesa and Planar type transistors, a number of fairly low speed silicon types are available, offering: low cost; high voltage characteristics; and small (TO-18) size. This results in even more miniaturization in indicator lights.

Computer manufacturers have come-up with some notable requests for the indicator light industry. And the light manufacturers have given birth to some remarkable indicators. Typical are: indicators with built-in "memory" characteristics—the unit is turned "on" and stays "on" until some other function is accomplished, and the unit is turned "off" by removing the supply voltage or putting in another pulse. In some cases these lights will work from a train of pulses rather than a steady state dc. These signals can be varied in height and/or width. They might be pulses; or a certain high or low frequency signal. They can also be bursts of pulses. Consult the manufacturer before your design is frozen. He will save you both time and money, and might even make your design simpler and more reliable.

Input Circuits

One of the basic concepts of the transistorized indicator light is to have as much of the hardware as possible included in the indicator, rather than in the computer. The indicators serve no computing function. No information goes through the light. It only shows the operator that some function has been performed. The indicator can fail and the computer can still compute.

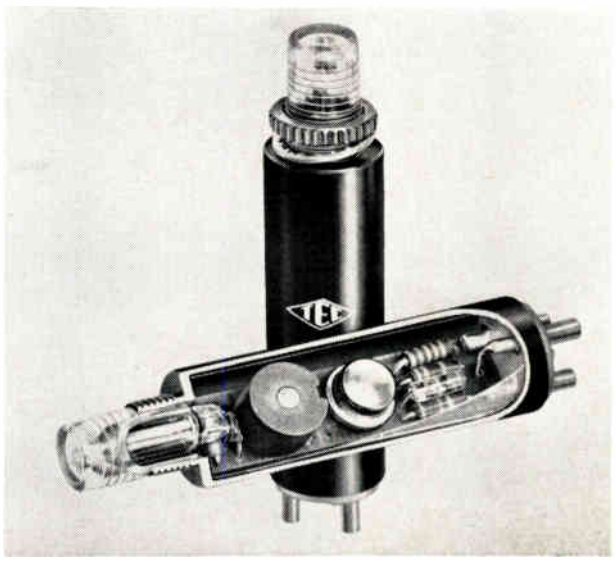
It is logical for the computer designer to have the light manufacturer put everything that has to do with the light, into the light housing. The light manufacturer also likes to be complete. He wants to put out a total unit, safe and easy to use under all conditions. The indicator light manufacturer can simplify the designer's job in a large majority of cases if—he is consulted before the computer design is completed.

What the manufacturer wants to know from the prospective purchaser is:

1. What supply voltage(s) do you have available?
2. What bias voltage(s) available?
3. What is the signal condition?
4. When do you want the light "on"; when "off"?
5. Do you want the impedance of the light limited to a specific value?
6. Do you prefer neon for reliability? or, need the incandescent lamp for its brightness?
7. Do you want the lamp replaceable or not?
8. Is there a switching function that should be built-into the lamp? (e.g. a press-to-test function; testing the whole computer indicator circuit with the lamp lighting to show circuit O.K.)

Cut-away view of a transistor-controlled, neon lamped indicator light for use on low voltages, typically 3 to 28v.

(Courtesy Transistor Electronics)



Low Voltage Neon Indicators—The Big Boost

For high reliability circuits, and applications where there is no high voltage available; or where you want to keep high voltages away from the console, the low voltage, transistor-controlled neon indicator light is the answer. This indicator makes its own high voltage (Fig. 4).

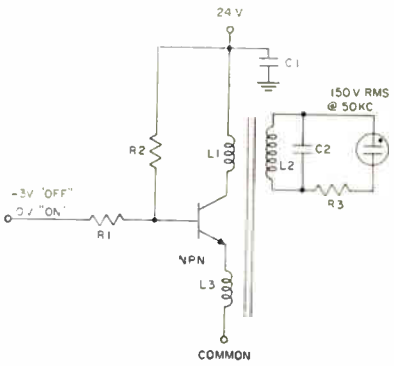


Fig. 4: Circuit of neon lamped, transistor-controlled indicator light for use on low voltages. L_3 is feed-back winding in basic Hartley Oscillator control circuit.

(Courtesy TEC-LITE)

The supply is typically 24v, but units are available in "stack" down to 6v. The transistor is used in a basic Hartley Oscillator circuit. Coil L_3 is the feed-back winding, introducing the feed-back signal into the emitter circuit. R_2 is the bias resistor. The signal to cut-off the transistor comes through R_1. L_2 is the high voltage winding, picking-off some 150v RMS at a freq. of about 50KC. C_1 is for minimizing any harmonics that might be introduced from the circuit into the power supply.

A typical "on" signal would be 0v; typical "off" would be —3v. These lights include the advantage of the incandescent low supply voltage, with the long life and ruggedness of the neon lamp. One factor that can not be overlooked is the lower level light output. The light out is less than from an incandescent, but is more than enough, in most cases, for any indicating function. While light output is sacrificed, reliability and the space saved with the low voltage power supply are big advantages.

The oscillator is more or less self-resonant as to frequency, except for capacitor C_2 across the high voltage winding. The frequency is actually determined more by the size of the core and the winding of it, than by anything else. The frequency is kept as low as possible, consistent with taking full advantage of the properties (small size) of the ferrite core.

The author wishes to thank Messrs. G. Williams, Vice President, and C. Anderson, Public Relations Director, TEC-LITE Div., Transistor Electronics Corp., Minneapolis, Minn., for their warm cooperation and technical assistance.

DESIGNER'S GUIDE TO ILLUMINATED SWITCHES

Many factors must be considered when using illuminated push-button switches. Units displaying 1 to 12 messages are discussed, along with more lighting information. A Human Factors Check-List is presented at the conclusion of this article.

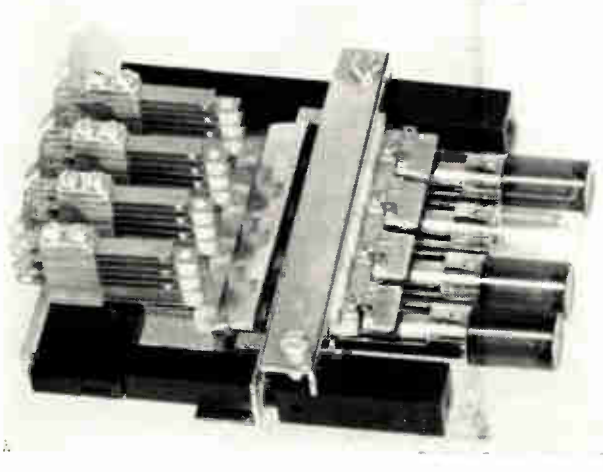
Part Three of Three Parts

FOR IMPROVED PANEL DESIGN, simpler system operation, and increased operator efficiency, the illuminated push-button switch is the answer. The time it takes an operator to find a switch associated with an indicator light (operator search time) and to perform some switching function is greatly reduced with illuminated switches. Operator training time is also reduced—the lighted screen of the illuminated switch tells them what to do—there is no need to memorize a multitude of switch functions.

Illuminated switches also offer better looking consoles and panels. One illuminated switch can display 1 to 12 (in some cases more) messages. Instead of a mass of display units, 3 illuminated switches can take the place of 12 indicator lights and their associated switches. In certain cases only one specialized illuminated switch is needed to perform the same functions as the 3 'standard' types.

The Lighted LPS Push Button Switch features lamps replaceable from the front of the panel, without the use of tools. Uses No. 327 lamps on 28v. Behind panel depth is 4¼ inches. Engraved and colored buttons are available, with engraved characters ⅛ in high and up to 3 characters/button. Can be mounted vertically or horizontally; offered in 4 different types of inter-locks with a smooth, positive, light pushbutton action.

(Courtesy General Control Co.)



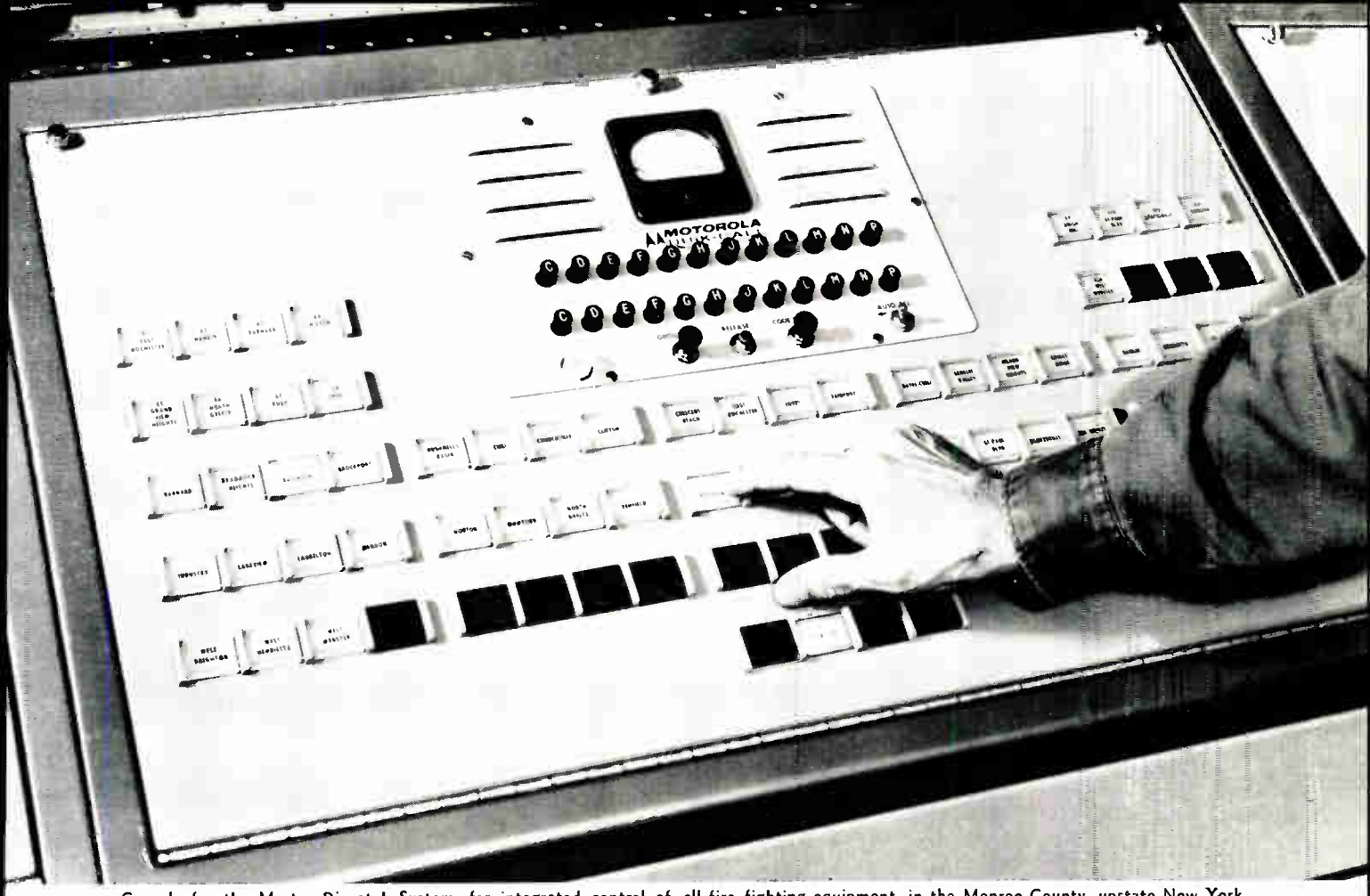
The total number of conditions monitored will, of course, depend on your particular project. And the total number of units you will need, to display these conditions will depend on the design of your circuitry. If you have a large number of conditions, consult the illuminated switch manufacturer as soon as possible. He may be able to simplify your design problems.

The factors affecting the use of these units are many, and a number will have to be simultaneously worked on for best panel design. The Illuminated Switch Check-List is the result of talking with the major manufacturers—they feel the order of considerations, as listed, should make your job easier, not only from the design angle, but also from a purchasing point of view. With this information, you can quickly let him know just what you are doing, what is needed, and find out whether he can fill the bill.

How much back and front panel space is available? Illuminated switches are complicated units, and somewhat larger than most indicator lights. If your switching function is simple, there are smaller units available, either in square or round configurations. Some are smaller than most indicator lights, or the same size. But for the more sophisticated switching requirements, the units are naturally of a larger size, offered with square, rectangular, or round legend screens. Before you freeze the design of your project, make sure you have enough space to fit in the illuminated switch you want.

The arrangement of the units will depend on human factor and industrial design considerations. Here, these will depend upon your particular philosophy and any customer requirements. The Human Factors Check-List at the end of this article will be a useful guide line if you have no specific design requirement to meet.

Do you want the units to be interchangeable, or



Console for the Master Dispatch System, for integrated control of all fire-fighting equipment, in the Monroe County, upstate New York area. Names on the Micro Switch Series 2 illuminated switches are individual city and suburban fire companies. Any number of buttons can be depressed together, calling individual companies in sequence and automatically, without further operator action. Another milestone in the ever expanding area of automation. *(Courtesy General Railway Signal Co.)*

not? One advantage of interchangeability is simpler logistics. You will not have to stock many replacement parts. On the other hand, you will want the units—screens, lamp holders, lens holders, switch modules, etc.,—keyed, if, for example, the lamps are changed on a Time Cycle (widely used in the military), or, more than one display will possibly be out of the panel at the same time. Keying assures proper positioning (and re-positioning) of not only the indicating unit itself, but also of all its component parts. You avoid up-side-down legends, false indications (should read red but, reads green), and does away with pushing the wrong switch at the right time.

As in the case of indicator lights, the illuminated switch is built around its lamps. But, the switch should also be given serious consideration. What rating must it have: voltage, cycle, and current wise?

Loads and Switch Actions

What kind of switch load do you have? If the switch is used to actuate other indicators, you have the cold filament resistance of the other lamps to deal with. Until the filament warms up and the resistance changes (decreases) it will be drawing a large amount of current. Is the rating you want for the contacts sufficient to handle this current? The same is true of the resistive load.

On the inductive load you get a tremendous current flow (assuming this is a dc circuit) upon contact 'break'. You will draw an inductive arc, without some protection. Also, you can get large spikes; for example, in a 28v circuit you could conceivably get a spike of 3000v, if there is no contact protection.

The motor load is mainly concerned with what is called the 'locked rotor current'. When the switch is first depressed the current spikes (contact in 'make' position). The contacts must be rated to carry this high current, until the motor load current levels off.

Some of the contacts offered are: palladium, platinum, and silver plated; with gold plated over silver plate for use in dry circuits where microscopic film resistances are a problem. Silver contacts are not efficient in dry circuits because the silver will form a sulfide of silver (a film resistance) under normal ambient conditions. Using gold over silver combines the current carrying properties of the silver with the non-corrosion, inert protection properties of the gold.

Some of the terminals offered on illuminated switches are: solder lug; screw; and turret, both long and short. *(Continued on following page)*

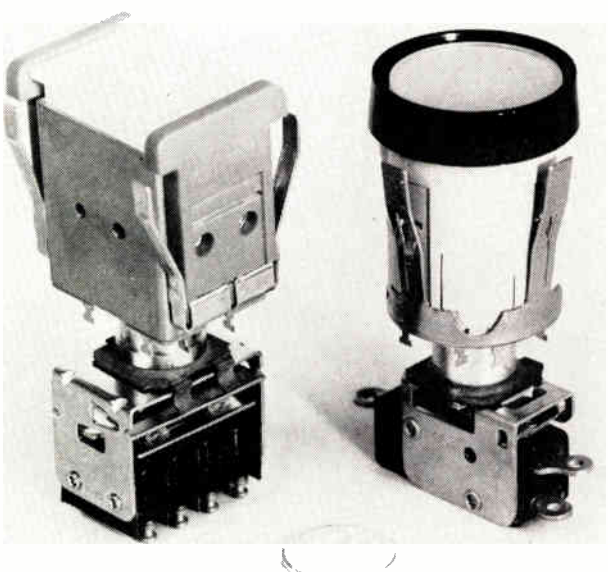
What are the voltage and current requirements of the lamps in the illuminated switch? Do you have this supply available, if not, what do you have? Illuminated switches take a wide variety of lamps to fit most power supplies. Do you want simple, single lamp units, or a wide screen type with 2 or more lamps? The number can go up to 12. The number of lamps used will be in direct ratio to the number of messages you want to display, and also to the reliability level you need.

Do you want the indicating circuit(s) connected directly into the switching circuit? Do you want the indicating and switching circuits separate? Both methods are used and illuminated switches are available to meet the differing requirements.

What kind of switching action do you want? With momentary action the switch is triggered and released immediately. This is all you will need if you are turning on a piece of equipment or setting up stages for further processing. The alternate or on/off (also called push-push) type of action has the push-button screen depressed and the switch holds. To reverse the condition the switch must be depressed again. This is advantageous where a train of pulses is being passed, a sequence is controlled by the switch, or equipment must be operated for a specific period of time.

Rectangular and round models of Series 2 Illuminated Pushbutton Switches. Screens are pushbutton and indicator. Use 2, 3 or 4 lamp (2 can be wired in parallel for reliability) projected color for split screen legend. Offered in barrier and flange type mounting. Mount in panels from 1/16 to 5/16 in. thick.

(Courtesy Micro Switch)



Solenoid-held action is best where a system is semi-automated. The operator depresses the switch when the solenoid is energized and the switch is held in that position until some other function is completed. When that operation is over the voltage to the solenoid is cut off, releasing the switch. The operator does not have to be in constant attendance.

Where a series of illuminated switches is used for a sequence operation you have a choice of mechanical interlocks:

1. Accumulative lock—all the buttons pushed remain locked in until a reset button is depressed.
2. Lock release—any button pushed releases any previously depressed button. But 2 buttons can be depressed simultaneously.
3. No two interlock—same as the above except with the addition of a positive mechanical interlock, so that no more than 1 button in a row can be actuated at any one time.

Illuminated switches are also offered with push-pull action. If you want to avoid accidental depression of the push-button twice instead of once (turning off the equipment before it is even turned on) this is the switch you want. To activate a circuit takes a positive push in. To de-activate takes a positive pull out.

With all these switching actions you have the choice of positive feel or not. The advantage of positive feel is that the circuit can not be accidentally activated. The operator can not brush by and depress the switch—it allows only a deliberate pressure (this force is called Tactile Feedback—a mechanical impulse transmitted from the button to the operator's finger: done by a build-up of force, then an abrupt drop-off).

As far as the number of poles is concerned, this will depend on your switching requirements. There is not space here to go into pole arrangements, and, there are a number of good works out on this subject. The illuminated switch manufacturer will give you any help you might need, and you can save time and money, if you consult him early in your design.

Give the manufacturer as much information on the environment (if it is of concern) as possible. The shock and vibration will affect the mounting method. The temperatures will affect the type screens or lens caps you use, and also the insulation requirements.

What is the minimum contact resistance you require? What is the maximum? Contact resistance must be maintained, to avoid any drastic change in the current requirements.

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Electrical contact life must be considered. When the contacts 'break' a number of things happen. The major occurrences are:

1. There may be contact material erosion.
2. With ac or dc loads you can get transfer of contact material from one contact to another.
3. The transfer might build-up and, with accumulation on the insulating surfaces, cause dielectric breakdown.
4. The inner action of the contact deposits may, under severe environments, cause contact failure.

These factors also affect mechanical contact life.

As far as protection goes, these requirements will also depend entirely on your project. One word of caution. Don't specify too much—the manufacturer will, of course, supply any protection you demand, but the cost will also rise. In the environments these displays are usually used in, they already have as much protection as they require. The main types of protection available and most widely asked for are included in the Check-List.

Many types of mountings are available. The most popular are: bushing with knurled nut (for the small illuminated push-button switches); friction-flange; and barrier-friction. The individual manufacturer's catalogs give full information (and these are included in this month's Tech Data).

If you are mounting the displays individually, do you want a decorative bezel? The same applies to matrix mounting. Remember, the purchaser of this equipment will want to see what he has bought, from the front of the panel.

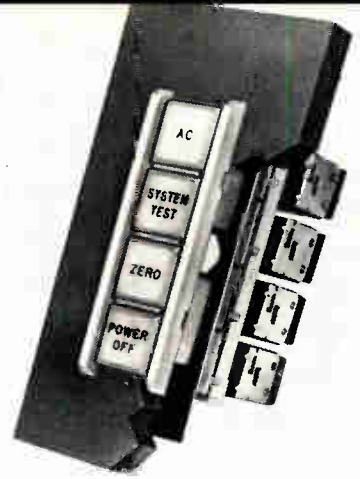
Almost all the illuminated switches available can be mounted: protruding from the panel; flush with the panel and sub-panel.

Some Lighting Considerations

For the multiple lamped illuminated switches, the brightness of the screen is in direct ratio to the number of lamps used. The hue (color) of the screen will deepen as the number of lamps is increased.

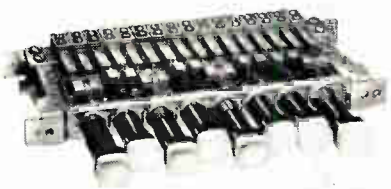
There are 3 principal ways of lighting these displays. The first is using a colored screen or lens cap over a lamp. The second is using a colored insert in the lens cap or screen over a lamp. The third is projecting the color (using either small silicone rubber filter caps directly on the lamp bulb or filter lenses placed in front of the lamps) onto a white translucent screen.

A matte or non-reflecting finish will help contrast and visibility; a black matte finish gives max. contrast. Using polished finishes of metal or plastic in light colors or white is a poor choice. One other fac-



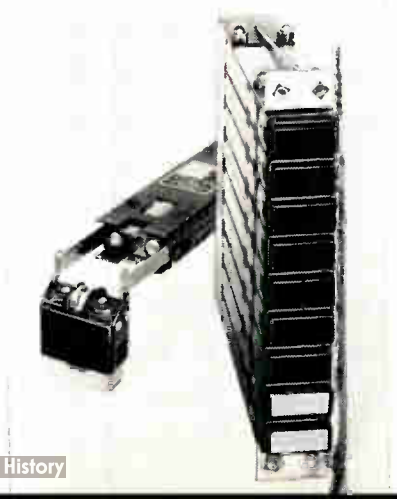
The 210 Series Control Keyboards, mounting interlocked pushbutton switch lights. Re-lamping is from front of panel without tools without interrupting power supply, and switches are not actuated when caps are re-inserted into switch. *(Courtesy Korry)*

Press-Lites are offered in 2 models: a 2a unit measuring 9/16 in. O.D.; and a 15a model which is ¾ in. O.D. Switching is SPDT, maintained contact for both. Use incandescent T-1 ¾ flanged base lamps on 6, 14, and 28v. Lens caps are 11/32 and 7/16 in. in diameter. *(Courtesy Oak)*

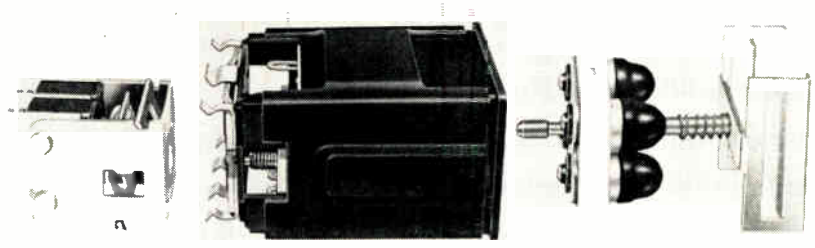


Multi-Switch, illuminated Series 21000 use incandescent or neon lamps. Buttons have concave face with front and side lighting, in a wide choice of button colors, on 6, and 28v; and 115 vac lines. *(Courtesy Switchcraft)*

The Series 40, Lighted Push Button Switch measures 0.44 in. dia. by 1.85 in. long. Use NE-2E, or No. 1764 incandescent lamp. SPST momentary contact switch. Mounting hole 25/16 in. in dia. Lamp and switch circuits are independent. *(Courtesy Grayhill)*



Consolswitch, Series 20,000 offered in 1 to 4 pole, DT, with momentary, alternate or magnetic holding action. Use T-1 ¾ color coated lamps, in red, green, amber and white. Lamps and legends changed without tools. May be stacked in any direction. A 6 lamp unit is available. *(Courtesy Jay-El)*



Exploded view of M-Series Switchlight: switch module, lamp housing (front mounting without barriers), 4 lamps with silicon rubber, colored filters for projected color on the translucent white button screen. Relamps from frunt without removing filters, without tools. Screen lights 1 color, quarters, or vertical or horizontal halves. Snap-on switch modules are 2PDT or 4PDT momentary, alternate and or solenoid-held action.

(Courtesy Control Switch Div.)

tor can be added to this: glare will add to poor visibility and increase operator fatigue.

There are 3 means of balancing the brightness of different colors. As we said in *"Designer's Guide To Indicator Lights"*, certain colors show up better than others. To get a good Average Brightness you can operate the lamps behind the red and yellow screens at under voltage, and the lamps behind the blue and green screens at design voltage. Also, you can use 2 lamps behind the brighter screens and 3 or 4 lamps behind the dimmer ones. The 3rd way is to specify screens in which the red and yellow colors are opaque, to a degree, by using a less translucent material in the screens. The blue and green screens will use a material with a higher degree of translucence.

If you want to be able to read the legend whether the unit is lit or not, a popular combination of backgrounds and colors is: black lettering on amber, yellow or white backgrounds; and silver lettering on blue, green or red backgrounds.

When using projected color, the screens will look softer in color than with a unit having a solid color screen. Split screens (both sides a translucent white) can also be used with projected color. On the non-split screens, up to 4 different colors can be projected on the screen—one at a time (full color screen); in pairs; all at the same time (dividing the screen into quadrants with 4 messages showing); and one at a time on ¼ of the screen.

As was the case with the indicator light screens, 2 lamps should be used for reliability. This gives you uniform screen lighting and fail-safe operation. If you have a critical application, you can use all 4 lamps behind a single screen, increasing the reliability tremendously.

Twelve Message Indicator

If space is a real problem, but you need a visual indication of more than 4 functions; or you have a complicated sequence and want to make it as easy as possible on the operator, then Industrial Electronic Engineers, Inc., N. Hollywood, Calif., have a unit you should seriously take a look at.

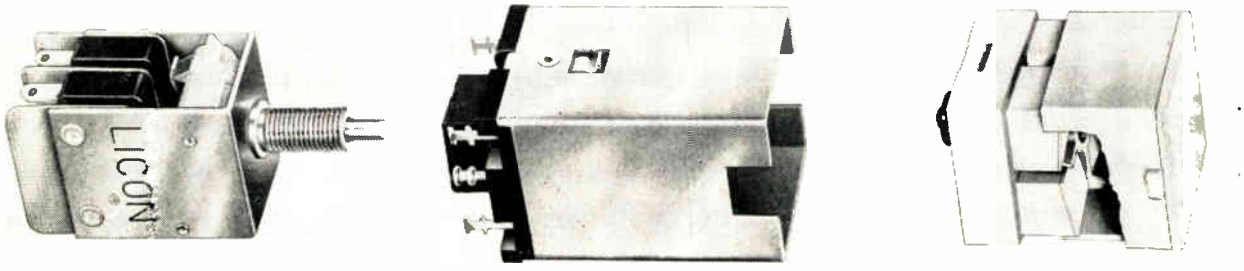
Known as the "Cue Switch", this compact unit (2 x 1 x 4 inches) can display up to 12 messages, either in sequence or random operation. The unit is IEE's standard 120ooSP miniature readout with a precision switch added for push-button capabilities. The push-button also serves as the viewing screen. On it, 12 messages, either in pairs or separately, are rear-projected from 12 different lamps. We have already talked about the different types of projection systems —this one uses negative film screens. The letters, words, symbols, or number, from ⅛ to ⅝ in. high, appear white on a black screen, but colored negatives are also offered. The Cue consists of 12 lamps, 12 condensing lenses and their associated film negatives, and 12 projection lenses. These component parts can be used in a number of ways:

1. For 12 different messages.
2. For 6 messages with dual lamp lighting.
3. One lamp for a word, one for a number, and a third for a mode color, all displayed simultaneously.

(*Continued on page* 168)

Exploded view of Licon's 04 Series of Lighted Pushbutton Switches. Shown is the: screw-in switch module (permitting increase or decrease of switch actuating pressure) available in momentary, maintained or solenoid-held action; housing; and colored filter lenses and transulcent white screen. Cut-away just behind screen shows filters, offered in a wide choice of colors, for projected lighting of screen. For use on 6, 12 and 28v.

(Courtesy Licon Div.)



ILLUMINATED SWITCH CHECK-LIST

1. Application . . . . . .
   - A. Total number of monitoring conditions . . . . .
   - B. Total number of units required . . . . . .
   - C. Back panel space . . . . . .
   - D. Front panel space . . . . . .
   - E. Size: length . . . . .; height . . . . .; width . . . . .
   - F. Arrangement of units (conform with human engineering factors)
   - G. Interchangeability of unit/displays:
     1. keying . . . . . .
     2. other . . . . . .
   - H. Means of lamp replacement . . . . . .
2. Lamp:
   - A. Voltage . . . . . .
   - B. Current . . . . . .
   - C. Single or multiple lamp unit . . . . . .
3. Switch:
   - A. Voltage . . . . . .; ac(50/60 . . . . . , or 400 . . . . . .cps); dc . . . . . .
   - B. Current . . . . . .
4. Class of switch load:
   - A. Lamp . . . . . .
   - B. Resistive . . . . . .
   - C. Inductive . . . . . .
   - D. Motor . . . . . .
5. Circuitry required, if any, relating switching function to lamps . . . . . .
6. Switching Action:
   - A. Momentary . . . . . .
   - B. Alternate (on/off; push-push) . . . . . .
   - C. Solenoid-held . . . . . .
   - D. Mechanical latching . . . . . .
   - E. Push-pull . . . . . .
   - F. Number of poles and arrangement . . . . . .
7. Environment:
   - A. Shock & vibration . . . . . .
   - B. Ambient temp. . . . . .
8. Operating life:
   - A. Minimum contact resistance . . . . . .
   - B. Electrical contact life . . . . . .
   - C. Mechanical contact life . . . . . .
   - D. Lamp life time . . . . . .
   - E. Minimum contact bounce . . . . . .
9. Protection:
   - A. Splash proof . . . . . .
   - B. Environmental free . . . . . .
   - C. Hermetically sealed . . . . . .
   - D. Any panel sealing requirement . . . . . .
   - E. Fungus resistance . . . . . .
   - F. Corrosion resistance . . . . . .
10. Mounting and Legend Screens:
    - A. Mounting:
      1. Individual . . . . . 2. Matrix . . . . . .
         - a. Protruding from panel . . . . . .
         - b. Flush with panel . . . . . .
         - c. Sub-panel . . . . . .
    - B. Legend screens:
      1. Color: projected . . . . . .; solid . . . . . .
      2. Message:
         - a. Words . . . . . .; Letters . . . . . .; Symbols . . . . . .; Numbers . . . . . .

         Specify . . . . . .
         - b. Size . . . . . .
         - c. Style . . . . . .
         - d. Color . . . . . .

      3. Background . . . . . .
      4. Divisions:
         - a. Full screen (no divisions) . . . . . .
         - b. Split screen . . . . . .
           1. Horizontal . . . . . .
           2. Vertical . . . . . .
           3. Tri . . . . . .
           4. Quadrant . . . . . .

ILLUMINATED SWITCHES (Concluded)

A variety of lamps can be used with the "Cue" for operation on 6, 14, and 28 volt systems. Panel thickness is ⅛ inch. Standard colors for lenses are amber, blue, green, red, white and yellow. Special colors are also available.

Simultaneous display of 2 or more messages on different portions of the screen, or single messages one at a time, from one location on the console or panel, make for reduced operator search time, easy sequential operation, increased operator attention, and reduced operator training time.

This Illuminated Computer - type Switch is snap-in, flush mounting for use on ac, dc, or dry circuits. Push-buttons at top and bottom. Screen lit by 2, 10v push-in bulbs. Maintained contact switch shown; momentary, as well as simple indicating light, available.
(Courtesy Cutler-Hammer)

If increased reliability is desired, along with high brightness, 2 lamps and 2 negative films (with identical information on them) can be used in parallel. If one lamp burns out, the other still lights, the message is still displayed. The decreased brightness indicates that replacement is necessary—thus giving you fail-safe operation. With this type of operation you still get the advantage of 6 messages from one indicator.

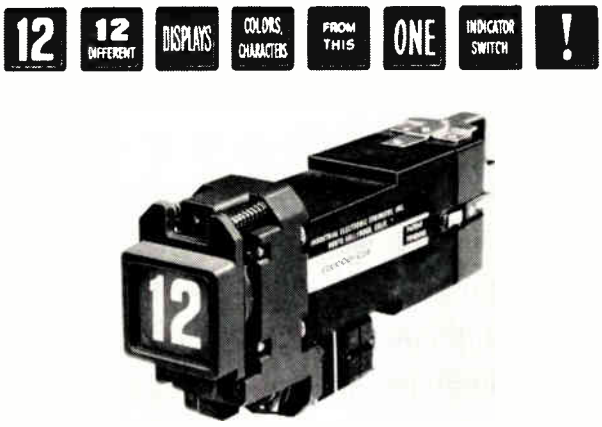
An optional quick-disconnect back is available for the "Cue", giving fast access to the lamps from the rear of the panel. Only fingertip pressure is needed to release the attachment.

Other units are also available, so that you can purchase: switch-displays; switches only; displays only; and switch-pilot lights; all with identical front panel appearance to meet industrial design criteria.

Cut-away view of the 120,000 Cue Switch. The 4 rays of light show 3 different words and 1 background color. Other 8 lamps still available for other uses.
(Courtesy IEE, Inc.)
Photo at right shows 12 types of messages that are possible, out of wide selection offered. Complete unit had pushbutton screen, switch module below, and quick-disconnect back.

The author wishes to thank especially the following for their gracious effort in helping him prepare these articles.

Alden Products Co., Brockton, Mass.
Allen-Bradley Co., Milwaukee, Wis.
American Machine & Foundry Co., AMF Instrument Div., Alexandria, Va.
AMP, Inc., Harrisburg, Pa.
Army Ballistic Missile Agency, Redstone Arsenal, Ala.
Boeing Co., Seattle, Wash.
Capitol Machine and Switch Co., Danbury, Conn.
Controls Co. of America, Control Switch Div., Folcroft, Pa.
Curtiss-Wright Corp., Wood-Ridge, N. J.
Cutler-Hammer, Inc., Milwaukee, Wis.
Dialight Corp., Brooklyn, N. Y.
Drake Manufacturing Co., Chicago, Ill.
Eldema Corp., El Monte, Calif.
General Control Co., Boston, Mass.
General Electric Co., General Purpose Control Dept., Schenectady, N. Y.
General Electric Co., Miniature Lamp Dept., Cleveland, Ohio
Grayhill, Inc., La Grange, Ill.
Haydon Switch, Inc., Waterbury, Conn.
Hudson Lamp Co., Kearny, N. J.
Illinois Tool Works, Inc., Licon Div., Chicago, Ill.
Industrial Electronic Engineers, Inc., N. Hollywood, Calif.
International Telephone and Telegraph Corp., New York, N. Y.
Jay-El Products, Inc., Gardena, Calif.
Kay Electric Co., Pinlite Div., Pine Brook, N. J.
Korry Manufacturing Co., Seattle, Wash.
Leecraft Manufacturing Co., Inc., Long Island City, N. Y.
Marco Industries Co., Anaheim, Calif.
Micro-Miniature Lamp Co., New York, N. Y.
Minneapolis - Honeywell Regulator Co., Micro Switch Div., Freeport, Ill.
Donald P. Mossman, Inc., Brewster, N. Y.
Oak Manufacturing Co., Crystal Lake, Ill.
Panellit, Inc., div. of Information Systems, Inc., Skokie, Ill.
Signalite, Inc., Neptune, N. J.
Sloan Co., Sun Valley, Calif.
Sperry Rand Corp., Univac Div., New York, N. Y.
Switchcraft, Inc., Chicago, Ill.
Sylvania Electric Products, Inc., Sylvania Lighting Products Div., Salem, Mass.
Transistor Electronics Corp., Minneapolis, Minn.
Tung-Sol Electric Inc., Newark, N. J.
Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.
Westinghouse Electric Corp., Standard Control Div., Beaver, Pa.



HUMAN FACTORS DESIGN CHECK-LIST

This material was originally written for use with only simple legend lights. These lights are defined as: single-color, incandescent, trans-illuminated, having generally rectangular screens with legends imprinted on them. You might not agree with all the data presented here, but the author of this study does not present it as the 'bible.' He recognizes that human factors engineering is a very subjective subject. This material is only presented as a general set of guide-lines, to be used as a reminder.

☐ Hardware Considerations*

The following factors should be considered when choosing legend lights for use on system panels:

A. Legend lights with a small screen area should be avoided. The screen should be large enough for easily readable legends.

B. If a master indicator or lamp testing circuit can not be designed into the panel, press-to-test legend lights should be used.

C. When mounted, the legend screen should be reasonably flush with the panel face. Units which extend from the panel can, under certain conditions, hamper the operation of adjacent controls. They may also hinder clear vision of any adjacent panelware.

D. On the other hand, the screen should not be recessed too much into its housing, or below the panel.

E. For reliability use 2 lamps for lighting the screen, if possible. If one burns out the screen will still be partially lit. Dual lamps are a necessity in critical indicating applications.

F. Replacement of lamps should be from front of panel. It should be done without need of any tools. If possible, use the same type lamp throughout the system.

G. Avoid confusion when changing a lamp. Keep screen loss or interchanging to a minimum by using captive screens, coded keyways, etc.

H. For a minimum of operator confusion use screens of same size. Oversize screens should be used for emphasis, such as a master system summing, if possible.

I. Make sure the screen and the unit are "light-tight." Avoid light leakage.

J. Trademarks, company names, or other markings unrelated to the information displayed, should not appear on the screen in such a way as to distract the operator.

☐ Operating Characteristics

Requirements for using legend lights are essentially those for using indicator lights (and—with modification—also illuminated switches). Legend lights should give the operator a CLEAR, IMMEDIATE indication of CURRENT equipment or system conditions. These indications should be QUALITATIVE, and the information ESSENTIAL for operation. The indications should cover all operational and maintenance eventualities.

A. Number of legend lights used should be kept to a practical minimum, yet give all information needed.

B. Legend lights should be used only to isolate malfunctions down to the point of immediate concern to the operator. Where this point is depends on your particular maintenance philosophy.

C. A malfunction should be indicated as such. Do not depend on the mere absence of some operating-condition signal to warn the operator.

D. A legend light should come "on" immediately when the condition described on its screen occurs; it should immediately go "out" when that condition ends.

E. Do not use legend lights merely to show manual switch positions.

F. Legend lights should be used to give qualitative information. They do not normally give commands. If the light is used to give a command, then the legend on the screen should show this clearly and boldly. There should be no chance for mistakes.

G. Legend lights should operate in a fail-safe manner. The monitored circuits or equipment should not fail if the legend light or its indicator circuit fails.

☐ Coding

A. Color Coding

In general, the color coding of legend lights should conform to the following definitions:

1. RED—should designate an unsatisfactory condition, or inoperative piece of equipment which is preventing successful operation. Red lights should display information such as: malfunction; failure; error; etc. Red *is not* necessarily the converse of green.

2. GREEN—should designate a satisfactory condition, or equipment operation which is necessary for total system operation. Green lights should display information such as: test complete; ready; in-tolerance; etc.

3. AMBER—should designate a marginal condition, or equipment which may adversely affect or delay overall system operation; as such it is a "caution" indication. Amber lights should display information such as: caution, hold, etc.

4. WHITE—should designate system conditions or status, but should not imply a right or a wrong condition. White light should display information such as: operating mode; test in progress; etc.

5. Your system design or maintenance philosophy may dictate that you change this color code. Remember this — whatever color code you use, keep it consistent throughout the system.

6. Colors which are strong and easily seen (whether the lamps are on or not) should be used for indicating anticipated signal quality information.

B. Flash Coding

Flash coding should conform to the following:

1. *Flashing Red* indicates a dangerous condition. Equipment damage or personnel injuries are apt to result, unless immediate corrective action is taken.

2. Flash rates, for warning lights, should be between 3 to 5 flashes per second. "On" and "off" times should be about the same length of time.

3. The light should burn steadily if it is energized when its flasher device has failed.

4. Red flash coding should not be used for any function but warning of personnel equipment disaster.

* Material taken from Report No. RE-TR-2-61, "*Selection and Utilization of Simple Legend Lights*," written by Mr. Gerald Chaikin, Human Factors Engineering Branch, Engineering Requirements Coordination Office, Directorate of Research & Development, Army Missile Command, Redstone Arsenal, Ala.

5. Avoid wide spread use of flash coding. If possible, limit its use to emergency conditions.

☐ Lettering

A. Legends should be engraved (applied by a process which recesses the letters into the screen) and filled with an appropriate pigment.

B. Rear engraving through a color-coded layer, to a clear front layer, can give improved protection against legend wear or damage.

C. Legend markings should be visible when the light is off, as well as when it is on.

D. Space on the screen is usually at a premium. Keep the legends as brief as possible, without destroying the intended meaning.

E. If you have to use abbreviations, follow Mil-STD-12 as a guide. If standard abbreviations are not possible or inappropriate, use substitutes. When picking the substitutes be careful that they are meaningful and clear. Avoid confusing the operator.

F. The legend should fit the condition exactly. Avoid similarities to non-related system legends.

G. All lettering should be capitals. Do not go smaller than ⅛ inch in height (approximately 9 points).

H. Use Arabic numerals instead of Roman, if possible.

I. Letters and numbers should be a simple, sans-serif style. This is the style generally recommended for panel labeling.

J. Do not use mathematical and/or scientific notations as legends, unless the meanings are absolutely clear to operators, maintenance presonnel, and trainees.

K. Choose the legend for its exact condition description, and also for its training value. The clearer the meaning; the better the legend.

☐ Auxiliary Controls

A. Design a master lamp or indicator test circuit into the panel when using a large number of legend lights, if possible. A master test circuit is preferred to individual press-to-test circuits. This allows the operator to make one quick test of all the indicators before he uses the panel. If you cannot include the master test circuit, then individual press-to-test hardware should be used.

B. The operator's monitoring alertness can be lowered if the indicators are either not bright enough, or too bright for the ambient light. This can degrade system operation. A compromise between indicator and ambient light brightness is the solution. A brief study will usually show what the level of indicator brightness should be, in comparison with the ambient light.

☐ Location Considerations

A. Arrange the legend lights in a logical, orderly manner. If possible, they should be located according to:

1. Sequence.
2. Function.
3. Importance.
4. Frequency of use.

B. If the operator has to perform a number of operations in sequence, arrange the legend lights in that sequence, if possible. If there is no such requirement, group the indicators according to function.

C. Usually, a legend light used to display a condition to be started by pushing a button should be placed above the button. This prevents the operator's hand from blocking his view of the legend.

D. When you use a legend light to show a condition begun by moving a toggle switch, place the legend light next to the switch position to which the toggle is moved.

E. If you use a legend light to display a condition begun by moving a selector (multi-detent) switch, place the legend light next to the switch position to which the switch is moved. Avoid crowding legend lights.

F. Place critical warning lights as close as possible to where the operator should be looking (either seated or standing). If this location interferes with the logical layout of the panel display, the warning lights can be located outside of the operators normal line of sight. But, not too far. Critical warning lights should not be located more than 30° to the left or right; more than 10° up or 25° down with respect to the operator's normal line of sight. Critical lights are most effective if isolated from other lights. Place the button or switch the operator must operate in the critical period next to the warning light, if possible.

G. When slanted panels (facing up) are used, keep those critical warning lights out off the lower ⅓ of the panel. The operator might accidently block any indication if using the panel as an arm rest. Or, he or she may cover the warning light if they lean forward to do some operation on a higher panel.

H. If the operator is not required to sit in constant attendance, or must divide his attention while the system is operating, couple a buzzer or bell to the warning light. Anything to immediately bring his attention back to the panel.

I. In most cases, you do not have to label the panel near individual legend lights. Their legends should clearly tell the condition or function being monitored. But, group labeling should be used where appropriate.

J. The following information should be used, when laying out panel locations for legend lights:

1. Assume a 28 inch normal viewing distance from vertical panels.
2. Design for the extreme dimensions of operating personnel (most people will fit between the 5% and 95% figures):
   a. Min. standing eye height for all but 5% is 60 inches from the floor. Max. standing eye height for all but 5% is 68 inches from the floor.
   b. Min. seated eye height for all but 5% is 27½ inches from the floor. Max. seated eye height for all but 5% is 33½ inches from the floor.

☐ Consistency

Legend lights should be used in a consistent manner. Be consistent in choosing hardware, color-coding, physical layout, lettering and abbreviations, and panel-to-panel repetitive grouping. Being consistent in using indicators pays-off in:

1. Simplifying training.
2. Easing supply problems.
3. Improves maintenance.
4. Contributes to higher operating efficiency.

TEC LITE

"TRANSISTORIZED" INDICATORS DESIGNED TO SOLVE YOUR SPACE/CIRCUITRY PROBLEMS

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TRANSISTOR CONTROLLED INCANDESCENT LITE controls replaceable lamp with small current signal

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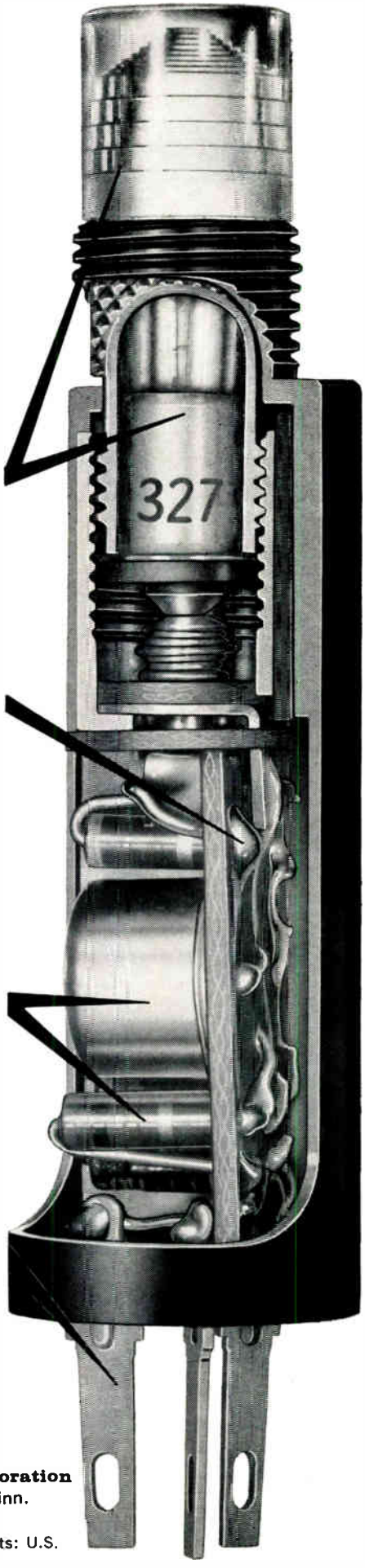
A full selection of terminals compatible with current design techniques is offered—Taper Pin, Taper Tab/Solder Lug, Turret Lug and "Wire-Wrap".



Contact your TEC Representative or write direct.

TEC LITE DIVISION

Transistor Electronics Corporation
Box 6191, Minneapolis 24, Minn.
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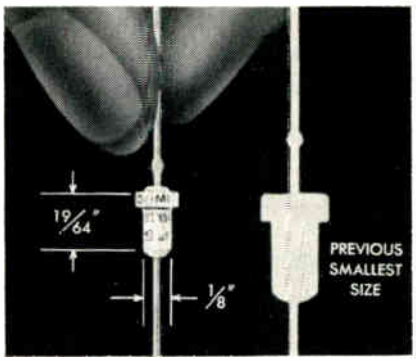
TEC-LITE Transistorized Indicators are protected by one or more of the following patents: U.S. Pat. Nos. 2,985,874 & 3,041,499. French Pat. No. 1,291,911

NEW PRODUCTS

TANTALUM SLUG CAPACITOR

Measures 19/64 in. long, body dia. of 1/8 in., and flange of 13/64 in.



Capacitance, for the "Y" size Series TS, ranges from 0.91 to 15μf; voltage ranges from 6 to 125vdc depending upon capacitance. Meet all the requirements of Mil-C-3965B and have high load life capability. The present units are rated for operation in 85°C max. ambient temp. Series TS capacitors feature a porous anode of sintered tantalum, sealed into a fine silver case which serves as the cathode and container for the electrolyte. Ohmite Mfg. Co., 3631 Howard St., Skokie, Ill.

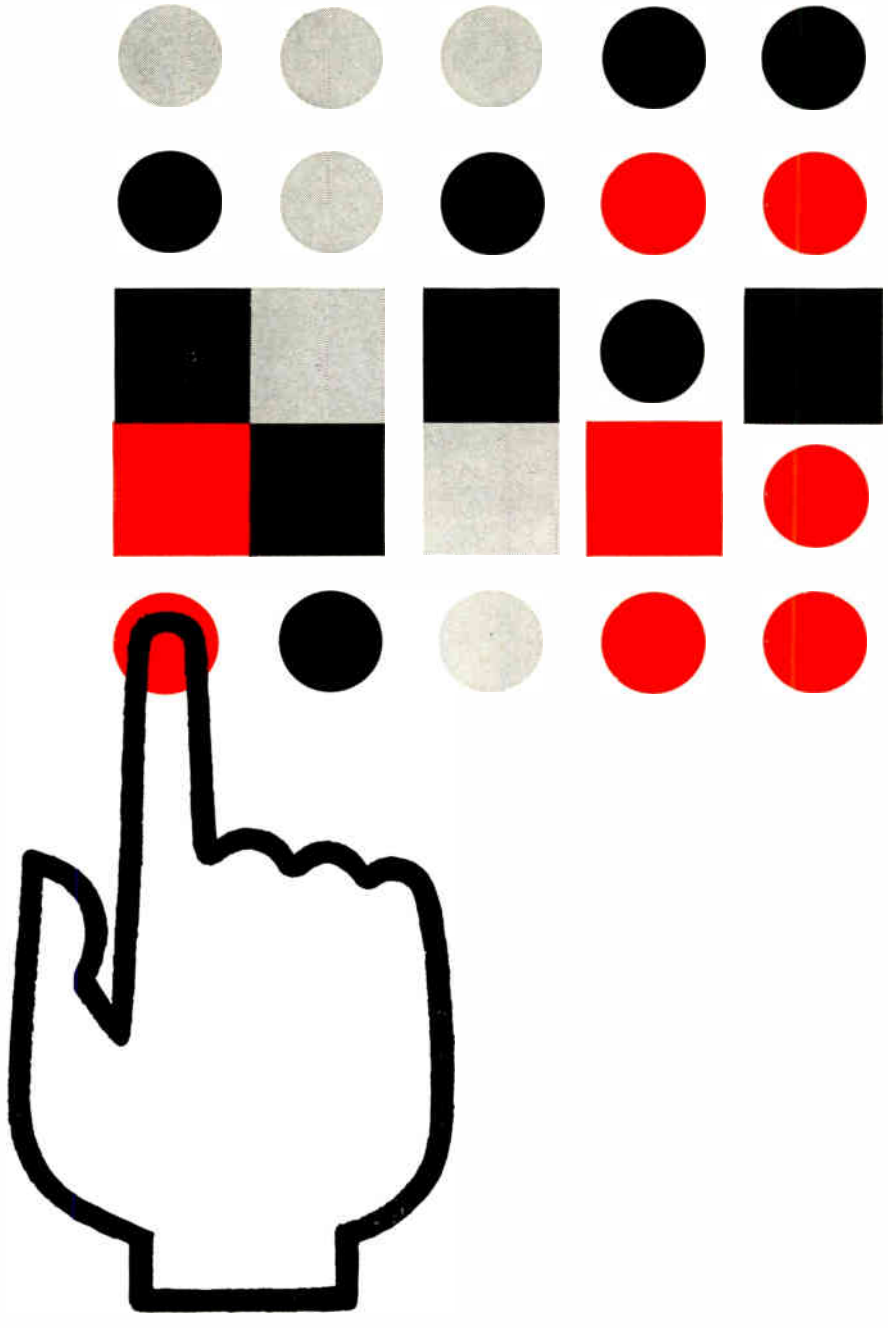
Circle 257 on Inquiry Card

POWER OSCILLATORS

Cover from 200 to 1050MC; power outputs from 50mw to 50w.

Line of VHF-UHF Power Oscillators Models 408 and 410 features compactly designed r-f cavities, and are capable of operating in three modes: CW; 1 KC pulse; and external pulse. Continuously tunable over 2 to 1 freq. bands, and have high ratio dial featuring negligible backlash, and a logging scale permitting a resettability of 0.002%. For antenna evaluation; calibration of power measuring devices and driving amplifiers. Operate from 115vac; measure 8 x 11½ x 17 in. and weigh under 50 lbs. Microdot, Inc., 220 Pasadena Ave., S. Pasadena, Calif.

Circle 258 on Inquiry Card



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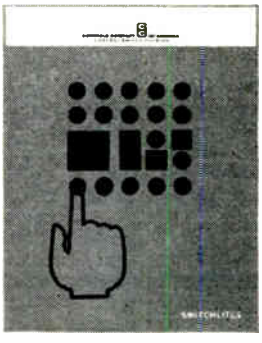

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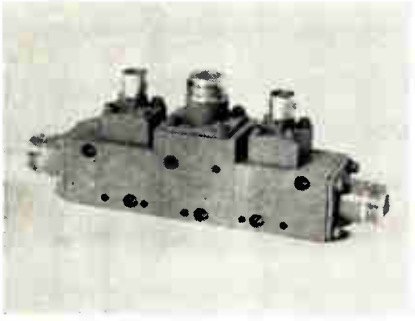
CONTROL SWITCH DIVISION
1420 Delmar Drive, Folcroft, Pennsylvania

NEW PRODUCTS

MULTI-THROW SWITCH

This broadband, coaxial with unit covers from 0.3 to 7GC.

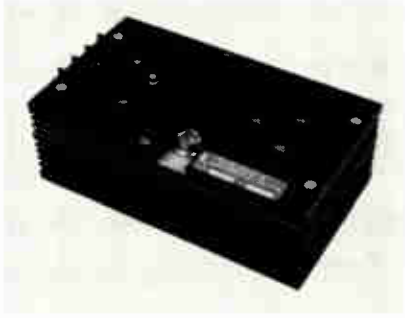


Useful for broadband operation over a wide range. It is available in SP4T and SPDT models and has characteristics comparable to that of SPST units. The switches have insertion losses as low as 1.2db and isolation as great as 43db in portions of the band. The switching speed of these new devices is in the nanosecond range. American Electronic Laboratories, Inc., 301 Richardson Rd., Colmar, Pa.

Circle 289 on Inquiry Card

TELEMETRY TRANSMITTER

The TRPT-5v is a 5w solid state telemetry transmitter.

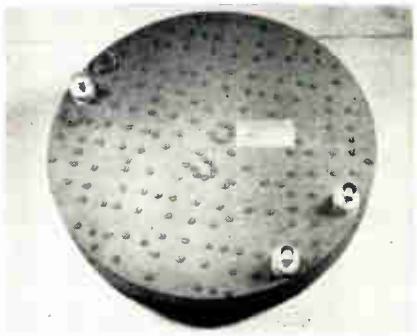


This rugged and ultra-stable transmitter is designed for missiles, space, and mobile applications. Performance characteristics are: output impedance is 50Ω; frequency range is 215 to 260MC; frequency stability is ±0.005%; power output is 5w; power input is 28vdc ±10% @ 1.6a; and temperature range is −20°C to +80°C. Vector Manufacturing Co., Inc., Southampton, Pa.

Circle 290 on Inquiry Card

DIGITAL PHASE SHIFTER

Real time delays in 16 equal steps between 0 and 1 uhf period.



The time delay steps are by 4 diode phase shifters switching line lengths in and out of the path connecting them in 16 combinations. The entire phase shifter, with four 3db couplers as well as diode switches and line lengths, is printed on a single sheet of dielectric-filled strip transmission line. For operation at 600MC, exhibiting a phase error of less than ±4° with overall insertion loss between 1 and 2db. Built to fit in an area 8 in. in dia. Has power handling capacity of 2w. Hyletronics Corp., 185 Cambridge St., Burlington, Mass.

Circle 291 on Inquiry Card

NEW PRODUCTS

MICROWAVE RECEIVER

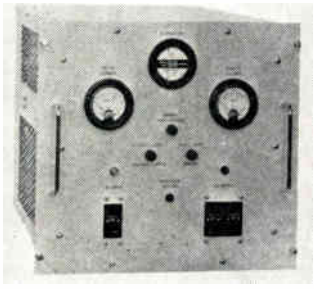
LAB-CVR is packaged without local oscillator for cost savings.

The LO function can be provided by widely available laboratory signal generators with 1-10mw output. LAB-CVR, a superhet type unit, covers from 500mc to 11gc providing both AM and FM reception. Can be used for microwave monitoring, measuring, and spectrum analysis (when the LO is a swept freq. generator). Operating range is 95db (−115 to −20dbm), AGC dynamic range is 80db. Typical meter sensitivity, (narrow band) is −115dbm. Panel Height is 5¼ x 17 in. and cabinet depth is 16 in. Melabs, 3300 Hillview Ave., Stanford Industrial Pk., Palo Alto, Calif.

Circle 292 on Inquiry Card

POWER SUPPLY

Silicon Controlled Rectifier type system.

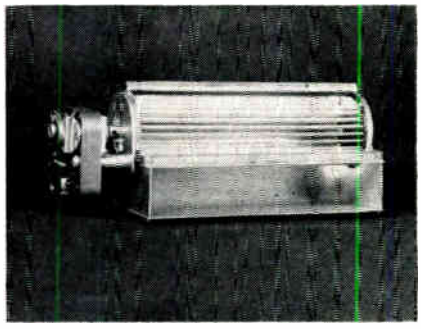


Provides precise regulation of 0.01%. Designated Model No. 3037-1, this 24-34v at 100adc power supply was designated for ground support equipment. The unit operates from a 208/230/460v 3ϕ, 57-63cps ac line and has low dynamic line and load regulation. Ripple and noise do not exceed 5mv RMS max. The unit has recovery time of 100μsec and an output impedance of 0.1 milliohms. Perkin Electronics Corp., 345 Kansas St., El Segundo, Calif.

Circle 293 on Inquiry Card

BLOWERS

Crossflo models available for design study and evaluation.



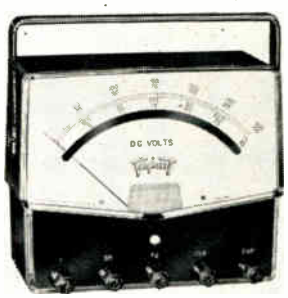
Hand-made models for industry engineering evaluation of the transverse-flow principle, these units, in three impeller diameter sizes of 2, 3.15 and 4 in. (photo) and each 7 in. long, are believed to be the first transverse-flow design models immediately available at reasonable cost. The discharge area and air output can be increased simply by placing Crossflo modules of required size side by side. Air Impeller Div., The Torrington Mfg. Co., Torrington, Conn.

Circle 294 on Inquiry Card

NEW PRODUCTS

DC/AC PORTABLES

Engineered to the requirements of laboratory accuracies.



The dc portables feature the Triplett suspension movement (no pivots, no bearings, no hairsprings, thus no rolling friction) providing very rugged instruments with high sensitivity and repeatability. Other features are the long 6 13/32 in. mirror scale, knife edge pointer, and fully open meter front with top and side natural lighting for easy and accurate reading. Measures 7⅝ x 6 7/16 x 3¾ in. in a molded case with carrying handle attached. The Triplett Electrical Instrument Co., Bluffton, Ohio.

Circle 295 on Inquiry Card

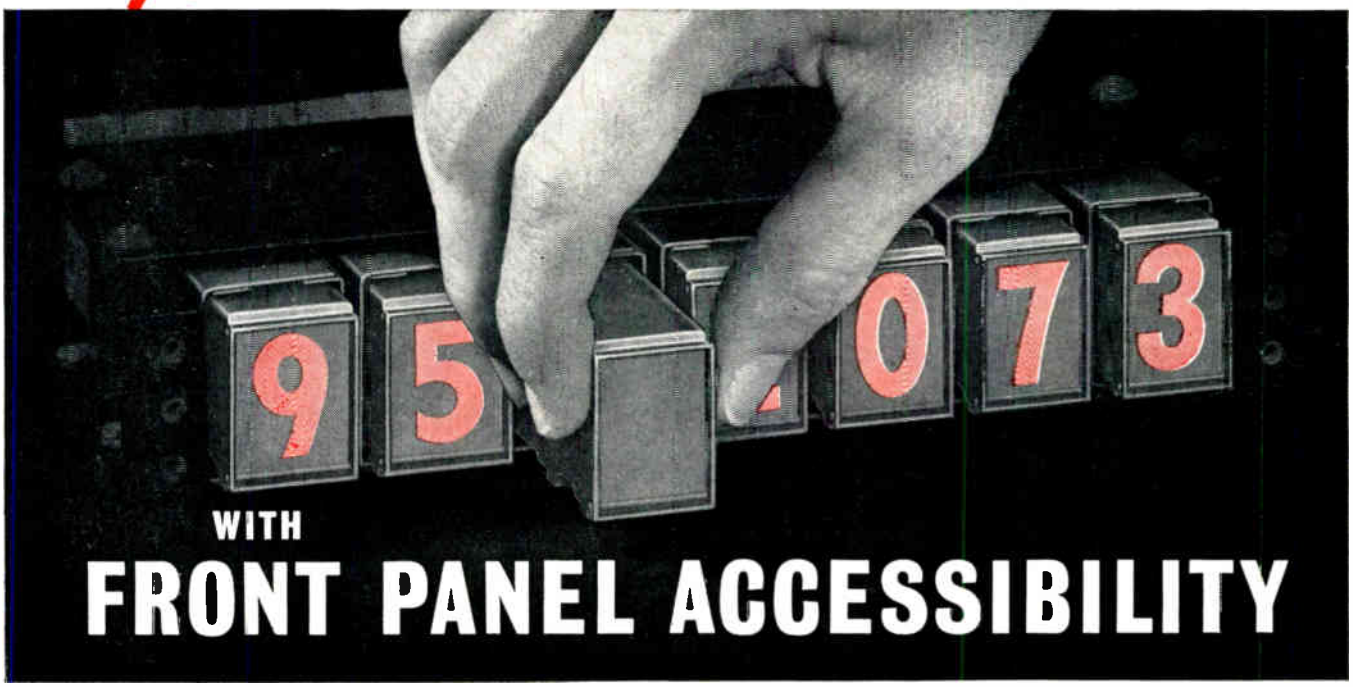
SERVO AMPLIFIER

Model 140 drives 6w servo motors from low level 400cps signals.

The unit uses silicon transistors and will operate at amb. temp. of −55° to 125°C. The gain of the amplifier is 1000. For high performance servo loops in computers and instrument systems. Internal signal limiting prevents overdrive or phase shift for large input signals. Input impedance is 50K. Plug-in construction with captive hold down screws. Operates on standard 28vdc power and will withstand Mil-E-5272 environmentals. Size is 17/16 x 1⅞ x 2 1/16 in. Control Technology Co., Inc., 41-16 29th St., Long Island City 1, N.Y.

Circle 296 on Inquiry Card

New IEE MINIATURE READOUT



WITH FRONT PANEL ACCESSIBILITY

Series 220000 miniature readout can be installed individually or in a 230000 assembly.

Series 220000 Specifications — Single Unit

CHARACTER SIZE
⅛" to ¾" maximum

INPUT
Straight decimal system

VIEWING ANGLE
160° both vertical and horizontal, standard screen
175° both vertical and horizontal, V-1 screen

SINGLE UNIT SIZE
1 1/16" W x 1 13/16" H x 4½" D

Also available for sub-panel mounting with common screen. Single unit prices start at $47.50 in 1-9 quantities.

New IEE Series 230000 front plug-in readout assemblies permit quick, easy lamp replacement, allow permanent wiring, and eliminate the need for flexible cabling.

Available in both single units and assemblies, these rear projection readouts give you 12 displays (one for each lamp) that can consist of words, numbers, colors, or symbols either singly or in combination.

Only IEE One-Plane Readouts Give You So Much *Versatility*

START COUNT NOW!

Up to 12 single or multiple-word messages can be obtained by using one lamp for each message.

3 TRACK

Mode designations can be added by using one of the 12 lamps for each mode number and one lamp for each message.

10

Color emphasis can be added to indicate condition by using one of the 12 lamps for each color and one lamp for each message.

+8

Polarity can be obtained by using one lamp each for plus and minus, and the remaining 10 lamps for 0 through 9 numerals.

Now you can design your own readout message display. Write on your company letterhead for FREE Readout-Message Designer's Kit.

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

5528 Vineland Avenue • North Hollywood, Calif. • Phone: TR 7-1144

NEW PRODUCTS

SOLID STATE SWITCH

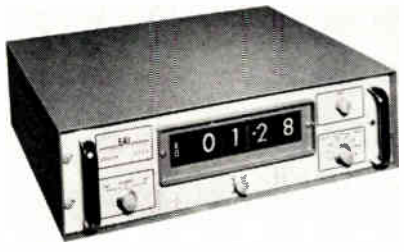
The MINISTAT features low offset, high speed and low cost.

Can be driven from a square wave from 0 to 50kc and typically requires 6 to 12v at 3 to 8ma to operate. Switching properties are such that 0 to ±12v signals may be switched at currents up to 10ma. Nominal forward resistance (either polarity) is 3Ω; a max. offset voltage of not greater than ±50μv from −25° to +70°C is guaranteed. Measures 1.0 x 0.8 x 0.625 in. The Ministat solid state unit is also available in a DPDT or SPDT configuration, and as SPDT switch with integral driver. Western Electrosystems, 1041 E. 7th St., Long Beach, Calif.

Circle 297 on Inquiry Card

VOLT-OHMMETER

Series 5100 is a 4-digit solid state digital unit.



It has 0.01% + 1 digit absolute dc accuracy; 6 months stability, 200 readings/sec. average; with 4 ranges of 1, 10, 100, and 1000vdc; full time input impedance to 1000megs; plus 1K, 10K, 100K and 1meg ranges selected by front panel switch. Ohms accuracy is ±0.05% of full scale. Power source: 115/230v, 50-60cps with 400cps optional. Size: 5¼ x 19 in. RETMA front panel by 16 in. deep. Size in case: 19¼ x 6¼ x 17½ in. Weight: 45 lbs. in case, 30 lbs. for rack mounting. Electronic Associates, Inc., Long Branch, N. J.

Circle 298 on Inquiry Card

NEW PRODUCTS

TOUCH CONTROL SWITCH

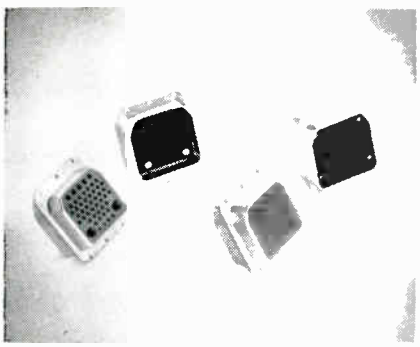
Designed around 4-layer device, operates from body capacity.

Operates by merely touching an antenna input wire, to turn on, and touching another, to turn off. Circuitry is designed around the Dynaquad—a pnpn semiconductor which can be turned on by applying a small negative pulse to the base. For capacitance triggering in counting, sorting and switching. Works directly from 105-25vac, with a load up to 100w. Measures 3 x 1¼ x 1¼ in. Six leads are brought out from the package: 2 for power; 2 for load; and 2 antennas for activation. Tung-Sol Electric Inc., One Summer Ave., Newark 4, N. J.

Circle 243 on Inquiry Card

RACK AND PANEL CONNECTOR

Designed for use with Mil-C 26636 type contacts.



Designated the 500L series, they are available in 6 insert arrangements and 3 shell sizes. Features of the 500L line are insertable crimp-style contacts, high-strength die-cast aluminum shells, glass-filled diallyl phthalate insulator blocks and replaceable contact retainers. Interfacial grommets are of silicon rubber. No. 16, 20, and coax contacts may be intermixed in the same configuration. Connectors are available with 2, 3, 4, and 5 No. 16 contacts; 13, 17, 25, 43 and 59 No. 20 contacts, and 2 and 5 coax contacts. The Deutsch Co., Electronic Components Div., Banning, Calif.

Circle 244 on Inquiry Card

NEW PRODUCTS

MAGNETIC RECORDER

This 25 lb. unit is self-powered for direct or FM data recording.

It is a 4-track portable magnetic instrumentation recorder. Capable of continuous 4-hour operation by means of a rechargeable self-contained battery, the Model 411 uses either direct- or FM-recording techniques (optional at purchase). It measures 13¾ x 15 x 16 in. Tape speeds of 7½, 3¾, and 1⅞ ips permit simultaneous recording / reproduction of direct data signals up to 20,000CPS or FM data signals up to 2,000CPS. Flutter is less than 0.18% RMS and signal-to-noise ratio is 46db at 1KC and 7½ ips. Lockheed Electronic Co., Rte. 1, Metuchen, N. J.

Circle 259 on Inquiry Card

PROTECTIVE COMPOUND

For use in a general purpose protective coating.

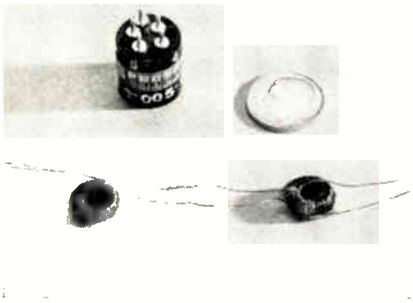
This silicone dielectric compound, SS-4067, provides a non-corrosive, chemically inert, water repellent protective coating which is not subject to oxidation or evaporation. Characterized by low bleed, it is useful over a temp. range of —40° to 400°F. Easily applied and self-adhering it is a combination of silicone dielectric fluids and inert silica filler. For use as a water repellent seal and electrical insulator for terminals, connectors, and process control or electronic assemblies. General Electric Co., Silicone Products Dept., Waterford, N. Y.

Circle 260 on Inquiry Card

NEW PRODUCTS

CASCADED TRANSFORMER

Used in balanced modulators, demodulators, and phase inverters.

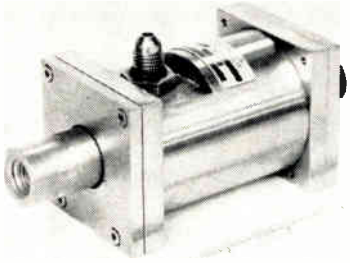


The 2 element cascade S-005-119 transformer shown before encapsulation. The element on the right provides impedance transformation and a balanced output from an unbalanced drive. The element on the left is a "trifilar" providing a "push-pull" balanced output. Cascaded elements permit specialized windings capable of providing precise balance. The S-005-119 is intended for 20 to 500kc local oscillator injection. Spectran Electronics Corp., 146 Main St., Maynard, Mass.

Circle 261 on Inquiry Card

PRESSURE SWITCH

Accuracy of ±0.70% under all environmental conditions.

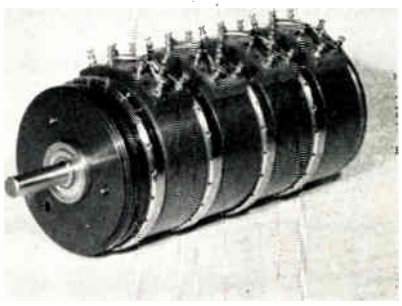


This solid-state electronic pressure switch, Type P36-1103 offers built-in calibration check points and has a switching capacity of up to 1a. Pressure sensing is done through a differential pressure transducer which is compatible with liquid oxygen at both high and low pressure ports. Several pressure ranges are available, from 15 to 500psid. Gage or absolute models and other pressure ranges can also be provided. Wiancko Engineering, 255 N. Halstead Ave., Pasadena, Calif.

Circle 262 on Inquiry Card

POTENTIOMETER

Available in 2 in., 1⅝ in., 1 in., ⅞ in., sizes, single or ganged.



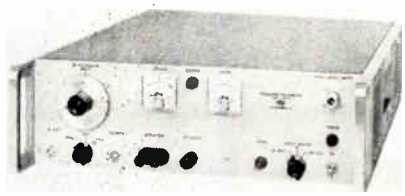
Drum potentiometers, rotary switches, and slide-wires are also available. Resistance values 1Ω to 1 meg and special values, ±5PPM resistance elements, anodized aluminum housings. Noise resistance 140Ω max., dielectric strength 1000vdc; contacts are precious metals. Switch sections, and taps are also available. Resistance tolerance ±5% or closer. Independent linearity ±5% or closer. Starting torque on ball bearing models 0.6 oz. in. max. Voltronics, Inc., 7746 W. Addison St., Chicago 34, Ill.

Circle 263 on Inquiry Card

NEW PRODUCTS

OSCILLATOR SYNCHRONIZER

Stabilizes VHF/microwave signals to 1 part in 10^8.

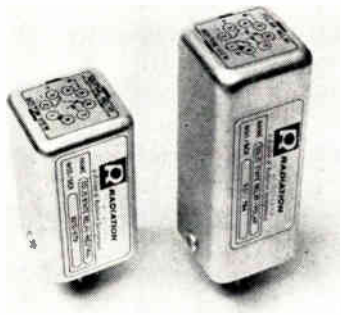


The DY-2650A Oscillator Synchronizer gives extremely stable signals, as required in such areas as doppler systems, microwave frequency standards labs and parametric amplifier pump applications. The DY-2650A phase locks a reflex klystron oscillator (1 to 24GC), with almost complete elimination of drift, to an internal crystal reference to achieve stability of 1 part in 10^8/sec., 1 part in 10^6/week. Temperature stability is 1 part in 10^8 from 0-50°C. Dymec Div., Hewlett-Packard Co., Palo Alto, Calif.

Circle 264 on Inquiry Card

SOLID STATE RELAYS

Telegraph units can handle speeds to 2400 bauds.

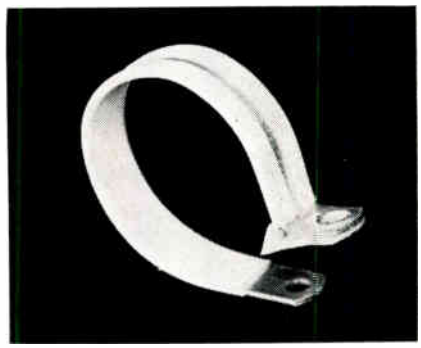


Model 9210, for neutral, and Model 9211, for polar installation, feature less than 3% distortion at max. speed and less than 1% at normal telegraph speeds. Both units have a max. output of 70ma. The neutral model works from an input of 15ma min. and 70ma max. Both units have a resistance in the "ON" position of less than 70Ω. Leakage in the "OFF" position is less than 10μa with 260v across the open contact. No external power source is required. Radiation Inc., Melbourne, Fla.

Circle 265 on Inquiry Card

HARNESS CLAMPS

High Strength Titanium clamps for aircraft and missile uses.



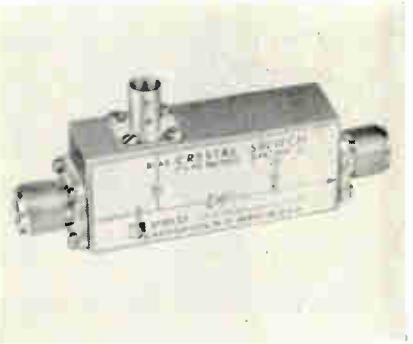
These tube and wire clamps offer a substantial weight saving over stainless steel, while maintaining high tensile strength in a greater temp. range. Titanium, lighter than steel, offers tensile strength up to 80,000 psi. It is considered non-magnetic and has a high electrical resistivity. The clamps are particularly suited for use in "hot spots." They are available with insulating cushions of neoprene, teflon, fiberglass, and many other materials. TA Mfg. Corp., 4607 Alger St., Los Angeles 39, Calif.

Circle 266 on Inquiry Card

NEW PRODUCTS

CRYSTAL SWITCH

A broadband r-f modulator covering from 400 to 4000MC.

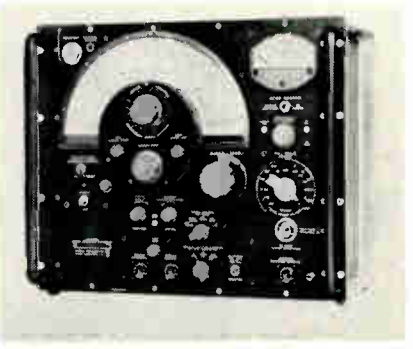


The N6001 Crystal Switch consists of 2 diodes in series with the center conductor of a 50Ω coaxial line. Helical coils are incorporated for 40ma forward and 30v reverse dc biasing. Insertion loss is 2db max. and isolation is 32db min. The max. r-f power handling capabilities, depending on biasing conditions, are 2w average, and pulse 5 to 15w. Max. switching time is 0.16µsec. Max. rise and fall time is 200nsec. Insertion length is 4⅝ in., approximately 1 in. wide, and 2 in. high. PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y.

Circle 299 on Inquiry Card

SWEEP GENERATOR

Type 1025-A covers from 700KC to 230MC in 10 ranges.



It also has bandspread ranges for 400 to 500KC and 10.4 to 11MC. The selected freq. range is swept from low- to high-freq. end in 22.2 msec., 20 times/sec. Output is blanked during return sweep. A synchronized sawtooth sweep voltage for display oscilloscope deflection is adjustable to 100v peak-to-peak. Starting point of display sweep is adjustable. An adjustable trangular marker gives freq. calibration of the display and amplitude calibration from 30mv to 100v. General Radio Co., West Concord, Mass.

Circle 300 on Inquiry Card

Why you should buy the expensive power supply

Because Alfred supplies have full floating output with 7.5 kv insulation to ground. They can be operated with either positive or negative grounding or full floating. Actually, you save money because you get a double duty power supply. **Because Alfred** supplies have adjustable overcurrent trip-out and current range switching to protect costly devices under test from damage by excessive current. Trip-out current can be set as low as 0.3 ma on 50 ma supplies, 0.5 ma on 150 ma units. These features allow a high current supply to be safely used in low current applications. **Because Alfred** supplies offer millisecond turn-off for quick protection of a load. A shorting relay rapidly reduces output voltage to zero, for power removal simultaneous with other supplies. **Because Alfred** supplies, all of them, go to 0 volts, while competing units start at 50 to 500 volts. You get two-supply capability at one unit price. The wide voltage and current ranges offered by Alfred supplies (see specs below) permit operation of specialized tubes such as photomultipliers, klystrons, TWT's and BWO's. **Because Alfred's** carefully designed supplies have minimum downtime. Derated components are essential to satisfy low ripple and tight regulation specs during floating operation. Trouble-free operation alone will return the difference in price. **Because Alfred** supplies include provisions for system operation. Connections are provided for remote master control and metering. Supplies may be interconnected so that overcurrent relay trip-out in any one unit automatically turns off high voltage in all other supplies. **Because Alfred** uses rugged and reliable taut band meters for monitoring voltage and current, elimination of meter bearing friction assures accuracy with long term repeatability. **Because Alfred** publishes complete specifications on all instruments and guarantees them as stated. For full information on power supplies and associated equipment such as filament supplies, modulators and system control panels, please contact your Alfred engineering representative or write us directly.

SPECIFICATIONS

Model Number	Voltage dc	Current ma	Pk-to-Pk Ripple	Regulation		Price
				Line	Load	
262	0 to 500	0 to 100	5 mv	.01%	.02%	$ 850
265	0 to 1500	0 to 150	10 mv	.01%	.02%	990
267	0 to 3500	0 to 50	15 mv	.005%	.006%	1090
270	0 to 5000	0 to 50	20 mv	.002%	.006%	1250
271	0 to 5000	0 to 150	30 mv	.002%	.006%	1450

ALFRED ELECTRONICS
3176 Porter Drive
Palo Alto, California
Phone: (415) 326-6796

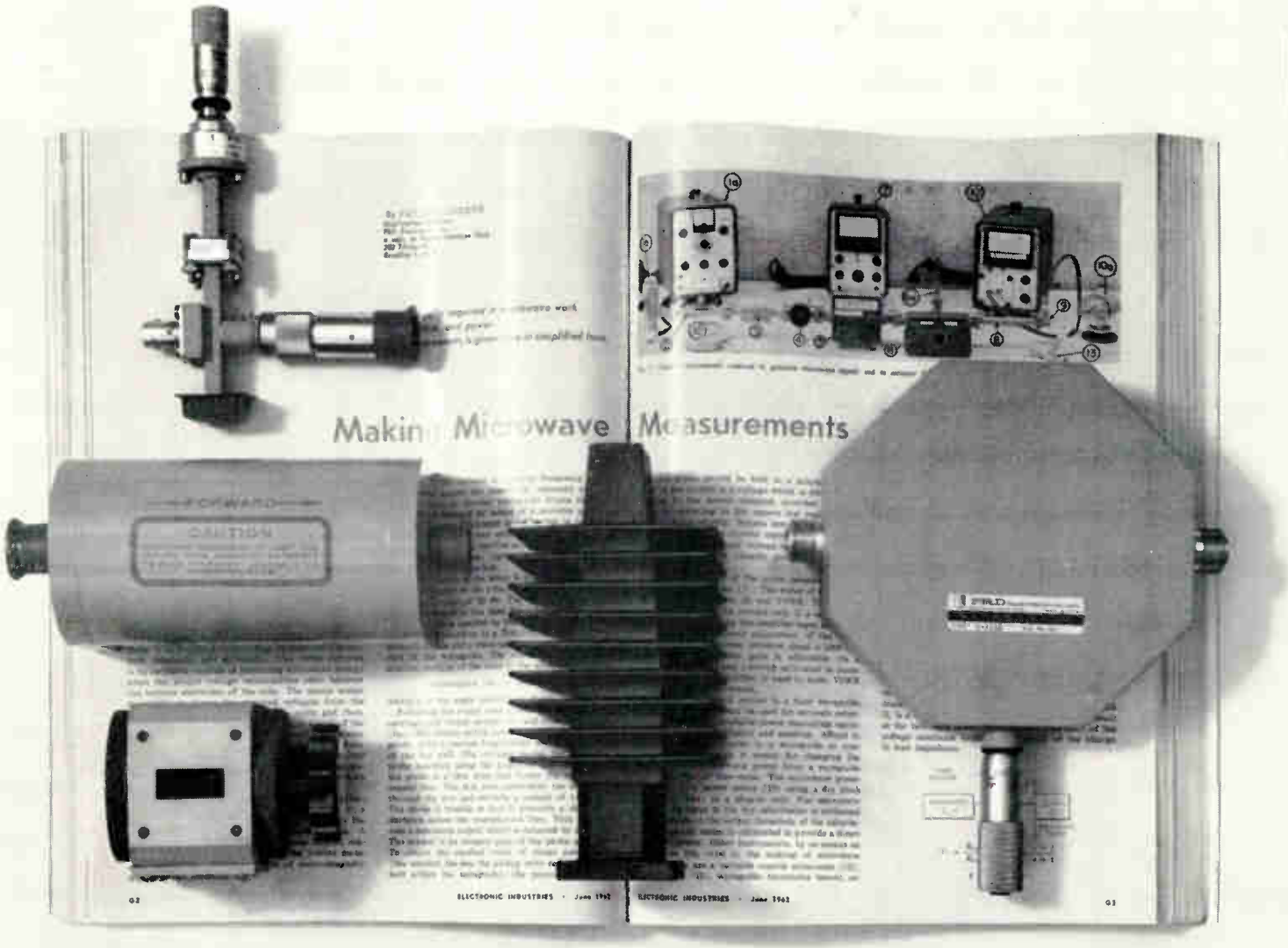
15

Here are some of the newest additions to the long line of microwave equipment from PRD. Reading counter-clockwise below are these new precision components:
(**1**) the PRD A6611 Varactor Harmonic Generator, one of a series of five which cover the frequency range of 4 to 40 kmc; (**2**) one of the PRD Series 1212 Coaxial Ferrite Isolators;
(**3**) the PRD X4001, from a new series of Waveguide Switches; (**4**) the PRD X1410 High Power Load, one of the waveguide series for S through X band; (**5**) the PRD S1110, from our new Series of Variable Coaxial Attenuators (UHF and L band also available). And the technical article by Pat Tucciarone of PRD, "Making Microwave Measurements"? It's available now as a 12-page reprint . . . send for your free copy!

PRD ELECTRONICS, INC.
202 Tillary St., Brooklyn 1, N.Y., ULster 2-6800 • *A Subsidiary of Harris-Intertype Corporation*

HARRIS INTERTYPE CORPORATION

STILL MORE NEW COMPONENTS FROM PRD!



PRD Electronics, Inc.

Brooklyn, N.Y. · Los Angeles and Redwood City, Calif. · Cherry Hill, N.J.

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EI-09 JANUARY, 1963

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JANUARY, 1963

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- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Type of Military Products and Equipment.
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- ☐ Mfr. of electronic components, parts, tubes and like products.
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TRANSISTOR SOCKETS

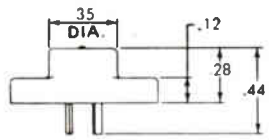
for

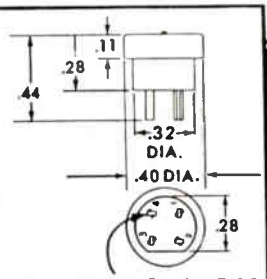
TO's 5, 9, 11, 12, 16, 18, 25, 28, 29, 31, 39 and 46

One piece contacts – extend all the way through socket. Molded thermosetting plastic per MIL-M-14. Terminal numbers are molded into bottom of socket – top face keyed for alignment with transistors.

No. 22-11

screw mount style for ⅜" hole. 4 terminals standard. 3 terminals on special order.



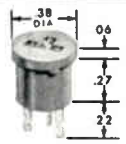


No. 22-16

Solder direct to printed circuit, or fits "D" hole. 3 or 4 terminals. Also available in colors.

No. 22-101

allows transistor leads to extend all the way through socket.



NO. 22-101 for TO's 18, 28 and 46

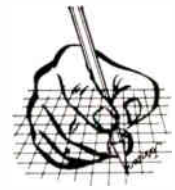
Write for complete specifications. Your current Grayhill Engineering Catalog will be sent on request.

"N. Gineer"

Grayhill INC.

Area Code 312, Phone 354-1040
543 Hillgrove Avenue
La Grange, Illinois

Circle 101 on Inquiry Card



Printed Circuit Connectors with operating voltages to 1500 V RMS... up to 5 amps current carrying capacity!

Ideally suited for limited space applications! Extremely compact —highly resistant to extremes of shock, vibration, temperature and moisture. Body, tough low-loss polyamide per MIL-P-17091 (Du Pont Zytel 101 nylon). Available in 13 colors, including basic colors for MS16108C coding applications. Contact resistance: less than 2 milliohms. Capacitance between two adjacent jacks: less than one mmf.

TIP JACKS—Formed silver-plated berylium contact. Horizontal Jack accepts .080" dia. tip plug in either end, top or bottom. Vertical Jack mounts through single .052" hole requiring minimum mounting area.

SUB-MINIATURE TIP PLUGS—One-piece, nickel-plated, machined brass tip. Solder type lead connection. Available in standard length or with 4" body for access to "hard to reach" test points.

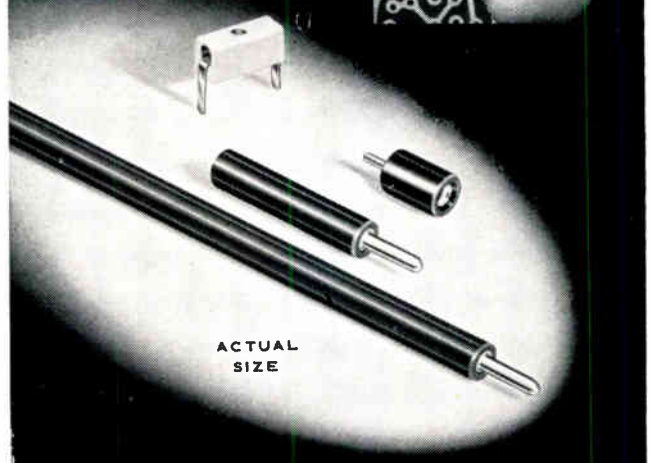
STANDARD NYLON CONNECTORS—Complete line of Tip Plugs; Standard, Metal-Clad, and Rapid-Mount Tip Jacks; Banana Plugs and Jacks; Binding Posts. Tough, low-loss, shock-proof nylon will not chip or crack. Voltage breakdowns to 12,500 VDC. Catalog lists available types.

OTHER CONNECTORS—In addition to nylon types, Johnson also manufactures standard connectors. Catalog lists available types.

E. F. JOHNSON COMPANY
3002 TENTH AVENUE S.W. • WASECA, MINNESOTA

DESIGNED FOR PRINTED CIRCUIT USE:

MINIATURE Nylon Plugs and Jacks



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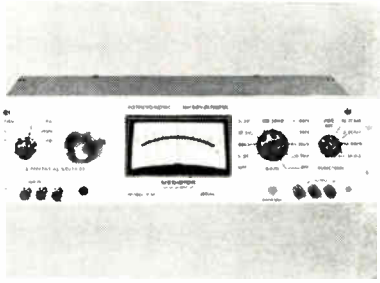
Circle 102 on Inquiry Card

NEW PRODUCTS

MICROVOLTMETER

Potentiometric unit is precise through ½μv to 1kv range.

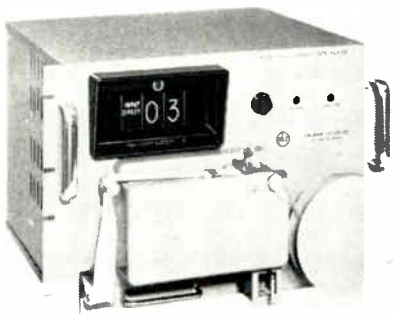


Fully-transistorized Model A-61 Potentiometric Microvoltmeter offers full-scale linear sensitivities from 3μv to 1kv and allows dc potentiometric measurements from ½μv to 1v, with infinite resistance at null. Potentiometric mode has: 5 decade ranges; 3-digit readout; 0.5% accuracy; ±0.01%/hr. stability; and fully floating input with isolated output. Voltage shifts as small as 0.001% can be measured. With external probe, measurements can be made from 1v to 1kv (at constant input impedance of 10megs. Medistor Instrument Co., 1443 N. Northlake Way, Seattle 3, Wash.

Circle 301 on Inquiry Card

LOW-COST DATALOGGER

The NLS RS3 will automatically scan up to 20 input channels.



It feeds the readings through a digital voltmeter and provides a punched tape record of each 4-digit measurement with its channel number. Can easily accommodate any 5, 6, 7 or 8 channel tape code; coding can be changed by simply shifting diodes on a plug-in circuit board or by interchanging pre-wired plug-in boards; "word" structure (program) can be changed by rearranging jumpers on an externally accessible plug-in program connector or merely interchanging pre-wired plug-in connectors. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 302 on Inquiry Card

ANOTHER APPROVAL FOR EL-MENCO...

BELL TELEPHONE LABORATORIES
INCORPORATED
463 WEST STREET, NEW YORK 14, N.Y.
AREA CODE 212
CH 3-1000

September 13, 1962

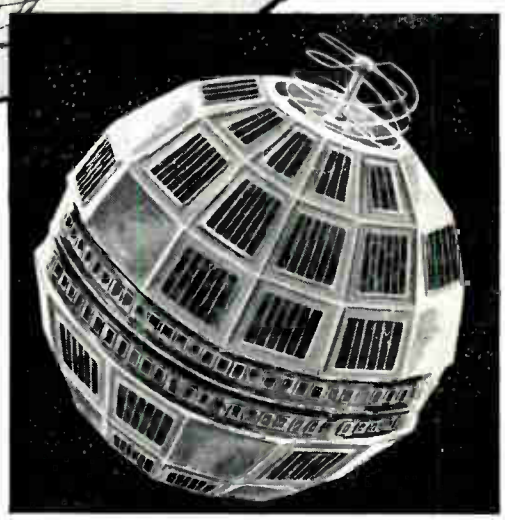
W. P. H. STEVENS
PURCHASING AGENT

A NOTE OF APPRECIATION

I take pleasure in sending you an advance copy of a

You will note that you are listed as one of the companies which helped us make Telstar a success. In behalf of Bell Laboratories, I would like to take this opportunity to express again our appreciation for your cooperation in this important endeavor.

Sincerely,



a star performer- TELSTAR, we mean

El-Menco MICA CAPACITORS were selected for TELSTAR

■ In the words of the Bell Telephone System, El-Menco was chosen "because of its competence in its field for the job required." ■ At El-Menco we believe that competence in our work of designing and building the best practical capacitors will instill your confidence in our product. This philosophy has resulted in our producing capacitors which have a high order of *quality*, *reliability*, and *availability*. Hence the selection of El-Menco mica capacitors for many important missile and satellite programs. ■ Still widely discussed is the *RCA test evaluation of El-Menco high reliability dipped mica capacitors in which enough actual test unit-hours were accumulated at *elevated temperature and with 225% of the rated temperature applied* to verify failure rates on the order of 0.0001% and 0.00004% at a 90% confidence level.

**The El-Menco high reliability dipped mica capacitors are being supplied to the Radio Corporation of America for a high reliability military ground electronics project.*

Write for reliability study and technical brochures.

THE ELECTRO MOTIVE MFG. CO., INC.

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Dipped Mica • Molded Mica • Silvered Mica Films • Mica Trimmers & Padders
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MANUFACTURERS OF El-Menco Capacitors

ARCO ELECTRONICS, INC.,
Community Drive,
Great Neck, L. I., New York
Exclusive Supplier to Jobbers and Distributors in the U. S. and Canada

West Coast Manufacturers Contact:
COLLINS & HYDE CO.,
535 Middlefield Road,
Palo Alto, California
5380 Whittier Boulevard, Los Angeles, California

NEW PRODUCTS

LINE PRINTER

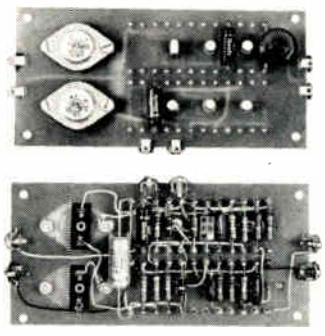
Prints 64 characters at 300 lines/minute.

Also features print ribbon with 3 times former life. Other features of the H207 Medium Speed unit: interchangeable print drums for increased speed when a large selection of characters is not needed; hammers permanently timed to high degree of accuracy; and swing-up drum arm. Specs. are: printing speed of 64 charac. at 300 lines/min., 48 at 383, 16 at 854, and 10 at 1010; line width 120 columns; character pitch 10 charac./in.; line pitch 6 or 8 lines/in.; and line advance control optically read from punched tape, 1 to 8 levels. Holley Computer Products Co., Warren, Mich.

Circle 267 on Inquiry Card

MILLIWATT AMPLIFIERS

May be used as a modular sub-assembly for power gains of up to 60db.



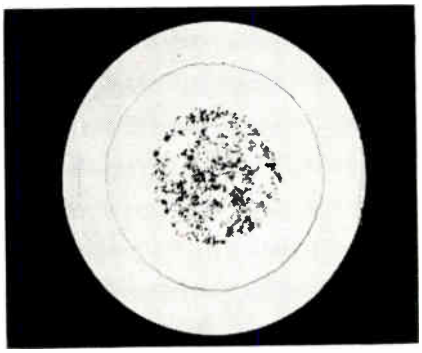
These direct-coupled modules have a very low damping factor for use with multiple earphone installations (up to 100). They are also useful as tandem or series-connected low-level drivers. All models deliver 100mw at less than 1% distortion into a 600Ω load. Two standard models available: Wide-Range Module (WR-100) with freq. response of ±1db, 10CPS to 100KC; and a General-Purpose Module (GP-100) with freq. response, ±1db 20CPS to 15KC. Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.

Circle 268 on Inquiry Card

NEW PRODUCTS

SUPERCONDUCTIVE WIRE

More than twice the field strength of zirconium-columbium wire.



It can be used at temps. as low as 18.5°K. The composite wire is available in both single and multiple sheath forms. The multiple sheath's outer sheath acts as an insulating layer offering high electrical resistance, with better thermal conductivity than non-metallic insulation. Thus the entire magnet can be maintained more readily at super-cooled temps. The composite is being used to field strengths of 80 kilogauss. Available as small as 0.010 in. and in lengths up to 10,000 ft. Superior Tube Co., 1614 Germantown Ave., Norristown, Pa.

Circle 269 on Inquiry Card

CAPACITOR ELECTROMETER

Measure currents below 1 femtoamp (10^{-15}a) with high stability.

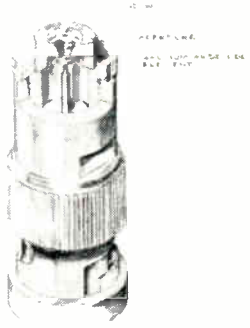
Known as the Victoreen Model 475 Femtometer, it measures down to levels near the threshold of thermal agitation, i.e., currents of the magnitude of only 8000 electrons/sec. At about 1/3 of full-scale, the Femtometer measures currents of less than 1 femtoamp (10^{-15}a, or 1 millipicoamp), and charges of less than 1 femtocoulomb (10^{-15}C, or 1 millipicocoulomb), and voltages from ultra-high impedance sources. For ionization current measurements in radiation monitoring and control. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 270 on Inquiry Card

NEW PRODUCTS

LIGHT-EMITTING DIODE

Radiated power outputs of 1mw are obtainable.

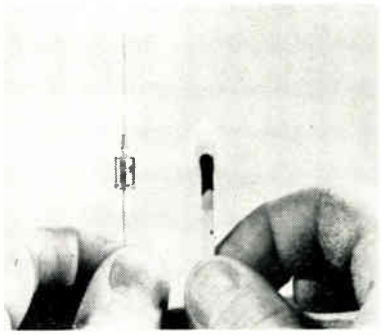


This gallium arsenide light-emitting diode makes possible solid state optical communications systems. The GAE-402 does not need a complex power supply and modulating system. It is a diffused junction GaAs diode which, when forward biased, emits monochromatic light near 9000° A. Modulation power required is only a few tenths of a watt, and radiated power outputs over 1mw are obtainable when operated at room temps., with more than 25mw of output power when diode cooled to 77°K. Mounted in a UG-88/U type BNC connector. Philco Corp., Lansdale Div., Lansdale, Pa.

Circle 271 on Inquiry Card

SILICON RECTIFIER DIODES

Can dissipate reverse power transients up to 1kw.



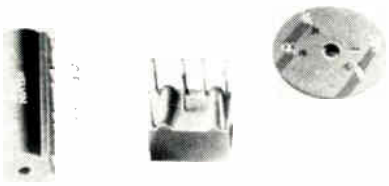
Small pigtail-mounted silicon rectifiers, (flangeless, and 0.570 in. max. length) rated at 2a and have built-in Voltage Impulse Protection (VIP) against reverse power dissipation capability of 1kw for 25μ sec. transients. Use their controlled avalanche characteristic to dissipate large reverse power pulses without protective circuitry. For severe industrial uses; exceed requirements of EIA-NEMA class B service. Three types rated to 600v PRV available. Rectifier Div., General Instrument Corp., 65 Gouverneur St., Newark, N. J.

Circle 272 on Inquiry Card

NEW PRODUCTS

RESISTOR NETWORKS

Precision resistive networks with very fast rise time response.



Especially suited for computer uses. Rise time responses with time constants as low as 50nsec. with virtually no ringing are available. Features are: absolute initial accuracy of resistors ±0.005% at 25°C or any specified ambient up to +40°C; temp. limit of ±2°C from the specified temp.; matching ratio of ±0.001% to the specified temp. range; temp. coefficient as low as 0.5 PPM/°C from +55° to +85°C at the medium resistance range. Resistance stability of 0.002% over a 10 times temp. cycle from −65° to +85°C. Kelvin Electric Co., 5907 Noble Ave., Van Nuys, Calif.

Circle 303 on Inquiry Card

MINIATURE RELAY

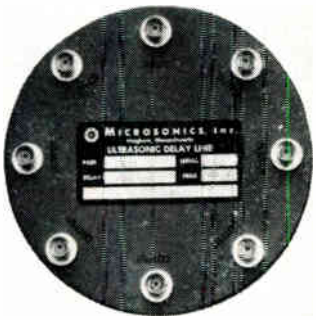
Type AZ designed for extra long life at low cost.

Available in 2 series, AZ420 (shown) and the AZ421. General basic specifications for both relays are: mechanical life expectancy: 100,000,000 operations; life expectancy at rated load: 10,000,000 operations; contact configuration to 4 form C; weight: 1.2 oz. maximum; terminals: plug-in; and sizes: AZ420: ¾ x 15/16 x 1 3/16 in. and AZ421: ¾ x 1 11/64 x 1 3/16 in. Controls Div., Elgin National Watch Co., Industrial Group, 2435 N. Naomi St., Burbank, Calif.

Circle 304 on Inquiry Card

TAPPED DELAY LINES

For use in pulse code modulation and digital computers.



These devices may be operated up to 70MC for max. bandwidth. Taps are available, which are any sub-multiple of the total delay time up to 1600μsec. In addition, certain output taps can be provided in delay lines from 1600 to 5000μsec. For extreme environmental conditions, Microsonics can provide temperature control systems capable of maintaining stabilities of ±0.01°C. Microsonics, Inc., 60 Winter St., Weymouth 88, Mass.

Circle 305 on Inquiry Card

RELIABILITY LIFE TEST REPORT

CK5703WB

DATE ISSUED July 1962

REPORT NO 2

SUMMARY OF TEST RESULTS	NO TESTED	TOTAL TUBE HOURS	NO FAILED	FAILURE RATE IN % PER 1000 HOURS	
				IN PLANT ACTUAL FAILURES	ESTIMATED EQUIPMENT FAILURES
Catastophic Failures Only	1040	880,000	2	0.23	0.12
Total Failures Catastrophic & Electrical	1040	880,000	4	0.46	0.23

TEST DESCRIPTION

Type: Intermittent Life, 1000 Hours, per MIL-E-1/1070

Operating Conditions: E_f=6.3V E_b=120Vdc R_k=220ohms E_{hk}=+200Vdc

E_{c1}=0 R_{g1}=1.0 meg. T_{bulb}=+220°C min.

End Points:

I - Catastrophic: Shorts, opens, air tube (MIL-E-1D)

II - Electrical: Time change in Transconductance [Δ_tSm(1)] for individual tubes, exceeding 30% at 1000 hours.

APPLICATIONS The CK5703WB is a heater-cathode type medium-mu triode of subminiature construction capable of operation as an oscillator, Class C Amplifier, or frequency multiplier in the UHF region. This type is characterized by long life and stable performance. It is designed for service where conditions of high temperature and mechanical shock or vibration are encountered.

REMARKS Summary data and failure rates are based on observations of tests run at MIL-SPEC. conditions. No derating or multiplying factors have been used. In actual use, the operational failure rates may usually be expected to be less than those computed from the above Life Test data.

Backup

Tube reliability backed up in writing. That's what the Raytheon Reliability Reports mean to equipment and system designers. These valuable reports give data on actual in-plant failure rates for typical industrial and military tube types, as well as tube reliability under estimated equipment conditions.

Prepared by Raytheon quality control specialists with long experience in life test procedures, the reports define types of tube failures and give methods for calculating confidence limits on failure rates.

The Raytheon Reliability Reports are a continuing service. Volume II of this report is now ready. You can receive your copy by writing to: Raytheon Company, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

RAYTHEON

Circle 74 on Inquiry Card

The Systems Engineering Section of ELECTRONIC INDUSTRIES

ELECTRONIC OPERATIONS

SYSTEMS WISE

AF DATACON—WORLD'S LARGEST

First of 5 centers in the world's largest digital data communications system has been turned over to the USAF by Western Union Telegraph Co. One of the systems jobs is to keep tabs on 1.5 million items of material. First center is at Norton AFB, Calif., other centers are expected to be completed in the early part of '63.

Scientists at IBM's Thomas J. Watson Research Center, Yorktown, N. Y., have continuously operated a gallium arsenide "injection laser." Current level required was about 100a. The device put out between 10 and 25mw of light, for an input of 50mw. Overall efficiency is between 20 and 50%; wavelength about 8400Å.

Telstar has developed difficulties in its command circuit. It won't turn its communications receiver and transmitter on or off. All originally planned experiments, plus some 250 technical tests and over 400 demonstrations have been carried out. Bell Telephone Laboratories scientists say the trouble may turn out to be a "boon." It will provide data for improving future ComSat reliability.

NASA has acquired a Univac 1107 Thin-Film Memory System from the UNIVAC Div. of Sperry Rand Corp., for use at Goddard Space Flight Center, Greenbelt, Md. The computing system will be used 24 hrs. a day, 6 days a week, to process telemetered data from satellites. Installation is scheduled for Jan. '63; operation to start in Feb.

Because radiation affects the solar cells of earth orbiting satellites, nuclear powered generators will come into widespread use in space, according to an atomic scientist from the Nuclear Div., of Martin Co., the Aerospace Div. of Martin Marietta Corp., Baltimore, Md. Radioisotope generators are simple, long-lived, and inherently reliable devices, besides offering space and weight savings.

A radar with a 300-mile detection range has been designed from lightweight materials by General Dynamics/Electronics, San Diego, Calif., so that the entire system can be flown or floated into battlefield positions. Contained in two watertight packages of 3,500 lbs. each, the radar can be assembled in two hours. Features for assembling under tactical conditions include: sequential unloading, "braille" part identification and a minimum of tools.

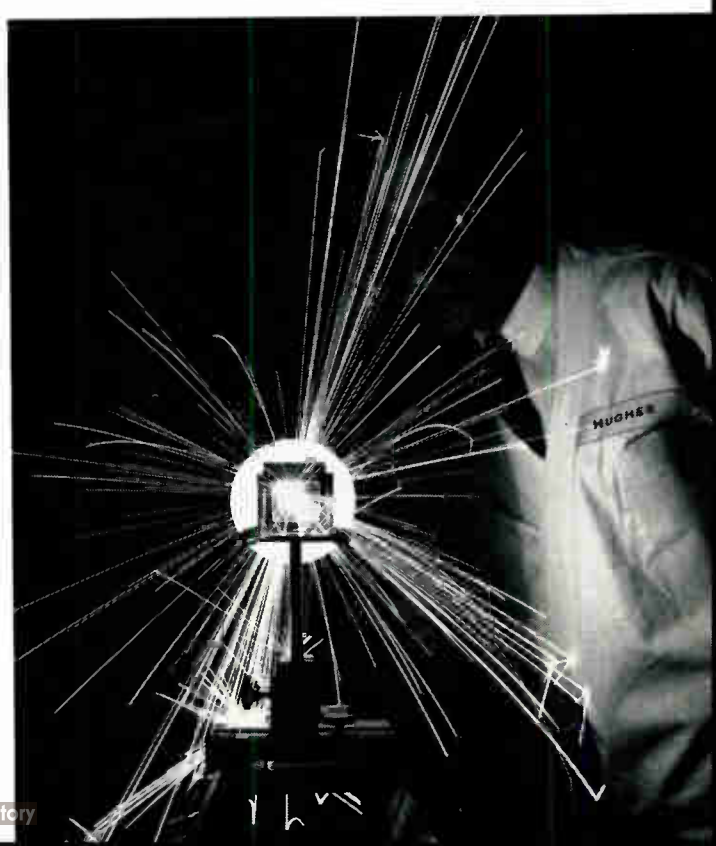
The radio-command guidance system that put the 3 Mercury shots into orbit will be used for NASA's Gemini program. General Electric Co.'s Defense Systems Dept., Syracuse, N. Y., received a letter contract from the USAF's Space Systems Div., for transistorized systems weighing a total of 34 lbs.; Mercury's transponder alone weighed 32 lbs.

A solar "steam boiler" generating electricity (using heat from the sun) to operate control and communications systems in satellites has been designed by Red Bank Div. of The Bendix Corp., Red Bank, N. J. Using mirrors to capture sun energy, the system uses liquid metal (instead of water) in a closed-cycle system similar to conventional steam engines. The vaporized working fluid drives a multi-stage turbine coupled to a generator which can supply up to 80,000 watts of electrical power.

Speech recognition machines will, at first, have to rely heavily on good "hearing" of individual sounds, according to a Bell Telephone Laboratories scientist at the recent meeting of the Acoustics Soc. of America in Seattle, Wash. Most frequent speech sounds are "uh," "t," "i" as in "bit," and "n." Least frequent: "zh" as in "pleasure."

LASER PIERCES TANTALUM AND DIAMOND

Built by Hughes Aircraft Co., Fullerton, Calif., this powerful ruby laser drilled through a very hard sheet of tantalum metal in less than a 1000th of a second. Metal boiling point is 10,000°F. The laser also pierced a diamond in a fraction of a split second.



A TRANSISTOR AMPLIFIER WITH AGC

The automatic program level control feature incorporated in this amplifier can be used in all types of communication equipment. Use of this circuitry would prevent overmodulation.

FOR A NUMBER OF YEARS we have been using a small transistorized amplifier for all of our sports broadcasts.[1] The unit has been so successful that we decided to develop a more modern version with added features.

We have a definite need for 3 mike channels, especially at football games. One channel for play-by-play, one for the announcer, and one for crowd and band pickup.

It would be very helpful if the need for riding gain was eliminated, because often the sportscaster is burdened with this duty, along with describing the event. With the level automatic, he would be free to concentrate on the event. This would also make it possible to discard the VU meter and further reduce the unit's size and weight.

The amplifier described here has been tested fully and has been giving very good performance. The gain is controlled much better than is possible by manual control.

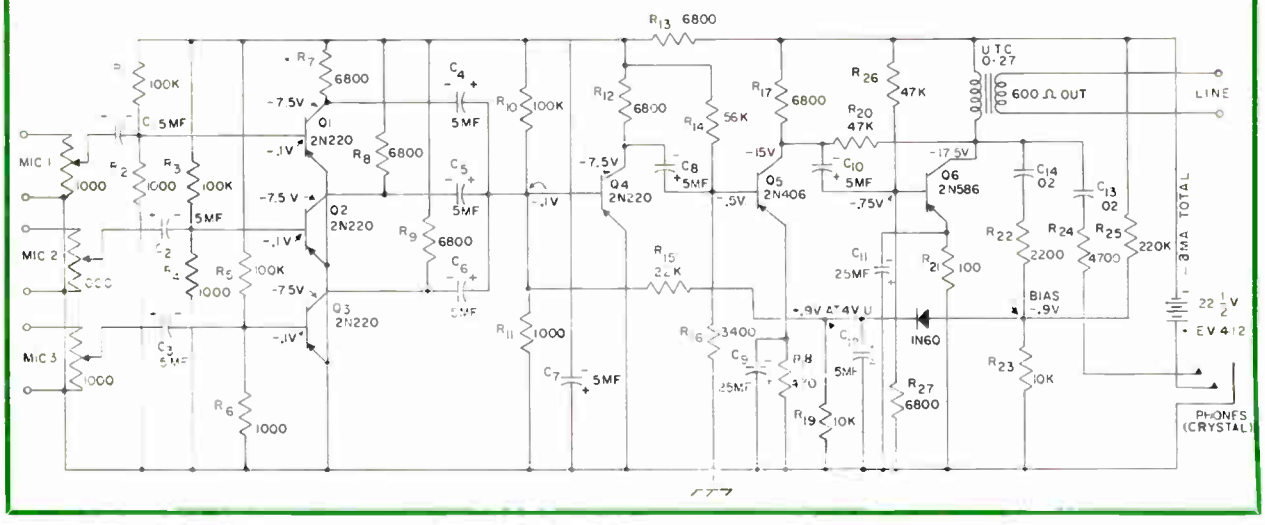
The attack time is very short and the recovery time is rapid enough to make the build-up during pauses unnoticeable. The whole operation is very smooth.

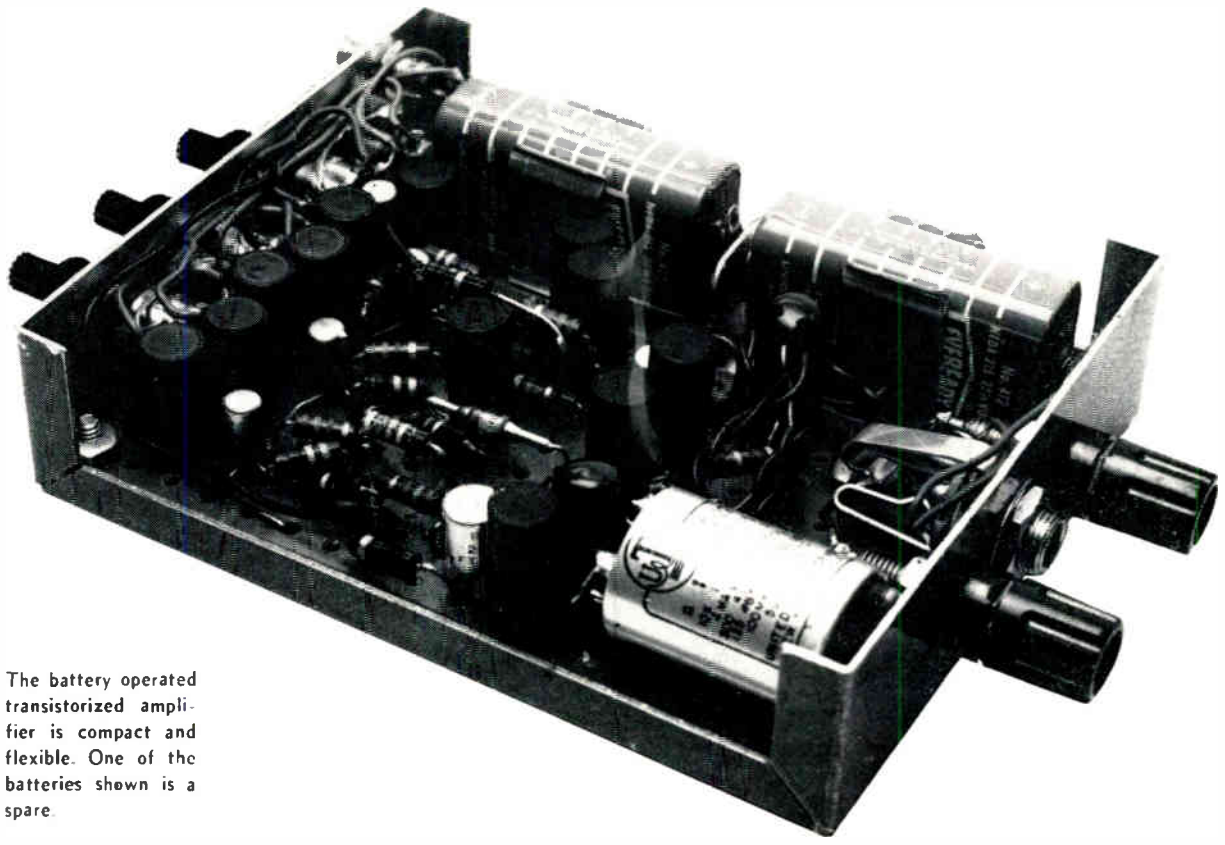
Although we are mainly interested in using it for broadcasting, the circuit could be used for level control in many other types of equipment.

By EDGAR C. SMITH
Chief Engineer
WFIN
Findlay, Ohio

[1] Transistor Remote Amplifier, E. C. Smith, *Electronic Industries* August 1956.

Schematic of a transistorized audio amplifier with AGC. Except for the AGC, the circuit is of standard design.





The battery operated transistorized amplifier is compact and flexible. One of the batteries shown is a spare.

Circuit Description

Three low impedance 250 ohm microphones are connected to the mixer transistors through the controls and C1, C2 and C3. Mixing takes place in the collector circuits of these transistors. Except for the AGC, the circuit is of standard design.

Audio voltage is applied to the 1N60 diode through C14 and the divider formed by R22 and R23. The 1N60 diode rectifies this voltage and the resulting dc voltage is filtered by C12. The dc voltage across R19 is applied to the base Q4 through R15. This voltage is positive and reduces the gain of Q4 as the output voltage of Q6 increases. To prevent gain reduction on low levels, the diode is biased by dc obtained from the divider formed by R25 and R23. This improves the overall performance, since only the higher levels need to be reduced.

The recovery time of the control circuit is controlled by C12 and R19. We prefer the recovery time obtained by the values shown, but it can be increased by increasing the value of C12 if needed.

One Eveready 412, 22½ volt battery is used. This provides about 10 hours of operation. A spare battery is mounted in the case.

Frequency response is within 2 db of 1000 cycle reference, 50 to 10,000 cycles (Fig. 1).

Distortion at +4 VU normal output is 3.5% or less, 50 to 10,000 cycles (Fig. 2).

Gain reduction at +4 VU normal output is 8.5 db (Fig. 3). The noise level measured better than 60 db below normal output. (*Continued on page 202*)

Fig. 1: Graph shows that frequency response is within 2db.

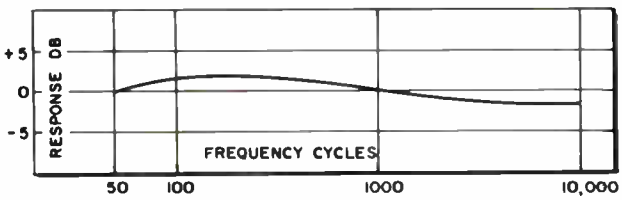
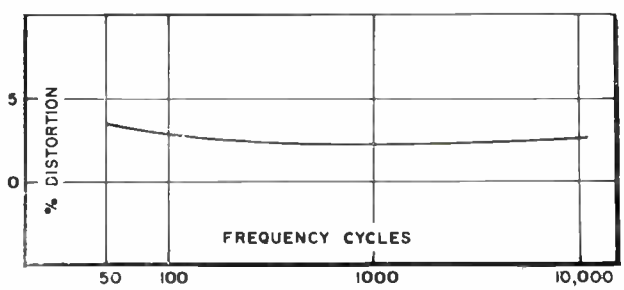


Fig. 2: Distortion of amplifier at +4VU is about 3.5%.



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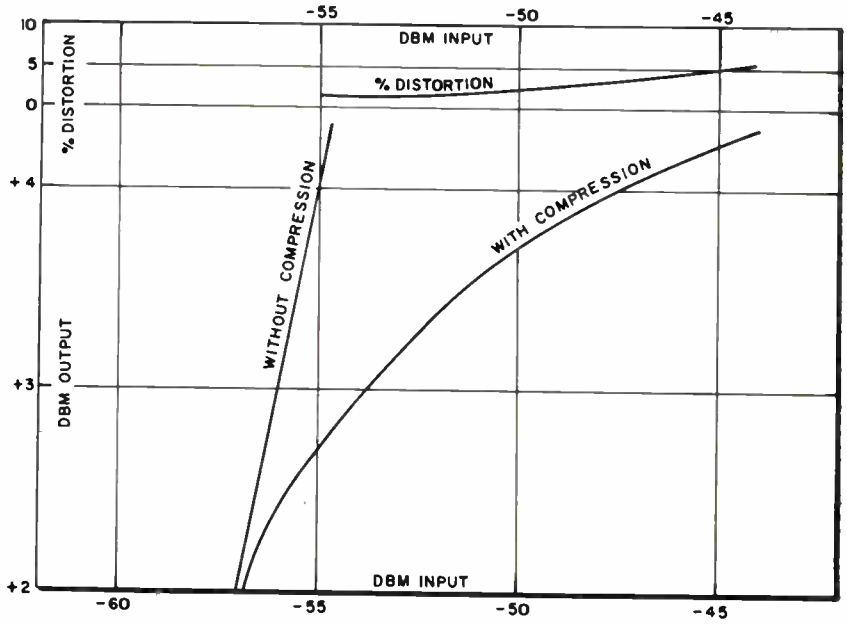


Fig. 3: Gain reduction at +4VU normal output is 8.5 db as shown in graph

TRANSISTOR AMPLIFIER (Continued)

Operation

Operation of the amplifier is very simple. A line is connected to the output terminals, and the microphones and the headphones are plugged in. The headphone plug also turns the battery on. This eliminates a switch which might be left on to discharge the battery.

The 3 controls are used mainly for selecting microphones. They are opened just enough to give normal output and need not be touched thereafter, except to cut off a mike. For our sportscaster the control is about one fourth on. Extra gain is available for pickup of distant events, such as halftime ceremonies, etc.

New KIFIS Alti-Coder Altimeter is as easy on the eyes as Kathy Malecki, TWA stewardess, who holds it up for close inspection.

KOLLSMAN INTRODUCES ALTITUDE-REPORTING DEVICES

A series of devices that automatically report digital altitude information to control towers has been introduced by Kollsman Instrument Corp., Elmhurst, N. Y.

Known as "Alti-Coders," the equipment will allow air traffic controllers to pinpoint aircraft altitudes in high-density airport areas.

Altitude information is automatically encoded into digital form to be sent from the aircraft transponder upon interrogation by an air controller.

Kollsman is making three types. They are the "KIFIS" Alti-Coder, for commercial jets with Kollsman's Integrated Flight Instrument System: the H/A Alti-Coder, for heavy aircraft not so equipped, and the L/A Alti-Coder, for planes weighing under 12,500 lbs.

The units are quite compact: the L/A Alti-Coder is 6 x 3¼ x 3¼ in., weighs 2 lbs. The other two are slightly larger. Correction for systems scale and airframe static source errors is provided on the KIFIS Alti-Coder.

Installation time is claimed to be immediate on KIFIS-equipped aircraft, very short on others. Components are said to meet or exceed FAA specifications.

LIDDEL APPOINTED NASA PLANETARY RESEARCH CHIEF

Dr. Urner Liddel, formerly Assistant Director of Hughes Research Laboratories, Malibu, Calif., has been appointed NASA Chief of Sciences for lunar and planetary Programs.

NASA MISSILE CIRCUIT CONNECTOR TESTED BY AF

NASA has developed a circuit connector to overcome one of the simplest but most exasperating problems in the missile business, that of faulty electrical plugs.

The new connector has no soldered connections.

Recently it was successfully tested at AF Systems Command's Missile Development Center, Holloman AFB, N. Mex. Tests were accomplished by simulating missile launchings with rocket sled runs on the base's 35,000-ft. captive missile test track.

These successful tests demonstrated that higher-than-normal takeoff and re-entry vibrations can be withstood by the connectors without breaking a circuit for as much as .0001 sec.

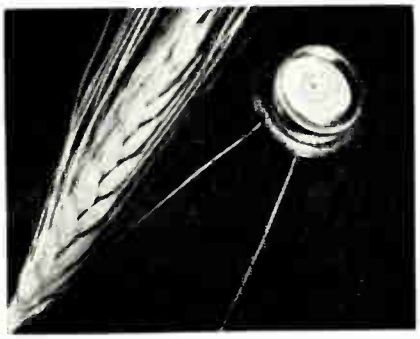
The devices reportedly eliminate much missile weight, short circuits, and broken and frayed connections so common in ordinary electrical hook-ups.

NEW PRODUCTS

...for the Electronic Industries

PHOTOCONDUCTIVE CELL

Half-inch unit responds to low light levels.



At the low light level of 2 ft.-candles illumination, the cell resistance is 1000Ω. Max. current-carrying capacity 20ma. Peak spectral response is 6100°A. Hermetically sealed against deterioration by moisture, it is an end-illuminated cadmium sulfide cell, Type B46. It carries a max. applied voltage rating of 60vdc or peak ac, 120mw power dissipation. The cell has a glass and metal envelope with 2 wire leads. Seated height is about 1/3 in. and max. dia. is 0.65 in. General Electric Co., Receiving Tube Dept., Owensboro, Ky.

Circle 237 on Inquiry Card

TO-5 PULSE TRANSFORMERS

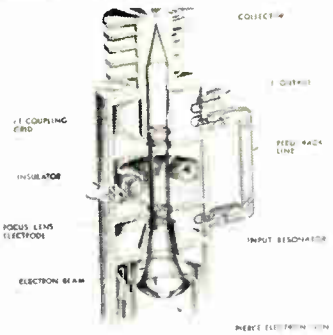
Series of subminiature units for use in the nanosecond region.

Subminiature pulse transformers in TO-5 transistor cases offer a welded hermetic seal in a low volume package. Bandwidths (ratio of pulse width to rise time) is somewhat restricted as to common to nanosec. transformers. Windings are kept uniform to minimize reflections in the transmission line mode. Type 45Z is designed for a max. voltage rating between windings of 200vdc. Temp. range is −55° to 105°C. Models rated at 125°C are available. Dissipation rating is 0.3w at 25°C with linear rerating to 105°C. Special Products Div., Sprague Electric Co., N. Adams, Mass.

Circle 238 on Inquiry Card

KLYSTRON

This type of klystron is called a lens modulated oscillator (LMO).

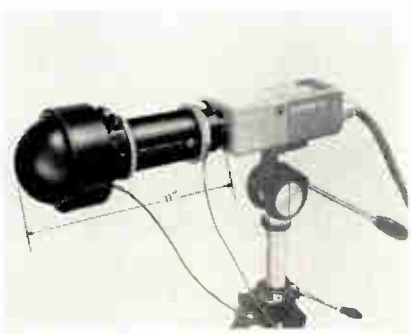


Reported to combine inherent features of a 2-cavity oscillator of high efficiency and power capacity, with an easier method of freq. modulation. Oscillator uses an electrode to vary electron transit time between 1st and 2nd cavity. Electrode is positioned outside the electron beam in the drift tube of the oscillator and does not draw current; freq. modulation is done without changing power input to the oscillator. The lens electrode pumps ions out of the beam, increasing life expectancy. Sperry Electronic Tube Div., Gainesville, Fla.

Circle 239 on Inquiry Card

TV OPTOLINER

For precision testing and alignment of all TV cameras.

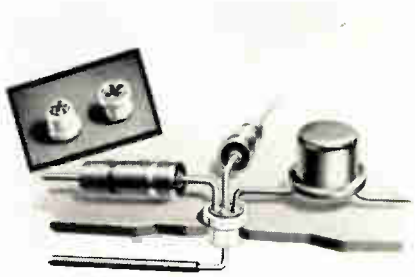


Designed for the critical alignment and standardization of TV cameras, the Optoliner attaches to the lens mount of any studio or closed-circuit TV camera and accurately checks opto-mechanical alignment, sensitivity, and calibration to laboratory standards. It precludes the variables present with external test patterns through the use of internal test pattern slides. Light level and color temperatures are adjustable, and even-illumination without hot spots is provided by an exclusive integrating sphere. Photo Research Corp., 837 N. Cahuenga Blvd., Hollywood 38, Calif.

Circle 240 on Inquiry Card

TERMINAL SYSTEM

Provides dip-soldering for metal chassis and hand wiring.

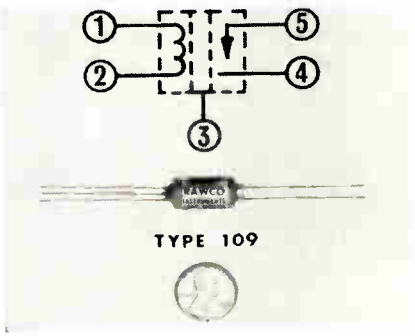


This receptacle design provides the economies of dip-soldering, and the reliability and repairability of hand-wired metal chassis construction. The "Press-Fit" Cloverleaf Receptacle permits hand-wiring from point-to-point, and metal chassis mechanical strength and field serviceability. Provides 4 insertion points for wire leads, with a center hole. Two series: The FT-E-10 for AWG-19 or smaller wire; the FT-E-12 for AWG-22 or smaller. For use on metal chassis from 0.040 to0.065 in. thick. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y.

Circle 241 on Inquiry Card

TRANSISTOR CHOPPER

Type 109 is for SPST switching applications.



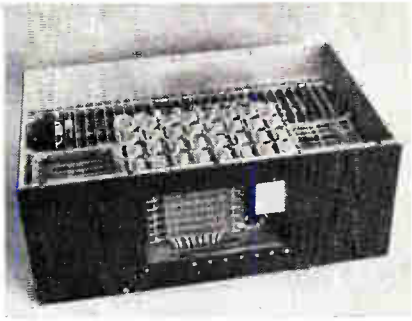
Potted in a ⅜ x 0.70 in. long steel casement, this chopper has a self-contained transformer providing complete isolation between drive and switching terminals. Sine or square wave drive can be used over a freq. range of 250 to 100,000cps. The unit's noise balancing circuit reduces switching spikes and offset to 5% of normal value. DC offset is typically 20μv with drift in the low microvolt level over a temp. range of −65° to +125°C. Noise level is 30μv at 10k impedance (400 cps). RAWCO Instruments, Inc., P.O. Box 7393, Ft. Worth 11, Tex.

Circle 242 on Inquiry Card

NEW PRODUCTS

SOLID STATE MEMORY

Random access, read or write memory and nondestructive read-out.



The 512 word, 15 bits/word system's read-cycle time is 1μsec, and its write-cycle is 4μsec. Multi-aperture ferrit cores operate in a reversible flux-change mode during the read operation, and in an irreversible mode during the write operation. Because of the system's modular construction, the memory capacity can be increased in multiples of 512 words up to 4096 words, and in word lengths up to 60 bits. Portions of the memory can be reserved for semipermanent, nonvolatile storage if required. Westinghouse Air Arm Div., P.O. Box 746, Baltimore 3, Md.

Circle 273 on Inquiry Card

MINIATURE COUPLINGS

Designed for 1/16 to 3/8 inch test shaft connections.

Coupling and collet sets provide immediate test connections for commonly used shafts between 1/16 and 3/8 in. dia. for speeds up to 30,000RPM. Set No. 808 has 2 center couplings with 6 pairs of hardened aluminum and fitting collets for 1/16, 3/32, 1/8, 5/32, 3/16, and 1/4 in. dia. shafts. A very flexible bellows center is used for torques below 140gm-cm. Set No. 808 is for very small servos and synchros and delicate torque tests for speeds to 25,000RPM. Set No. 816 is for oz.-in. work on low FHP tests. Power Instruments Inc., 7352 N. Lawndale Ave., Skokie, Ill.

Circle 274 on Inquiry Card

NEW PRODUCTS

PHOTOCONDUCTOR CELLS

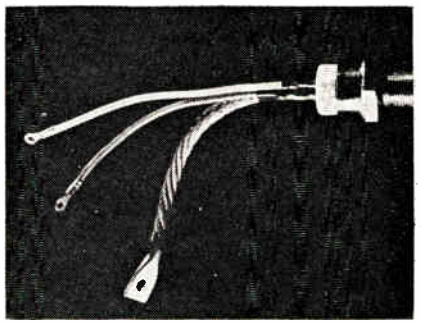
Six high sensitivity cadmium sulphide photoconductor cells.

Units are of the T-4 (½ in. dia.) size and offer cell resistances (at 2 FC) from 750 through 16,000Ω. Cell design feature true hermetic sealed-in-glass construction and a visual indicator that responds if the envelope becomes damaged and moisture enters the component. Type numbers are: 8347, 8143, 8100, 8346, 8142, and 8345. Other electrical characteristics include a dissipation rating of 300mw; a voltage rating of 400v; and an amb. operating temp. range of −40° to +70°C. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 275 on Inquiry Card

150-AMP TRINSISTOR

Type 200 supplied in forward-blocking voltages through 400v.



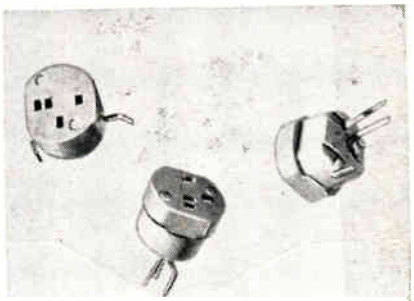
This high-current controlled rectifier is rated 150a at 180° conduction and at a case temperature of 85°C. The RMS rating of the device is 235a. In addition to the high-RMS current rating, the device features a 3500a surge rating. It is of Rock-Top ceramic construction and features fatigue-free, hard-solder construction, low thermal impedance, and high-peak reverse voltages. Designed for high-power applications in industrial and military equipment in inverters, converters, and freq. changers. Westinghouse Semiconductor Div., Youngwood, Pa.

Circle 276 on Inquiry Card

NEW PRODUCTS

TRANSISTOR SOCKET

Accept TO-2 in-line and TO-5, -18, -30 and -46 triangular arrangements.

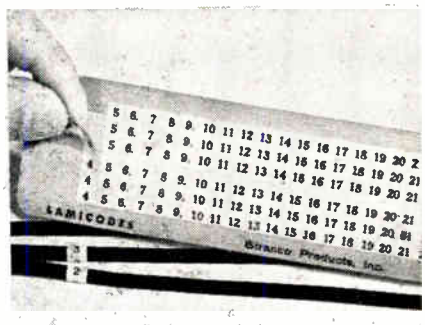


Sockets are generally furnished in mica-filled phenolic and are also available in general purpose material. Alternate terminal lengths of 3/16, 19/64, and 1 1/16 inch permit a socket to be hand wired with conventional soldering methods, circuit board mounted on close centers, or used with leads which can be used as jumpers to fit special assembly considerations. Provide maximum flexibility in equipment design and field replacement. Methode Mfg. Corp., 1700 Hicks Rd., Rolling Meadows, Ill.

Circle 306 on Inquiry Card

WIRE MARKERS

Mylar™ face makes for permanent legend, resistant to grease and oil.



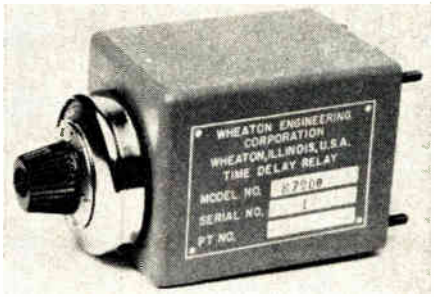
LAMICODES have a legend which will not rub off, yellow, or soak up oil and grease. Markers have high tensile and tear strength, in addition to high temp. resistance and dielectric strength. Resist water and moisture, acids, alkalies, solvents, and stay put over a temp. range from —50° to 400°F. Mounted on handy, release-coated dispenser cards. Available with numbers, letters, symbols, abbreviations and machine tool designations. Stranco Products, Inc., 1532 W. Van Buren St., Chicago 7, Ill.

Circle 307 on Inquiry Card

NEW PRODUCTS

TIME DELAY RELAY

Dial adjustable time delay up to 1000 sec. ±5%.

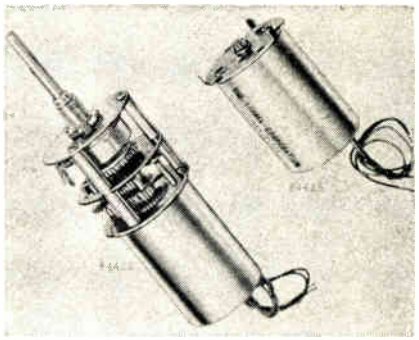


After time is dialed, lock the micro dial and time either on pick up or drop out with the Wheaton E790 or E791. Designed for use where different settings are required, or in laboratories for development of prototype systems. Available in 4PDT arrangement for up to 10a resistive at 32vdc and/or 115vac. Continuous duty with maximum recycle of 0.025 sec. Units are protected from transient spikes. A wide range in this line of time delay relays is available. Wheaton Engineering Div., Hurletron Inc., 920 Manchester Rd., Wheaton, Ill.

Circle 277 on Inquiry Card

MOTORIZED POTENTIOMETER

Features low level mechanical and electrical noise.

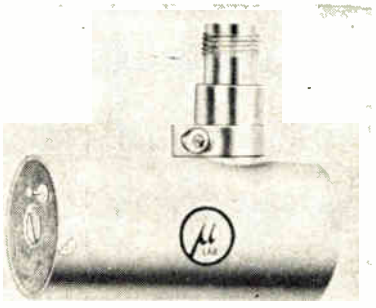


When the motor is de-energized, the shaft of the gear train of the potentiometer is disconnected from the drive system by a clutch coupling. Pots are to customer specs. Applications include: industrial controls; instrumentation; and displays. Specs. are: operating voltage is 6, 12, 24, 117vac or as specified—external capacitor must be used for operation and reversing; max. power input is 7.5v-a.; RPM is 6; and units are compact and light weight. Special Products Div., The Lionel Corp., Hoffman Place, Hillside, N. J.

Circle 279 on Inquiry Card

CAVITY OSCILLATORS

Light weight line cover from 960 to 5900MC.

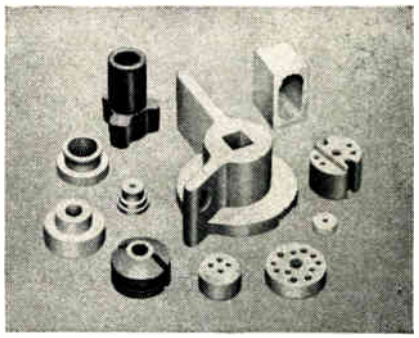


Four units, each within 10% tuning range are available. Designed around a ceramic triode for use in local oscillators, and CW signal sources. Cover C, S, SL, and L bands. The units varying in weight from 3.0 oz. to 6.0 oz. Tuning is accomplished by means of a single screw adjustment. Model EA4001—5400 to 5900-mc. power output of 5mw min. Model EA3002—2700 to 3000mc, power output of 50mw min. Model EA2003—1800 to 2000mc, power output of 30mw min. Model EA1003—960 to 1040mc, power output of 100mw min. Microlab, Livingston, N. J.

Circle 278 on Inquiry Card

PRECISION PARTS

Injection molded steatite and high alumina ceramic parts.

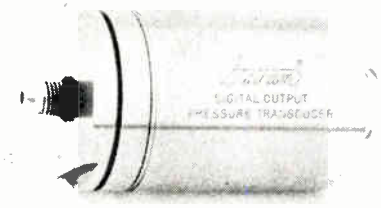


This injection molding process permits intricately shaped parts at lower costs due to the elimination of secondary finishing operations, with the assurance that all parts will be exactly the same size and shape. Products requiring extremely close tolerances can be provided by this process. A max. tolerance of 0.001 is routine. Products now available are industrial thread guides, spray nozzles, electrical insulation and small electronic parts. Technical Ceramics Div. of Centralab, The Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Circle 280 on Inquiry Card

PRESSURE TRANSDUCER

A high performance digital output pressure transducer.

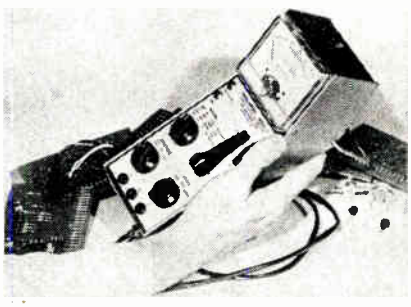


Model P606 converts pressure into a 7-bit unambiguous binary code output which divides the pressure into 128 discrete parts. The output can be read visually or it can be fed directly into a magnetic tape system, typewriter system, etc. Measures pressures from 0.1 psi through 0-1000 psi FS; absolute, gate, and differential. Size is approximately $1\frac{3}{4}$ x $3\frac{3}{8}$ in. Combined non-linearity and hysteresis is less than ±1% FS. Input is 1 to 10v; output is a 7-bit binary code, 1 to 10v. Stathem Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 281 on Inquiry Card

SEMICONDUCTOR TESTER

Portable instrument tests semiconductors in-circuit.



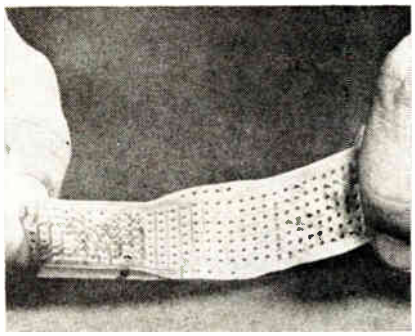
Circuit resistances down to 20Ω may be balanced for evaluating low and high power transistors or diodes. Saturation or forward resistance is measured in circuit with 5% accuracy at 5, 50, or 500 milliamperes by a simple, two-step sequence. The unit will also measure dc current gain and leakage out-of-circuit with 3% accuracy. Another feature is that it supplies a gate signal for testing or forward resistance is measured in-circuit Transistor Tester also measures dcβ and leakage out-of-circuit. Test Equipment Corp., P.O. Box 13185, Houston 19, Tex.

Circle 282 on Inquiry Card

NEW PRODUCTS

MINIATURE CONNECTOR

Pre-fab. system imbedded in plastic insulating material.

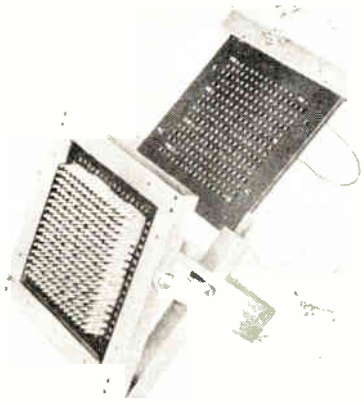


Called Intercon®, the pre-fabricated circuitry was developed to meet demands for smaller interconnecting devices for computers and other electronic systems. Little pins are actually nickel tabs that permit them to be welded. Intercon is used with both rigid and flexible insulating materials or combinations of both. Other materials, including ceramics, also may be used. Amphenol Connector Div., Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle 283 on Inquiry Card

PROGRAM BOARD

For use in computers, data processing and business machines.

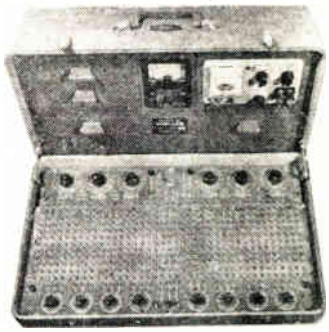


Called LOCKPATCH, it has been designed with locking terminals making it virtually impossible to pull out any cord accidentally, minimizing the hazard of handling already wired boards. Overall, the system consists of 2 insulated terminal boards, one fixed, the other removable, plus plug-in cords, and a hinged receiver to bring the 2 boards into contact. Major features are: positive locking of program; quick interchange of programs; lightweight for fast, easy programming; and high resistance insulation. Oak Manufacturing Co., Crystal Lake, Ill.

Circle 284 on Inquiry Card

BREADBOARD

A general purpose test instrument and circuit breadboard.

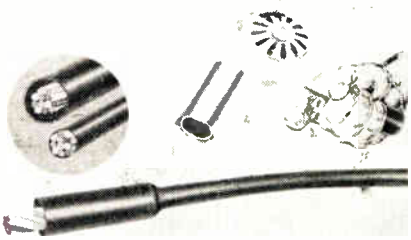


Equipped with 1 or 2 highly regulated power supplies, high impedance multimeter, with selection of built in components and linear pots for general use. The Solid State Circuit Lab. contains 560 miniature spring loaded jacks connected on busses and tie points for rapid hook-up of circuitry, components and solid state modular systems. Accessories include a supply of expendable plugs, flexible leads, short circuit jumpers, and socket adapters for transistors and for other components. Stanley Aviation Corp., 2501 Dallas St., Aurora, Colo.

Circle 285 on Inquiry Card

SHRINKABLE PVC TUBING

Simplifies jacketing of custom or short run prototype cables.

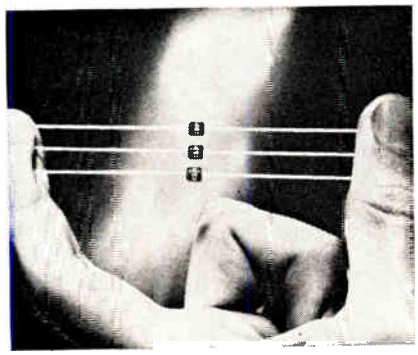


FIT-105 tubing is a modified PVC tubing meeting Mil-I-631 C, grade C specs. and shrinks down to ½ of its expanded dia. when heated to 325°F (163°C). Because of this shrinkage in dia., cable cores may be pulled through with relative ease and the tubing then shrunk down to form a tight-fitting flexible jacket with the strength and characteristics of the finest extruded plastic jackets. Resistant to fuel, oil, hydraulic fluid and solvents. Available in black, sizes 3/64 to 4 in. (min. I.D. before shrinking). Alpha Wire Corp., 200 Varick St., New York 14, N. Y.

Circle 286 on Inquiry Card

SUBMINIATURE RECTIFIER

Provides 1000ma @ 50°C; PRV range of 200 to 1000v.

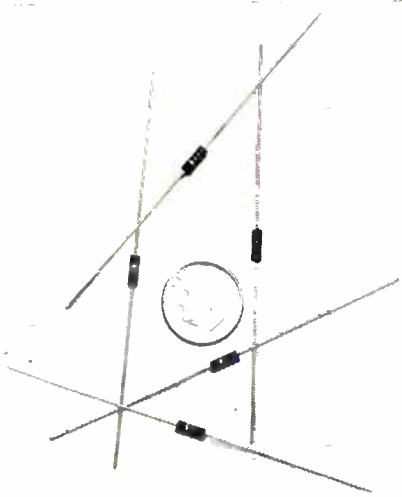


This series of silicon rectifier power packs are so small (0.150 x 0.150 in. dia.) that more than 200 units will fit into a cubic inch (not counting leads). Use advanced diffusion and encapsulation techniques to provide full-rated 1000ma dc output @ 50°C over a peak reverse voltage range from 200 to 1000v PRV. Reverse current is to 2ua @ 25°C at rated PRV with forward voltage drop of 0.90v @ 25°C at rated current. Pure silver 0.032 in. dia. leads increase heat dissipation. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 287 on Inquiry Card

¼ WATT RESISTOR

Line of ¼w fixed composition units offered.



Offered in standard values from 10Ω to 1meg, meeting all requirements of Mil R11D. Tolerances of 5, 10 and 20% offered. Load life tests for 3000 hrs. under full wattage dissipation at 70°C show changes on the order of 0.40 to 1.4% in resistance value. Body length of the ¼ watt resistors is 0.250 in. ±0.031 in. and diameter 0.090 in. ±0.008 in. Axial lead wires are #22 tinned copper 1.5 in. ±0.125 in. long. Speer Carbon Co., Theresia St., St. Marys, Pa.

Circle 288 on Inquiry Card

NEW TECH DATA

for Engineers.

LAMPS, INDICATOR LIGHTS, ILLUMINATED SWITCHES

Annunciator Systems

"Short-Form Selection Guide" covers hermetically-sealed, relay-type and solid-state annunciator systems. The 2-color folder-wall chart covers the various systems, sequences, and cabinet styles available. Dimension drawings are given for standard cabinet types which comprise both nameplate and bullseye signal-lamp configurations. Panellit, A Div. of Information Systems, Inc., 7401 N. Hamlin Ave., Skokie, Ill.

Circle 160 on Inquiry Card

Indicator Lights

Catalog C6102, 32 pages, contains comprehensive information on indicator light assemblies; lampholders; and special assemblies, for pilot-dial and indicating uses. How to order miniature lamps and indicator lights, information on electrical and physical characteristics is included along with outline drawings of indicator light assemblies, lenses, hardware, and mounting brackets. Information is also included on "Telslide" indicator lights for telephone slide base lamps and "Tinylite" midget screw indicator lights which mount in 7/16 or 15/32 in. holes on panels up to 9/32 in. thick. Drake Mfg. Co., 4626 N. Olcott Ave., Chicago 31, Ill.

Circle 161 on Inquiry Card

Subminiature Lamps

This catalog entitled "Tung-Sol Precision Subminiature Lamps for Read-Out and Indicator Applications" gives specifications, outline drawings and filament construction for Tung-Sol's line of subminiature wire lead and metal base type lamps. Tung-Sol Electric Inc., Newark 4, N. J.

Circle 162 on Inquiry Card

Wiring Diagrams

Bulletin 800-800T, 11 pages entitled "Push Button Wiring Diagrams" includes a glossary of symbols and wiring diagrams for such circuits as: one station; multi-station; pilot light; push-to-test pilot lights; maintained contract buttons; master stop buttons; circuits; reversing station circuits; speed indicating pilot light circuits; thermostat and selector switch circuits; and push-to-test for ground detection circuits. Also included is information on oiltight push button stations and units for rugged applications. Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee 4, Wis.

Circle 163 on Inquiry Card

Illuminated Switches

Catalog No. 306 contains photographs, dimensional drawings and complete descriptions on the Series 700, 8000, 17000, 18000 and 2100 and 22000 Multi-Switch units and the Series 5000, 5000L, 150000 and 15000L Push-Push Button Switches which are available with solenoid release, lock-out bar, twin latch bar, etc. interlocks. Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill.

Circle 164 on Inquiry Card

Read-Out Design Kit

The Read-Out-Message Designer's Kit aids engineers in finding out the full display possibilities of rear projection one plane readouts. Consists of four sheets: a translucent parchment tracing sheet with outlines of screens and guidelines; terminal sheet for determining character height, color and background color for each of the 12 lamps in the readout; Bina-View character spec. sheet for selecting messages of up to 6-bit binary coded inputs; and type sample sheet showing most readable and commonly used type faces. Industrial Electronic Engineers, Inc., 5528 Vineland Ave., N. Hollywood, Calif.

Circle 165 on Inquiry Card

Illuminated Switches

Tech. data is available on lighted push button switches and display modules including 1, 4 and 6 lamped types. Also included is a glossary on precision snap-acting switch. Included are photographs and dimensional drawings. Haydon Switch Inc., Waterbury 20, Conn.

Circle 166 on Inquiry Card

Neon Indicator Light

Tech. data is available on the AMPILLUME™ Neon Indicator Light which features a nylon housing and lens, a 25,000 hr. bulb operating life and mounts in standard 0.514 to 0.519 mounting holes. Amp Inc., Harrisburg, Pa.

Circle 167 on Inquiry Card

Indicator Lights

Catalog B10-61, 6-pages, entitled "B-Lites" covers low cost miniature indicator lights for commercial and military applications. Catalog No. E11-61, 11-pages, "E-Lites," features comprehensive information on miniature neon and incandescent indicators with permanent lamps which mount in a 3/8 in. dia. hole from the rear of the panel. Catalog CD5-62, 19 pages covers "C-Lites and D-Holders," which are replaceable miniature neon and incandescent panel lamps and holders designed to military spec. C-Lites are the replaceable lamp cartridge indicators. Eldema Corp., 1805 Belcroft Ave., El Monte, Calif.

Circle 168 on Inquiry Card

Illuminated Switches

Eight pages of tech. data is available on AMF's Series 1000 Indicator Push-Button Switches available in pre-assembled matrice units to meet a wide variety of specs; Series 2000 Illuminated Push-Button Switches which give shadow-free color in all light conditions and up to 4 colors in one unit; Series 7000 Illuminated Panel Indicators; AmFlite brochure and Data Sheets 7000 and 2000 are available from AMF Instrument Div., American Machine & Foundry Co., P.O. Box 929, Alexandria, Va.

Circle 169 on Inquiry Card

Indicator Lights

This 40-page catalog contains photographs, dimensional drawings and complete physical, electrical and environmental specs, along with applicable Mil and federal specs. and ordering information on the TNR Series transistorized Nixie® readout; the MTL Series Mini-Lite Indicators; transistor-controlled TIL and LVN Series incandescent lite (with replaceable lamp) and low voltage neon indicator lite; transistorized button-lites; miniature button-lites; button switches; replaceable lamp display-lites; replaceable lamp assemblies; miniature front mounting lites; and information on hot stamped legends for "TEC-Lite" indicator lenses and switch buttons; Transistor Electronics Corp., Box 6191, Minneapolis 24, Minn.

Circle 170 on Inquiry Card

Illuminated Switches

Tech. data is available on the 2a and 15a type, 125vac, Press-Lite Lighted Button Switches. Switching is SPDT, maintained contact for both models; the 2a model mounts in a 9/16 in. hole and the 15a model mounts in a 3/4 in. hole. Oak Mfg. Co., Crystal Lake, Ill.

Circle 171 on Inquiry Card

Illuminated Switches

This 25-page catalog contains photographs on a wide selection of button and lever switches with outline drawings and characteristic charts on illuminated single and multiple position; interlock push button; push-lock push release; momentary; telephone lever; push-turn-lock; single hole mounting; and accumulative locking illuminated switches. The Capitol Machine and Switch Co., 36 Balmforth Ave., Danbury, Conn.

Circle 172 on Inquiry Card

Lamps

Tech. data is available on Sylvania's electronic indicator lamps and sockets. Information covers short base, telephone slide-base indicator lamp, selection of plastic color caps, the Multi-Socket Strip, and Sylvania's Easy-Mount Single Socket. Sylvania Electric Products, Inc., Lighting Products Div., 60 Boston St., Salem, Mass.

Circle 173 on Inquiry Card

Illuminated Switches

Catalog 67d, 19 pages, entitled, "Series 2 Lighted Display and Pushbutton Switch Devices" includes a comprehensive amount of lighting and panel layout information with a split page feature allowing operator indicator style to be lined up with any switch unit for quick comparison of details, dimensions and capacities. Sections are also included on a wide selection of display screens; human engineering in panel design; and filters, their color significance and special effects. Micro Switch, div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 174 on Inquiry Card

NEW TECH DATA

for Engineers.

LAMPS, INDICATOR LIGHTS, ILLUMINATED SWITCHES

Indicator Lights

Tech. data is available on the sub-sub-miniature indicator light which conforms to MS25446 requiring only 0.193 in. of panel mounting clearance hole. Information is also included on ultra-miniature idicator light's (Datalight®) which use the 100,000 hr. G.E. lamps conforming to MS24367. They mount in 3/8 in. clearance hole from the back of the panel and are available in a wide variety of colored lenses. Also offered is Catalog L-169 entitled Sub-Miniature Illuminated Push-button Switches and Matching Indicator Lights. These lights feature single hole mounting with interchangeable caps. Included are full colored photographs of the units and the available lens caps in both square and round configuration in 1 and 2-color effects. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 175 on Inquiry Card

Illuminated Switches

Bulletin 7000 includes photographs, outline drawings, and specs. on the Series 7600-7700 non-illuminated and Illuminated Push Button Switches. Construction provides for interlocking action between stations in a single row assembly of 4 to 12 stations. Each button depressed releases any previously operated station and locks in the operated position. Donald P. Mossman, Inc., P.O. Box 265, Brewster, N. Y.

Circle 176 on Inquiry Card

Miniature Lamps

This 12-page catalog features spec. for miniature and subminiature incandescent lamps. Includes actual size dimensioned illustrations and also shows candle power values for all types listed. An expanded line of subminiature lamps, including Tu-Pin types, along with sections on lamp terminology and miniature lamp selection are also covered. Hudson Lamp Co., 528 Elm St., Kearny, N. J. *Write on Company letterhead.*

Illuminated Switches

The Lighted LPS Push Button Switch includes all the features of the reliable SPS series with the addition of lighted buttons. The lamps can be installed or changed from the front without use of tools, and may be wired to operate independent of the switching action. Behind panel depth is 4¼ in. General Control Co. 1200 Soldiers Field Rd., Boston 34, Mass.

Circle 177 on Inquiry Card

Illuminated Switches

This 3-color, 4-page brochure, "Illuminated Computer-Type Switches," gives detailed information on this unit which can be used as a maintained contact or momentary contact switch, or as an indicating light. Designed for ac, dc, and dry circuits. Cutler-Hammer, 315 N. 21st St., Milwaukee 1, Wis.

Circle 178 on Inquiry Card

Miniature Lamps

This 27-page catalog, "Miniature Lamps Types-Sizes-Specifications-Applications" covers miniature lamp selection factors, filaments, bases, bulb shapes, specifications for standard lamps and indicator lamps, and a comprehensive quick study on glow lamps. Included are filament diagrams, base photographs and bulb shaped photographs with a complete listing of General Electric's miniature lamps for operation on from 1.2 to 120v for incandescent types; and neon types for operation on from 105 to 125vac (standard and high brightness types). Also included is a 7-page article on "Glow Lamps as Circuit Control Components," covering response time, useful life, external effects, effects of aging, temp. effects, runaway characteristics, voltage differential and information on pulsed and voltage regulation circuits. General Electric, Miniature Lamp Dept., Nela Park, Cleveland 12, Ohio.

Circle 179 on Inquiry Card

Indicator Lights

Tech. data is available from The Sloan Co., 7704 San Fernando Rd., P. O. Box 367, Sun Valley, Calif. on: sub-miniature incandescent lamp holders; sub-miniature fixed bulb indicator lights; ultra-miniature indicator lights; the model 801 Lit-Switch (a lighted push button switch); and 2-terminal sub-miniature lampholders. Specs. and photographs, plus outline drawings are included.

Circle 180 on Inquiry Card

Illuminated Switches

Tech. data is available from the Westinghouse Electric Corp., Standard Control Div., Beaver, Pa., on their General Purpose Pushbutton Switches, standard and heavy duty types for service and flush mounting and rugged environments, and their Oil-Tite Pushbutton Type OT1 for use where liquids present a problem. Included are photographs, specifications, and descriptions.

Circle 181 on Inquiry Card

Indicator Lights

This 36-page catalog contains photographs, dimensional drawings, and electrical and mechanical specifications on Mil spec color coated lamps; lighted pushbutton switches; indicator lights; annunciator panels; and sub-miniature indicator lights and assemblies. Jay-El Products, Inc., 1845 W. 169th St., Gardena, Calif.

Circle 182 on Inquiry Card

Illuminated Panel

Tech. data is available on the Astromatic panel concept which features instant visual control with high accuracy, reduces human error and simplifies highly complex operations, besides giving space savings. Astromatic Div., Electrosnap Corp., 4218 W. Lake St., Chicago 24, Ill.

Circle 183 on Inquiry Card

Illuminated Switches

Bulletin 54-B, 6-pages, gives complete data on the QUADLITE, a 4-lamped push button switch which can give up to 9 different indications. Photographs, outline drawings and specs. are included on both flange and barrier mounting models. Bulletin 55-B is also offered on the TWINLITE, a lighted push button panel switch offering increased reliability with 2 lamps per split screen. Controls Co. of America, Control Switch Div., 1420 Delmar Dr., Folcroft, Pa.

Circle 184 on Inquiry Card

Indicator Lights

"Wall Guide to standard Alden Testing and Sensing Components" includes photographs, dimensional drawings, chart of most commonly used molding materials, on Alden Pan-i-Lites (indicator lights) and Pan-i-Lite Switch (illuminated switch). Also included are indicating fuseholders, safety fuseholders, test jacks, prod and jumper pair, phenolic test prod and patch cord. Alden Products Co., 3172 N. Main St., Brockton, Mass.

Circle 185 on Inquiry Card

Illuminated Switches

Catalog No. M-3, "Illuminated Indicator Push Button Switches," 9-pages, full color, includes photographs, outline drawings, and descriptions on Marco's wide line of lighted switches. Data covers legend plate styles, color selection, lamp selection, mounting and finish specs., switch action and size information. Marco Industries Co., 207 S. Helena St., Anaheim, Calif.

Circle 186 on Inquiry Card

Indicator Catalog

This catalog, over 100 pages, includes many illustrations in full color. It contains complete information on press-to-test indicators, fixed indicators, switch light indicators, flush mounted indicators, edge lights, lamp sockets, multiple panels, and interlocking keyboards. Included is information on bases and caps, legend plates, panels, sockets, keyboards, and ordering information. Korry Mfg. Co., 223 8th Ave., No., Seattle 9, Wash.

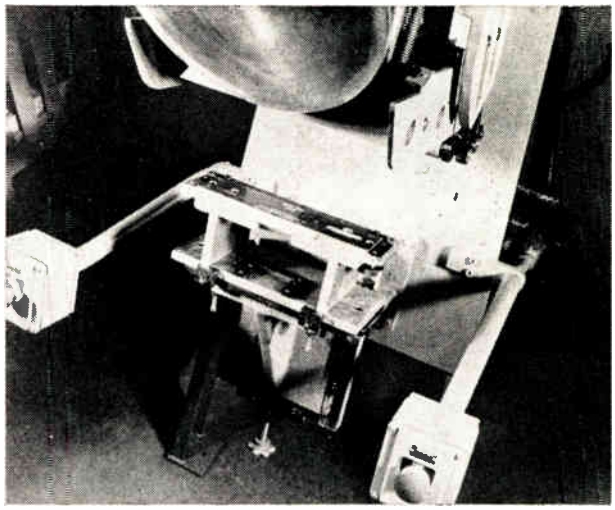
Circle 187 on Inquiry Card

Documentary in Sound

Raybestos-Manhattan, Inc., Passaic, N. J., is offering a high fidelity 12 in. record entitled, "The Space Age/The Age of Reliability." The record traces the development of the space age in America from the first rudimentary experiments in rocketry to the present Moon Shot program. Over 75 authentic sounds of the times are included. *Write for the record under company letterhead.*

Marking Panels

ONE OF THE COUNTRY'S LEADING DEVELOPERS and manufacturers of advanced FM and time-division-multiplex telemetry systems and other communication equipment, Electro-Mechanical Research, Inc., now identifies their panels, chassis and terminal boards with high production, direct marking equipment in their own plant. Production can average as many as 2500 pieces per day; and, the identification required ranges from fairly standard front panel



marking to imprinting individual serial numbers on each unit. Piece sizes range from about 1½ in. square to 19 in. x 19 in.

Lloyd A. Manus, EMR's Components Fabrication Department Manager, compares previous and present identification methods with the comment that "when we had our panels and chassis screen-printed by an outside printer it gave us the quality we needed, but made it necessary for us to plan our specific production needs for two or three weeks ahead. This made identification changes difficult after we had done our planning and sent a batch of panels to the printer. Continual delays in delivery slowed down our production. In addition, the serial number and other variables on some of the panels still had to be silk-screened in an entirely separate operation."

Mr. Manus also said that with their Markem Model 103 AE machine, EMR achieves the imprint quality they need to meet military specifications for readability and durability. To get this imprint quality, the operator normally lets the machine cycle two or three times for each piece. This causes the imprint to stand out even more when the cycle is repeated, giving the heavy coverage typical of screen process printing. The particular white used for the lettering was chosen for its good readability with the medium-gray panels.

To print serial number and other variable informa-

tion, the operator merely changes cast metal, rubber-faced type inserts in the Masterplate—a plate slotted to accept type inserts in the arrangement required. Changing inserts takes less than a minute. Another feature that EMR finds useful is the machine's ability to print flat surfaces recessed to a depth of 1¼ in.

By purchasing their own machine, type and ink, EMR saves the entire cost of outside labor with additional savings in production down time. They also have complete control over production output with more flexibility to meet last minute changes in identification specifications.

(Left) Type inserts change to print variable information such as serial numbers. (Right) Lettering obtained with the Markem 103 AE printer is crisp on this EMR Sub-carrier Discriminator.

MORE PRECISE DATA on power supplies and microwave instrumentation is the goal of two new groups set up within the Scientific Apparatus Makers Association (SAMA). The two separate groups will collect market data and establish standards of performance, in addition to alerting government agencies to the need of promoting specifications and terminology.

NEW TECH DATA

for Engineers.

Field-Effect Transistors

"How to Choose the Best Field-Effect Transistors for AC Amplifiers," includes formulas, diagrams, characteristic charts, and schematics, plus a definition of terms. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.

Circle 188 on Inquiry Card

Zener Diodes

Two bulletins describe 50w silicon zener voltage regulator diodes for electronic and electrical power systems. Bulletin 6.355 describes stud-mounted units (JEDEC DO-5 case). Bulletin 6.356 covers diamond-shaped transistor package units (JEDEC TO-3 case). Fansteel Metallurgical Corp., Rectifier-Capacitor Div., No. Chicago, Ill.

Circle 189 on Inquiry Card

Microwave Devices

Tech. data is available on Hyletronics' line of microwave switches and limiters, ferrite devices including freq. selective YIG limiters, tetrahedral switches, 3-port circulators, 3-port circulator switches and filters, telemetry diode switching network, a phase comparison module, monopulse comparators, and a 5-port S-band ferrite circulator. Hyletronics Corp., 185 Cambridge St., Burlington, Mass.

Circle 190 on Inquiry Card

Integrated Circuits

A complete reliability report summarizing the results of tests performed on 365 Series 51 SOLID CIRCUIT™ semiconductor networks is available from Texas Instruments Incorporated, Dept. 504-1A, P.O. Box 5012, Dallas 22, Tex. Information covers environmental tests, life tests, and step-stress tests.

Circle 191 on Inquiry Card

Plastics Catalog

This condensed catalog lists general information about Synthane and its fabricating services, as well as standards for Synthane laminated sheets, rods and tubes. Characteristics and properties of a few of the many grades of Synthane sheets are listed in a condensed table. Synthane Corp., Oaks, Pa.

Circle 192 on Inquiry Card

Piezoelectric Ceramics

"Modern Piezoelectric Ceramics," 12 pages, is illustrated with drawings, photographs and graphs and offers complete tech. data on Clevite's piezoelectric ceramics PZT-4, PZT-5 and Ceramic B. Charts and tables compare properties, illustrate basic piezoelectric actions, list ceramic shapes available "off the shelf" and provide the reader with useful reference guides to resonant freqs. and common MKS/English conversions. Also included is a bibliography on piezoelectricity and piezoelectric ceramics. Clevite Electric Components, 232 Forbes Rd., Bedford, Ohio.

Circle 193 on Inquiry Card

Power Transistors

Tech. data on silicon power transistors with ratings to 30a and 300v is available from Westinghouse Semiconductor Div., Youngwood, Pa. Max. ratings for 36 JEDEC types are presented in easy-to-read tabular form. Typical characteristics of the 2N1830-1833 and the 2N2130-2133 series are presented in 8 graphs. Technical Data TD 54-662, pages 1 thru 12 and 13 and 14 are offered.

Circle 194 on Inquiry Card

Bobbin Cores

Catalog 21-1 introduces a completely new version Bobbin Core, said to be the first manufactured by automation. Included are explanation of process and advantages resulting from automated production. Information on over 200 Bobbin Cores is included. Infinetics, Inc., Electro-Magnetic Div., 1601 Jessup St., Wilmington 2, Del.

Circle 195 on Inquiry Card

Noise Figure Discussion

An 8-page Application Note defining noise figure and how it may be measured is available from Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. Application Note No. 57 covers noise figure measurements with a signal generator; the noise source as a broadband signal generator; noise figure measurements with an excess noise source; networks in cascade; and accuracy considerations.

Circle 196 on Inquiry Card

Wire Wrapping

Data is available on HarnessRAP a spiral wrapping for flexible electrical harnesses, cables or groups of leads or conductors. HarnessRAP is easy to apply (twists on) and is easy to remove. Richco Plastic Co., 3722 W. North Ave., Chicago 47, Ill.

Circle 197 on Inquiry Card

Reed Relays/Choppers

Three series of standard reed relays and special reed relays along with chopper series MCP are described in tech. data available from Wintronics, Inc., 1132 So. Prairie Ave., Hawthorne, Calif. Dimensional drawings, schematics, contact data and standard specs. are included.

Circle 198 on Inquiry Card

Superconductive Wire

"Superconductive Wire," Data Memorandum No. 3, covers a new composite superconductive wire which has considerably higher field strengths than solid zirconium-columbium wire and can be used at temps. as high as 18.5°K. Materials, size range and lengths are given for both and single and multiple sheath finish wire sizes and for single and multiple sheath redraw sizes for further conversion. Superior Tube Co., 1614 Germantown Ave., Norristown, Pa.

Circle 199 on Inquiry Card

Vacuum Equipment

Ultek High Vacuum Equipment catalog, 60 pages, 2 colors, includes charts of ultra high vacuum pumps; electronic pump power supplies; sorption devices; connectors; valves and fittings; and high vacuum accessories. Comprehensive specs. along with photographs are also included on high vacuum octal feed through devices; ultra high vacuum gate valves; bells, jars, guards and gaskets. A bibliography of articles on high vacuum is also included. Ultek Corp., 920 Commercial St., Palo Alto, Calif.

Circle 200 on Inquiry Card

Power Supply

Tech. data is available on the Model TVR040-5 Programmable DC Power Supply offering 0-40v and 0.5a. Complete specifications are included. Perkin Electronics Corp., 345 Kansas St., El Segundo, Calif.

Circle 201 on Inquiry Card

Speed Control with SCRs

Versatile adjustable speed controls for shunt dc motors using silicon controlled rectifiers and packaged control circuitry are described in Tech. Paper VTP-2, available from Vectrol Engineering, Inc., a subsidiary of Sprague Electric Co., 93 Magee Ave., Stamford, Conn. Some 10 circuits for motor control, together with complete tech. information on how to use them are included.

Circle 202 on Inquiry Card

Plastic Handbook

This 16-page engineering handbook includes complete information on Spaulding's various grades of laminates, copper clads, vulcanized fibre, fibre boards, transformer boards, insulation and gasket papers, glass filament wound epoxy structures, as well as detailed data on Spaulding's value analysis service. Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N.Y.

Circle 203 on Inquiry Card

Film Resistor Chart

Mepco, Inc., 35 Abbett Ave., Morristown, N.J., is offering a wall chart listing Mil-R-10509-D specification summaries and environmental test limits for precision film resistors. The specs. summary lists Mil styles with wattage ratings, tolerances, temperature coefficients, voltage, zero derating temps. and physical dimensions as spelled out in Mil-R-10509-D. Printed in 2 colors on heavy paper, suitable for wall mounting.

Circle 204 on Inquiry Card

Impregnating Varnish

Data Sheet 07-023 describes Dow Corning's 997 varnish, a silicone impregnating varnish useable in 180 C and 220 C insulation systems and as a moisture resistant cooling for motors, solenoids, transformers, and servos. Uses and properties are included. Dow Corning Corp., Midland, Mich.

Circle 205 on Inquiry Card

Digital Modules

This 80-page illustrated catalog contains a comprehensive listing of EECo T-Series and CT-Series transistorized digital circuit modules. Included are descriptions, spec. tables, schematic drawings, symbols, loading information, and details covering related equipment, as well as ordering and price information. Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif.

Circle 206 on Inquiry Card

Ceramic Capacitor

Tech. data is available on general purpose VK® axial ribbon lead ceramic capacitor. Two types: VK 22 and VK 32, have unit capacitances from 10 to 10,000pf with 10 and 20% tolerances and offer a package density up to 1.5 million parts/cu. ft. in encapsulated assemblies. The units meet the requirements of Mil-C-11015C. Vitramon, Inc., P. O. Box 544, Bridgeport 1, Conn.

Circle 207 on Inquiry Card

Power Supplies

Tech. data is available F1 Series DC Power Supplies which feature dc outputs from 1.0 to 5.0a from 5-7v to 34-36v in line of 16 models. Also included is information on the F2 Series DC Power Supplies featuring outputs of 1.0 to 5.0a at 5-7 to 34-36v (16 models), a line regulation of ±10mv and load regulation of ±20mv. Scintillonics, Inc., P.O. Box 701, Ft. Collins, Colo.

Circle 208 on Inquiry Card

Synchro Catalog

This catalog containing Bureau of Weapons type synchros size 08 to size 23 inclusive. It also lists the latest applicable Mil specs. with specific designation for each particular unit; over 45 types are listed. Norden Div., United Aircraft Corp., Norwalk, Conn.

Circle 209 on Inquiry Card

Patching Systems

Bulletin T-3 entitled, "Coaxial R.F. Video Patching Systems" describes, with numerous photographs and comprehensive specs., standard patching systems and accessories and miniaturized patching systems and accessories. Information is included: on metal and phenolic jack strips, patch cords, and special accessories; and on the miniature patch panels, patch cords, special accessories and Type TPS gold mating connectors. Trompeter Electronics, 7238 Eton Ave., Canoga Park, Calif.

Circle 210 on Inquiry Card

Encapsulated Circuits

Bulletin TB-300 includes tech. data on "milli-pak" encapsulated circuits. Units are available in a variety of configurations and include such packages as matched diode pairs, quads, ring and bridge modulators, bridge rectifiers and millidiode gates. Clevite Transistor, Waltham 54, Mass.

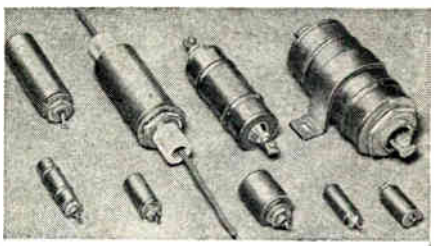
Circle 211 on Inquiry Card

Educational TV

The uses of 2,000MC freq. band for instructional TV by local school districts, colleges and universities is discussed in a 10-page paper available from Adler Electronics, Inc., 1 LeFevre Lane, New Rochelle, N.Y.

Circle 212 on Inquiry Card

Cylindrical Design keeps Interference Filters Small, Light, Efficient



Pioneered by the Sprague Electric Company in order to achieve the maximum reduction in physical volume and weight requirements, cylindrical-style radio interference filters follow the natural shape of rolled capacitor sections and toroidal inductors.

Threaded-neck mountings, for use on panel, bulkhead, or firewall, assure isolation between input and output terminals, as well as a firm peripheral mounting with minimum impedance to ground.

Sprague Cylindrical Interference Filters are of the popular low pass design, intended for use as three-terminal networks connected in series with the circuits to be filtered. The excellent interference attenuation characteristics reflect the use of Thrupass® capacitor sections.

Since maximum effectiveness of filtering involves elimination of mutual coupling between input or noise source and output terminals, these filters should be mounted where the leads being filtered pass through a shielded chassis or bulkhead. The threaded-neck mounting gives a firm metallic contact with the mounting surface over a closed path encircling the filtered line and eliminates unwanted contact resistance.

Because military applications have figured prominently in the development of these filters, Sprague has many designs which can help equipment engineers to bring apparatus into compliance with the requirements of Specifications MIL-I-6181, MIL-I-26600, MIL-I-16910, and MIL-I-11748.

With an extensive "library" of proven cylindrical filter designs available as standard catalog items, one of these can probably solve your next interference problem. Or, if special circumstances dictate special designs to meet unusual interference, rating, or space problems, the Sprague Interference Control Field Service Department is always at your service.

For additional information, write for Engineering Bulletin 8100A to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Circle 130 on Inquiry Card

NEW TECH DATA

for Engineers.

Field Effect Transistors

This 16-page folder gives tech. data on a broad line of silicon planar transistors, field effect transistors, and special assemblies. Information covers differential amplifiers, fast and very fast planar saturated switches, and small signal general purpose devices. Folder available from Amelco, Inc., 341 Moffett Blvd., Mountain View, Calif.

Circle 220 on Inquiry Card

Harness Tying System

The Ty-Rap system for tying, clamping and identification of harnesses and wire bundles is described in a 4-page folder available from The Thomas & Betts Co., Elizabeth, N.J. The Ty-Rap system is a harness assembly method based on adjustable cable ties and straps made of Zytel type 101 nylon which is said to reduce fabrication time by 50% or more.

Circle 221 on Inquiry Card

Antenna Systems

Photographs and data on large, precision antennas for satellite communications, target tracking, decoy discrimination, radioastronomy, telemetry, and space-communications research is available from Advanced Structures Div., Telecomputing Corp., 5159 Baltimore Dr., La Mesa, Calif.

Circle 222 on Inquiry Card

Semiconductor Tester

Tech. data is available on Fairchild's Series 500 Semiconductor Tester which features direct digital readout eliminating interpretation errors; simplified and quick digital programming; flexibility of test sequence and test types; and the ability to test transistors, diodes and zener diodes. Fairchild Semiconductor (Instrumentation), 844 Charles Rd., Palo Alto, Calif.

Circle 223 on Inquiry Card

Potentiometer Catalog

This 8-page engineering catalog is devoted to 1 potentiometer, the 15/16 in. dia., low carbon composition pot. designated the Model 2 Radiohm®. Engineering Bulletin 42-1081 includes illustrations and details dimensional drawings of 4 terminal types, 5 mountings, 10 shaft styles, and 5 switches that can be supplied. Complete electrical, mechanical, and environmental specs. are included along with left hand, right hand, and tapped resistance curves. Centralab, The Electronics Div. of Globe-Union., 900 E. Keefe Ave., Milwaukee 1, Wisc.

Circle 224 on Inquiry Card

Mounting Brochure

Bulletin No. 301 covering BTR (broad temperature range) elastomeric mountings for avionic equipment is available from Lord Mfg. Co., Erie, Pa. Included are dimension drawings, capacities, deflection charts, transmissibility curves, and materials and finishes specs.

Circle 225 on Inquiry Card

Photoelectric Scanners

Bulletin XP contains complete details on explosion-proof photoelectric light sources and photocell holders. They are designed to meet requirements for service under Class I Group D hazardous conditions. Scanning ranges, dimension diagram, detailed parts drawing, price list, and list of auxiliary equipment are included. Farmer Electric Products Co., Inc., Tech Circle, Natick, Mass.

Circle 226 on Inquiry Card

Microwave Components

Catalog 12 entitled "Microwave Components," includes comprehensive descriptions, characteristics, frequency charts, and full specifications on attenuators, preselectors, directional couplers, power dividers, filters, monitor tees, dc shorts, dc blocks, signal samplers, 729 components, tuners, terminations, crystal mounts, and crystal mixers. This 108-page catalog is available from Microlab, 570 W. Mount Pleasant Ave., Livingston, N.J.

Circle 227 on Inquiry Card

DC Solenoids

Bulletin No. PRB-31S, illustrated, describes a line of over 3000 models of Standard Linear D.C. Solenoids. The 10-page bulletin, in addition to the tabulated spec. data, describes design criteria and procedures for selecting solenoids. Tec Magnetics, 7742 Scout Ave., Bell Gardens, Calif.

Circle 228 on Inquiry Card

PM Motor Design

This 6-page engineering bulletin entitled, "Applying Indox Permanent Magnets to DC Motors" is available from Indiana General Corp., Magnet Div., Valparaiso, Ind. Bulletin 40 contains: performance curves showing differences in series; shunt and permanent magnet field motors; general considerations for Indox ceramic magnets; magnetic circuit configurations; design information; and magnetizing and test equipment.

Circle 229 on Inquiry Card

Mercury Decontaminant

Tech. data is available on HgX, a water soluble metallic-mercury-sulphide converting powder in combination with a chelating compound and dispersing agent, for protecting workers against mercury poisoning. Also offered is a wall chart entitled "Protection Against Mercury Poisoning" which lists 10 major points which should be watched when using mercury, plus a section on antidotes. Acton Associates, 1180 Raymond Blvd., Newark 2, N. J.

Circle 230 on Inquiry Card

Epoxy Casting Resin

Data is offered on Stycast 2651-40, easy to use, low viscosity, epoxy type casting resin with high adhesion to metals, plastics and ceramics. It is stable from —100 to 350°F. Emerson & Cuming, Inc., Canton, Mass.

Circle 231 on Inquiry Card

Integrated Circuits

"Signetics Condensed Catalog" gives diagrams, max. ratings and characteristics on compatible functional electronic blocks: DTL NAND/NOR gate; DTL Binary Element; a DTL Exclusive-OR Network; DTL Buffer; Diode Array; and transistor coupled NAND/NOR gate. A second catalog, "Signetics Process Control," details the 45 steps in the manufacturing process via a flow chart, with microphotographs, cross-sectional drawings and precision masking, diffusion, assembly process control and reliability testing photos included. Signetics Corp., Integrated Circuits, Dept. 3410, 680 W. Maude Ave., Sunnyvale, Calif.

Circle 232 on Inquiry Card

Meter Calibrator

Tech. data is available on the Twinco MC5500 Meter Calibrator which features a 0.2% accuracy full scale, 60 (or 50) and 400cps/sec.; and features dc, ac, rms and ac average for accurate calibration for all types of meters. Twinco Inc., 9 Erie Dr., Natick, Mass.

Circle 233 on Inquiry Card

High Voltage Diodes

This 4-page paper entitled "Surface Stabilized High Voltage Diodes," covers high voltage single junction diodes currently manufactured with breakdown voltages in excess of 1200v and exhibiting reverse leakage currents in the 5na range. Also included is tech. data on microwave switching micro diodes; a 300 mw zener micro diode; ultra-fast high conductance micro diode MC 7000; a 750 mw micro rectifier; and core driver micro diodes. MicroSemiconductor Corp., 11250 Playa Court, Culver City, Calif.

Circle 234 on Inquiry Card

Instrumentation

Catalog ES-11 lists and describes a wide variety of instruments used in sound and vibration research and application, and in data analysis. The 20-page catalog covers 24 types of instruments: deviation bridges, a megohmmeter, voltmeters, oscillators, a random-noise generator, filters, amplifiers, analyzers, spectrometers, level recorders, an a-f response tracer, a noise-limit indicator, standing-wave apparatus, vibration-control equipment, and accessory items. B & K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.

Circle 235 on Inquiry Card

Recessed R-F Receptacles

Tech. data is available on recessed r-f receptacles, eliminating the usual "in-front" protrusion on instrument and equipment panels. The receptacles are available in 50Ω and 75Ω ConheX types and made with all standard subminiature ConheX snap-on and slide-on connectors. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y.

Circle 236 on Inquiry Card

Heat Sink Applications

This 18-page manual contains information on heat dissipation. It presents basic principles of heat transfer and indicates the steps leading to the proper selection of a cooling system for critical electronic components. A nomograph is included which enables proper selection of heat sink models suited to any given application. Astro Dynamics, Inc., 2nd Ave., Northwest Industrial Park, Burlington, Mass.

Circle 213 on Inquiry Card

Glasses and Ceramics

The first of a series of tech. brochures to help electric design engineers to keep abreast of new applications for glasses and ceramics is entitled, "Materials for Electronics." It describes glass that can be chemically machined into precision parts for electrical and electronic uses. Tables lists mechanical and electrical properties as well as dimensional limitations and tolerances. Corning Glass Works, Corning, N.Y.

Circle 214 on Inquiry Card

Crossguide Couplers

Catalog XT 62 entitled, "Directional Crossguide Couplers," 12 pages, contains tables including RG waveguide vs. WR waveguide with waveguide reference, dimensions, electrical and mechanical data, characteristic curves, on grossguide coulers WR 28, 42, 62, 75, 90; MDL A102 and WR 112; WR137, 159, 187, and 284. Also included is ordering information. Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick Industrial Centre, Natick, Mass.

Circle 215 on Inquiry Card

Substrates

Smooth-Strate® is a highly reliable substrate for use in micro-miniature, thin-film and integrated circuitry devices used in computer missiles and tracking devices. Information includes photographs, drawings, and table of properties. Electro-Ceramics, Inc., 2645 S. 2nd West, Salt Lake City 15, Utah.

Circle 216 on Inquiry Card

DC Supply Remote Control

A detailed discussion of "Mhogramming," a method of remote control of dc power supplies, is available from Electronic Measurements Co., Inc., Eatontown, N. J. This technique uses conductance as the control constant, rather than resistance, as with conventional power supply programming. Fundamental circuitry, details, and practical aspects are covered in Bulletin 125.

Circle 217 on Inquiry Card

Telemetering Systems

Information is available covering the capabilities of Datex Corp., Monrovia, Calif. Included are photographs and descriptions. Also included are technical data on: V-scan shaft position encoders; a temperature scanning and logging system; and supervisory and telemetering systems.

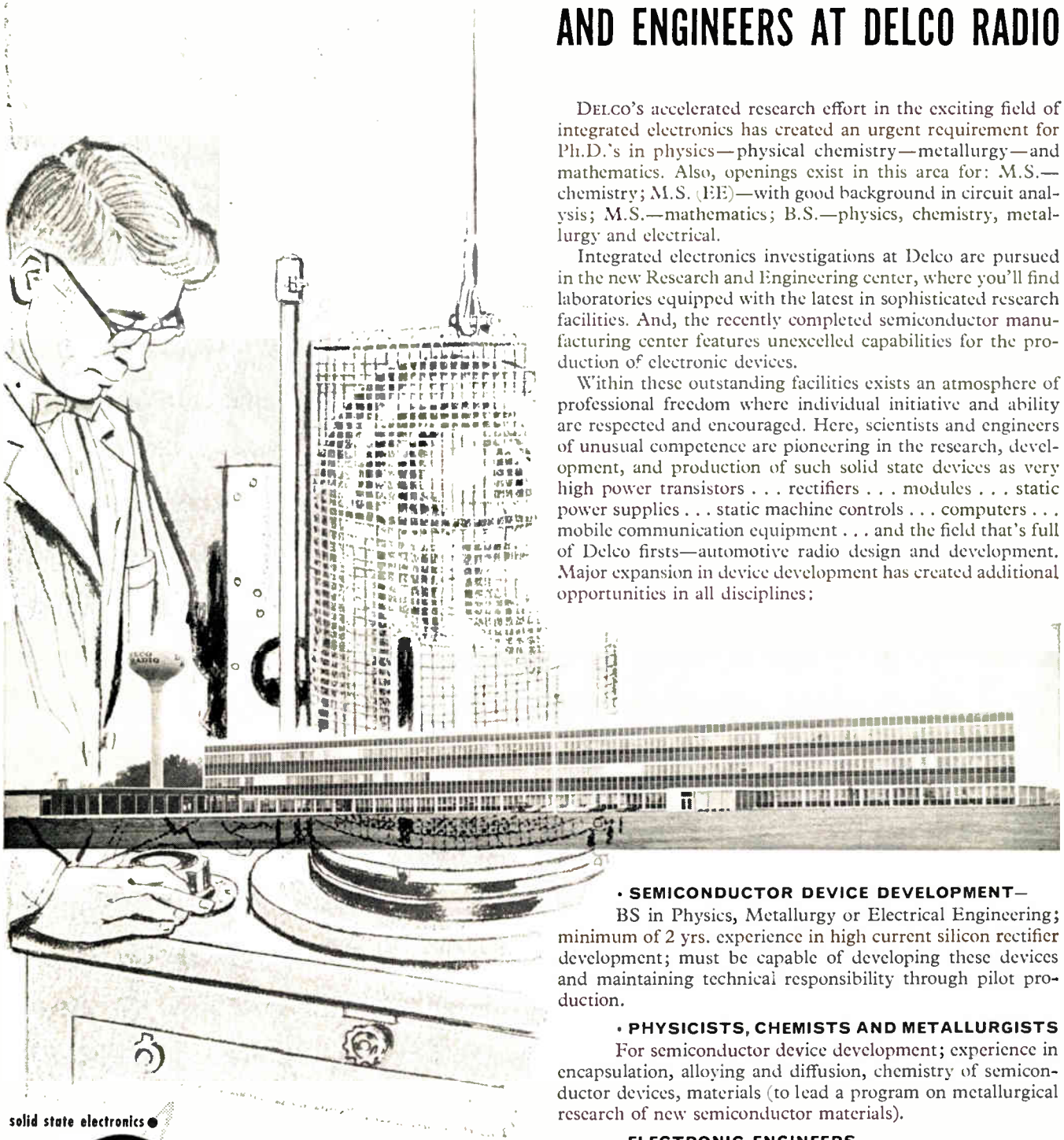
Circle 218 on Inquiry Card

Silicon Chart

This 11 x 17 in., 2-color chart shows "Resistivity vs. Carrier Concentration" by curves; available from MonoSilicon, Inc., 139 E. 157th St., Cardena, Calif.

Circle 219 on Inquiry Card

EXPANSION OF INTEGRATED ELECTRONICS PROGRAMS CREATES NEW OPENINGS FOR TOP LEVEL SCIENTISTS AND ENGINEERS AT DELCO RADIO



DELCO's accelerated research effort in the exciting field of integrated electronics has created an urgent requirement for Ph.D.'s in physics—physical chemistry—metallurgy—and mathematics. Also, openings exist in this area for: M.S.—chemistry; M.S. (EE)—with good background in circuit analysis; M.S.—mathematics; B.S.—physics, chemistry, metallurgy and electrical.

Integrated electronics investigations at Delco are pursued in the new Research and Engineering center, where you'll find laboratories equipped with the latest in sophisticated research facilities. And, the recently completed semiconductor manufacturing center features unexcelled capabilities for the production of electronic devices.

Within these outstanding facilities exists an atmosphere of professional freedom where individual initiative and ability are respected and encouraged. Here, scientists and engineers of unusual competence are pioneering in the research, development, and production of such solid state devices as very high power transistors . . . rectifiers . . . modules . . . static power supplies . . . static machine controls . . . computers . . . mobile communication equipment . . . and the field that's full of Delco firsts—automotive radio design and development. Major expansion in device development has created additional opportunities in all disciplines:

• SEMICONDUCTOR DEVICE DEVELOPMENT—
BS in Physics, Metallurgy or Electrical Engineering; minimum of 2 yrs. experience in high current silicon rectifier development; must be capable of developing these devices and maintaining technical responsibility through pilot production.

• PHYSICISTS, CHEMISTS AND METALLURGISTS
For semiconductor device development; experience in encapsulation, alloying and diffusion, chemistry of semiconductor devices, materials (to lead a program on metallurgical research of new semiconductor materials).

• ELECTRONIC ENGINEERS—
Experienced in machine controls (relay and or static) to assist in the development and application of static transistorized controls.

• TRANSISTOR PROCESS ENGINEERS—
MEs to develop and create new processes for manufacturing germanium and silicon semiconductor devices and to develop automatic and semi-automatic fabrication equipment. Experience preferred.

If you're looking for an opportunity to fully exercise your personal talents . . . among men of similar ability . . . in unmatched facilities . . . then let us hear from you. Send your resume to the attention of Mr. Carl Longshore, Supervisor Salaried Employment.

solid state electronics

DELCO RADIO
DIVISION OF
GENERAL MOTORS
KOKOMO, INDIANA

An equal opportunity employer

PROFESSIONAL OPPORTUNITIES

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

NSF SEEKS TEACHERS FOR SUMMER RESEARCH

The National Science Foundation is seeking some 700 applicants among the nation's science teachers for summer research programs which will begin this June at 90 colleges and universities throughout the country.

The programs range in length from 8 to 12 weeks, and provide stipends ($75 per week for pre-doctoral participants, $100 per week for post-doctorals), dependency and travel allowances.

About 40 institutions will have places for 300 high school teachers. More than 50 will provide opportunities for nearly 400 college teachers. Teachers will work alongside experienced scientists conducting research normally conducted at the respective institutions.

For further information including lists of participating schools prospective applicants should write the National Science Foundation, Special Projects, Science Education Section, Washington 25, D. C. Application blanks may be obtained from participating institutions. Deadline for receiving completed applications will be about Feb. 15.

PATENT OFFICE ESTABLISHES ACADEMY

Commissioner of Patents David L. Ladd has established a Patent Office Academy to step up training of patent examiners. He appointed George Hyman, Jr., a career Patent Office employee, as its director.

The Academy is located in the District National Building, 1406 G Street, N. W., Washington, D. C. Its establishment was part of a continuing series of moves in line with recommendations made in a management survey of the Office.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 226.

Computers Are Key to U. S. Business Survival, Honeywell President Advises DPMA at Conference

Faced with rising wages and shorter working hours at home, and increasing competition from abroad, American business must rely more and more on computers for processing data if it is to survive and profit, Walter W. Finke, President of Honeywell Electronic Data Processing, warned the Data Processing Management Association's South Central Conference.

Finke said the accelerated rate of electronic data processing applications would have no adverse effect on employment. He acknowledged that computers cause job displacements, but pointed out that this is one of their prime purposes. "Computers displace many costly, time-consuming clerical tasks that have constantly plagued and limited the efficiency of American business," Finke stated.

The keynote speaker added that computers create more and better jobs in new and expanding industries. As an example, Finke called attention to the rapidly growing aerospace industry which, though in its infancy, "has already created thousands of new job opportunities."

Recent estimates indicate that the computer industry alone has accounted for over a million new jobs. This total includes assembly, testing, sales, service and programming personnel, as well as those engaged in manufacturing components, he said.

Finke told DPMA members that it was time to stop apologizing for the computer. As the heart of electronic data processing, the computer "has made possible an infinite extension of man's ability to comprehend, control and forecast," he said.

Computers will also have a more effective role in managing and reducing inventory for American business, Finke said. If management could reduce inventories by just 10%, business would have an increase of working capital of nearly six billion dollars, he said. He added that a 10% reduction was not unreasonable in light of what some organizations have accomplished by putting computers to work on the problem.

TV ENGINEERING EDUCATION

From this Rhode Island Univ. classroom in Kingston, R. I., regularly scheduled graduate engineering lecture is beamed via TV to Raytheon Anti-submarine Warfare Ctr. It is 17 miles across Narragansett Bay in Portsmouth, R. I. Dage closed-circuit, 700-line resolution TV camera, Raytheon microwave relay equipment and two-way intercom make class possible for Raytheon engineers.

LABOR DEPT. TRAINING 400 ELECTRONIC WORKERS

The Labor Dept. has approved a program to train 400 unemployed Duluth, Minn., electronics workers under the Area Redevelopment Act.

The workers, mostly women, will be given a three-week course as electronics assemblers and employed by Duluth Avionics Corp., a division of Litton Systems, Inc. The training will be given at the Duluth Area Vocational School.

This is the second such program approved for this plant.

U. S. INVITES BIDS ON MICROWAVE NETWORK

The Bureau of Reclamation, U. S. Dept. of the Interior, has invited contractors to bid on installation of a complete multi-channel microwave radio system to serve the power system of the Colorado River Storage Project.

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 39, Pa.
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

THE ROLE OF R & D IN FUTURE PROFITS

How much does R & D affect a company's profits?
How much should it affect them?
How much should be directly related
to a company's profits?
Here are some observations by the Chief Executive
of a successful electronic firm.

AS A TECHNOLOGICALLY-BASED BUSINESS, I suppose our firm must be considered reasonably successful. At least our present $240-million per year level is more than 100 times our volume in 1946, the first post-World War II year. Much of this growth can be attributed to products created as a result of our own R&D efforts. Yet, I can think of no more appropriate introduction on the role of R&D in future profits than the simple statement that I am convinced that while the *relative* effectiveness of R&D may be quite satisfactory, the *absolute* effectiveness is often low. When I look at our successful R&D efforts, I recognize how important indeed these have been to our growth and profitability. But then I compare these with the funds and professional hours of effort wasted so far as important results are concerned. I can only conclude that we have yet to write most of the book on how to use R&D to assure maximum future profits.

There are some things that I think I have learned about a technologically-based company and about the relationships of R&D. First, we exist to create, make, and market profitably useful products and services to satisfy the needs of our customers. It is very easy to become enamored with the idea of R&D for its own sake and to pursue goals which, relate more to the need for intellectual exercise than to the needs of the company. Or, at the other pole, the pursuit of proper goals by R&D teams which simply do not have the intellectual and creative competence to handle the difficult problems involved.

Strategy & Tactics

I believe both these faults are the responsibility of general management. I am coming to believe that all R&D in an industrial organization ought to be deliberately categorized as either (1) frankly exploratory or (2) tactics in fulfillment of a clearly expressed, or at least understood, company strategy. If it's not one of these two, don't do it. Further, the exploratory work must be done to create a specific kind of knowledge which will directly or indirectly lead to new or improved (1) strategies or (2) tactics in fulfillment of strategic plans already laid.

Strategy selection bears heavily upon top management. Of course, much strategy and more tactics come into being almost automatically simply because you are in business; but I am afraid that far too large a percentage of the time, this is all the strategy and tactics for which we, as managers, can claim credit.

Strategies come in all shapes and sizes. There can be "hold the line" strategies, "modest gain" strategies, and "breakthrough" strategies. They all have their proper place in the management of a business; but, it is highly unlikely that any of them will have a major impact on the company. Unless, of course, just that is inherently built into the strategy in the first place.

Of course, a prime problem is that most strategies consume many years from conception to the point where one can state with certainty that the strategy is working, and the profits produced from it are adequate to justify the time and effort expended. We are engaged in two R&D programs which look as though they will be completely successful examples

By PATRICK E. HAGGERTY
President
Texas Instruments Incorporated
Dallas, Texas

This article is abstracted from a presentation made by Mr. Haggerty at the National Electronics Conference, Chicago, Ill., on Oct. 9, 1962.

of tactics carried out in a "breakthrough" strategy. Both strategies were initially expressed between five and six years ago and specific R&D programs introduced shortly thereafter. While we feel relatively confident of both our strategy and our tactics, it will be two more years before profits will flow from our investment in time, effort and money, and five more years before we will be able to state with certainty that both the strategy and the tactics were successful.

How Much Money?

How much money should a firm spend on R&D? Can it be specified as a fixed percentage of sales billed? With regard to the two categories of research and engineering I have suggested, I believe that the frankly exploratory R&D can and should be limited to a specific percentage of sales billed. For our kind of company, I would suggest that something between ½ of 1% and 1% of net sales billed may be about right, although your programs are going to have to be good; your people topnotch; and your organizational discipline high to approach constructively the upper limit.

Exploratory research is necessary. It can contribute in a major way to the understanding of new technology which will help to lead to new strategies or new tactics. As long as those responsible remember that this is why we do exploratory research, the work can often serve as the requisite "ticket of admission" to that of other organizations whose work may actually be more pertinent to the establishment of new strategies or tactics than that in one's own laboratories. Thus far, I have no firm feeling as to what proportion of one's R&D-determined strategy or tactics should flow from one's own exploratory R&D.

The sum total of exploratory research done at other industrial organizations, research institutes or universities is so much greater than one's own firm can perform that it seems almost inevitable that most strategic and tactical programs must evolve from exploratory R&D done outside. At the same time, one can't help but feel that where strategy and tactics do result from one's own exploratory R&D, an advantage should exist for the firm which ought to contribute to the maximization of future profits.

It is much more difficult to make any meaningful statement as to what percentage of sales billed ought to be devoted to tactical R&D programs in pursuit of company strategy. If the strategy is indeed a breakthrough strategy, the success of which will have a major impact on the company's growth and profits, then almost inevitably at some point, the efforts devoted and expenditures involved to bring it to a critical level will be very large, sufficiently so as to affect company profits over one or more years. When that happens the company's management had better be pretty determined about the propriety and effectiveness of the strategy and tactics being followed and, furthermore, they had better be right, because, if not, they are probably not going to be the company's top management in the near future. Of course, if a company is big enough it may, under most circumstances, get a sufficient distribution of the peaks of costs produced by these large scale tactical R&D programs to allow a relatively consistent expenditure for tactical R&D as a percentage of sales. But, this isn't even necessarily true for the very large companies.

Reasons for Few Successful Programs

Earlier, I said that we have relatively few really successful tactical R&D programs which could be clearly identified as having a major impact on company growth and profits and that I thought there ought to be more. What are the reasons there haven't been more?

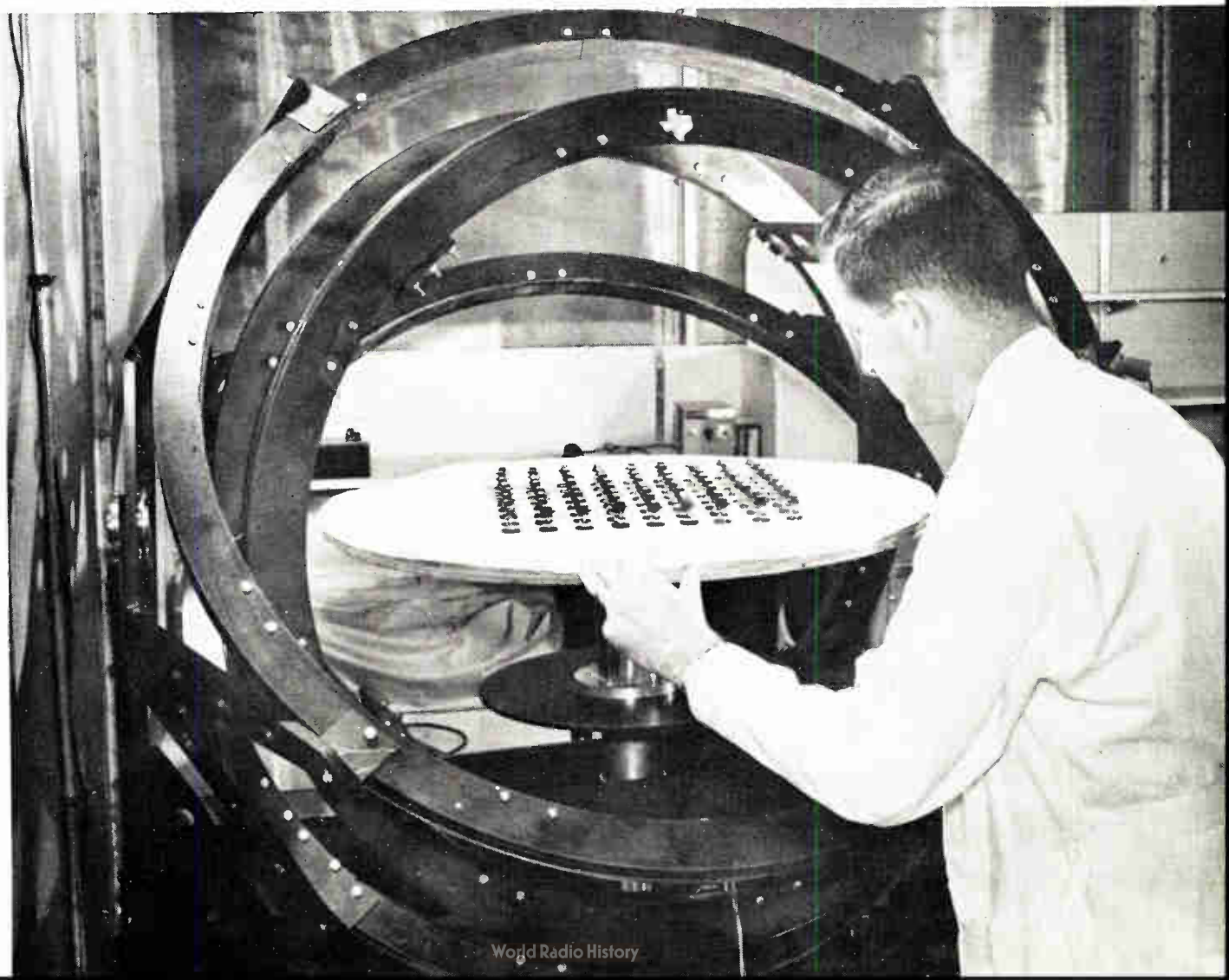
1. First, not enough breakthrough strategies . . . strategies deliberately designed to have a major impact on the firm if successful. These are tough to come by. They demand a concentration and a commitment on the part of management just where the risks are highest and the future haziest. Of course, not all strategies of a breakthrough nature necessarily involve major R&D successes. The key factor, for example, might be a different marketing approach. But R&D cases, the Chief Executive of a company must receive not just information, but inspiration from those in his management responsible at top levels for the R&D direction of his company.
2. Secondly, we've not only generated too few breakthrough strategies; we also have had inadequate strategies or strategies which, while perhaps adequate in concept, were inadequately communicated and understood and, finally, some of the strategy has been just plain wrong.
3. While we have often been deficient in our strategies, we have far more often failed to establish adequate tactical R&D programs to fulfill relatively well stated and communicated strategies. This perhaps is not surprising since it is here that one must define exactly how he intends to carry out the strategy. It is always tough to convert the

bright dreams of strategy to the real stuff of feasible R&D effort. On the other hand, much of the time the effort is not really made and R&D work is done because of the interest of individuals or in pursuit of bright ideas which are unquestionably just that and may be successful in the sense of paying for themselves, but still do not contribute to the fulfillment of the organization's basic strategies. R&D sometimes is also done because the organization is, in a certain posture; it has been pointed in a direction as a result of its past and it just keeps on doing the same things. And then, of course, one can fail because even though he has selected a tactical program, he turns out to be wrong and the means chosen were simply not the proper ones. This is often, but not always a direct consequence of the next major source of failure. 4. The dearth may derive from inadequate professional personnel. They may be inadequate because they are being asked to work in the wrong field. They may be inadequate because their training is not of the depth required. They may be inadequate because they themselves simply do not have the mental equipment to use the tools with which they have been equipped. Finally, they may be inadequate because they are just not interested enough in the accomplishment of the specific program to make it work.

All of these categories of failure are really management failures. This is why I believe the entire electronics industry is management-limited. Now, I hasten to add that the management in the electronics industry is inferior to that in other industries. What I am saying is that both the sheer quantity of variables which must be considered and the rate of change of these variables are so high that I am convinced the absolute level of our organizational and managerial effectiveness is very low.

Conversely, of course, this means that there is room for a great deal of improvement, and I hope my observations will in a small way at least suggest ideas which will contribute to that improvement.

Ferromagnetics research is one of many programs underway in the Physics Research Laboratory at Texas Instruments Incorporated. In this working simulator of the internal magnetic interaction within a film, rotating dipole permanent magnets within a magnetic field switch independently as their base plane is rotated by engineer.



INVENTIONS NEEDED BY THE GOVERNMENT

Over 300 inventions in every field of science and technology needed by Federal agencies are listed and described in "Inventions Wanted by the Armed Forces and Other Government Agencies," released by the National Inventors Council, U. S. Dept. of Commerce. The publication is available on request.

Some of the inventions wanted in the electronics and instrumentation fields are:

—High gain communications antennas for vehicles or aircraft.

—Way to reduce the size and increase radiating efficiency of VLF antennas.

—Use of backscatter to determine antenna patterns.

—Miniaturized antenna for space.

—High temperature resistant (up to 5000°F) dielectric material for use in missile antenna systems.

—Method for visually displaying distribution microwave fields in waveguide transmission lines.

—Low loss microwave delay line.

—Methods for non-destructive testing of electronic parts.

—Reliable 6⅛ in. r-f switch for use when very high power is used.

—Electrically and acoustically silent dc motor.

—Feed-back potentiometer for use in the high temperature (1000°F) environments associated with missile servos.

—Supersensitive audio amplifier.

—Solid state C-band CW microwave source which would replace the klystron oscillator tube used in most microwave receivers.

—Semiconductor cathode follower with a minimum impedance of 1000 megohms, an output of 100ma, and a 1 min. time constant.

—Compact, tunable microwave filters.

—Ultra-stable, fast-tunable source of microwave energy; and a source with 25% of 75% efficiency.

—Improvement in contactless electronic switching.

—Digitalized video signal transmission system for a conventional closed circuit color TV signal.

—Sonobuoy systems capable of accurate localization of targets.

—Equipment using new methods for long range detection, classification, and localization of underwater targets.

—Low light level TV camera, for detecting submarines.

—Tracking device for range telemetry of a missile test range which uses the principle of electronics for acquisition and display of missile flight test data.

—Miss-distance indicator for torpedo-submarine encounters.

—Study of the application of pulse compression techniques to active sonar devices.

—Airborne moving target indicator.

—Missile velocity measuring device.

—Method of attaining and maintaining low r-f transmission loss properties in concrete over entire radio frequency spectrum or a suitable low cost material for substitution.

—Inertial reference gyro.

—Method for continuous physiological and biochemical monitoring of pilot conditions during high altitude test flights.

—Indestructible device to record data in aircraft accidents.

—Anti-collision device for aircraft that signals the pilot when evasive action is required.

—New method of measuring airspeeds for airplanes to eliminate position error.

—System in conjunction with TACAN to provide the intercept pilot with a cockpit "go home" indication.

—A quick way to measure gyroscope drift rate when the rate is 0.001 in./hr. or less.

—Automatic pilot for terrain clearance.

—Inertial general purpose guidance system.

—Guidance system for mobile-launched missiles.

—Inertial navigator to measure distance along missile trajectory.

—Analog scanning of display surfaces.

—Digital output transducers.

—Anti-submarine warfare computer for locating submarines.

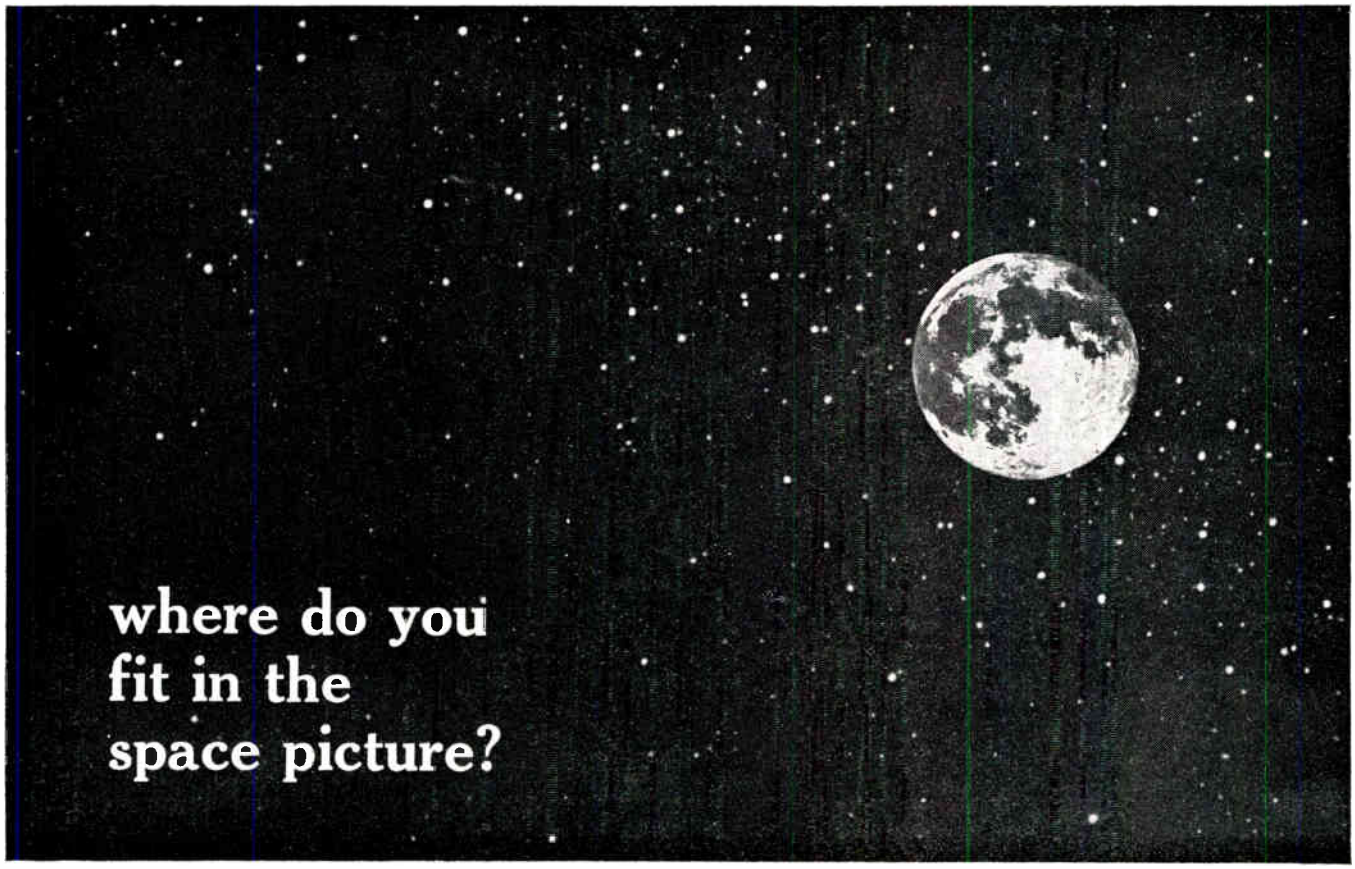
—Transducer for digital readout.

—Improved meteorological detecting, measuring, transmitting, and recording instruments for use at airfields.

—Equipment which will aid a searcher in an aircraft to a target in the water.

—Extension of the detection range of magnetic anamoly detectors (MAD) to increase the capability of ASW aircraft.

—Overload rating transducers.



Today, the design and development of space systems, vehicles and weapon systems is achieving an even greater degree of importance than before. Expenditures are increasing. The pace is being stepped up.

Hughes Aerospace Divisions are expanding with each of these progressions. Important projects such as MMRBM (Mobile Mid-Range Ballistic Missile — Integration, Assembly & Checkout), TFX(N) Electronics, SURVEYOR, SYNCOM, BAMBI, VATE, are now underway. Others will begin soon. This expansion is producing new, challenging assignments which never existed before. You can now be a part of, and benefit from, Hughes further expansion into the space age.

If you hold a degree from an accredited university in Mechanical Engineering, Electronic Engineering or Physics, are a U. S. citizen and have experience or interests related to Aerospace Vehicles or Weapon Systems, you can qualify. A few of the openings include:

controls engineers
Concerns airborne computers and other controls related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, controls systems, control techniques, transistorized equalization networks and control servomechanisms.

systems analysts
To consider such basic problems as the requirements of manned space flight; automatic target recognition requirements for unmanned satellites or high speed strike reconnaissance systems; IR systems requirements for ballistic missile defense.

circuit designers
Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command space television, guidance and control systems, and many others.

infrared specialists
To perform systems analysis and preliminary design in infrared activities involving satellite detection and identification, air-to-air missiles, AICBM, infrared range measurement, air to-air detection search sets, optical systems, detection cryogenics and others.

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INDUSTRY NEWS

George W. Leisz—named Vice President and General Manager, Inertial Navigation Product Div., Autonetics, a division of North American Aviation, Inc., Downey, Calif.

Harry A. Miller—appointed Vice President, Operations, Electronic Fittings Corp., Danbury, Conn.

Robert W. Smith—named Marketing Manager, Magnetics Div., Microdot, Inc., South Pasadena, Calif.; **Richard Ronald**—named western Regional Sales Manager for connector products.

Donald N. Yates—elected Vice President of Raytheon Co., Lexington, Mass., and appointed General Manager of its Missile & Space Div.

George M. Heffner—appointed Sales Manager, Microwave Components & Systems Corp., Monrovia, Calif.

Eugene A. Holmes III—named Vice President and General Manager, Semiconductor Div., Hoffman Electronics Corp., Los Angeles, Calif.

E. A. Holmes III

J. Mihalic

John Mihalic — named Group Vice President, Avco Corp., Cincinnati, Ohio.

Donn S. Randall—appointed Assistant to the President, Antenna Systems, Inc., Hingham, Mass.

James R. Rountree — named District Sales Engineer, Sola Electric Co., Los Angeles, Calif.

Dan Harris—named Advertising and Sales Promotion Manager, Industrial Electronic Engineers, Inc., North Hollywood, Calif.

Jack M. Gutzeit — appointed Eastern Regional Distributor Sales Manager International Rectifier Corp., El Segundo, Calif.; also **Don S. Prescott, Jr.**, — appointed Assistant Distributor Sales Manager.

Thaddeus L. Dmochowski—named Executive Vice President, Information Systems Div., International Telephone and Telegraph Corp., New York, N. Y.; **Arthur G. Williams**—named Vice President, ITT Europe, Inc.

William F. Cairns, Jr.—named Executive Vice President and Vice President, Manufacturing, Maxson Electronics Div., Maxson Electronics Corp., New York, N. Y.; **Murray Simpson**—named Vice President, Research and Development.

John B. Cowen — named President, Aerojet-General International Corp., Paris, France. Aerojet-General also announces the following appointments: **Vice Admiral Robert B. Pirie**—named Executive Assistant to the President; also **Col. Langdon F. Ayres**—named Assistant to the Executive Vice President.

John L. Lombardo—appointed General Manager, General Dynamics/Electronics, San Diego, Calif.

Robert T. Means — named Special Products Sales Manager, CTS Corp., Elkhart, Ind.

George A. Grossman—appointed Sales Manager, Clevite Transistor, Clevite Corp., Cleveland, Ohio.

G. A. Grossman

L. J. Torn

Lawrence J. Torn — appointed Vice President, Harman-Kardon, Inc., Plainview, N. Y., subsidiary of the Jerrold Corp.

Dr. E. T. Ferraro—appointed Director of Logistics, General Precision Equipment Corp., Tarrytown, N. Y.

Richard W. Shaughnessy — appointed Distributor Sales Manager, Bendix Semiconductor Div., Holmdel, N. J.

F. D. Hudson—appointed Latin American Sales Manager, Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., Newark, N. J.

John M. Britton—appointed Manager, Dayton, Ohio, office, Hughes Aircraft Co.

Robert A. Elliot—appointed Marketing Manager, Variable Resistors, Centralab, The Electronics Div. of Globe-Union, Inc., Milwaukee, Wis.

John E. Doane—named Distributor Sales Manager, Transitron Electronic Corp., Wakefield, Mass.

Donald W. Fuller—elected Vice President of Engineering, Redcor Corp., Canoga Park, Calif.

Dr. William E. Shoupp and **Dr. Sidney Krasik**—named Vice Presidents, Westinghouse Electric Corp., Pittsburgh, Pa.; **U. W. McDaniel**—named Sales Manager, Westinghouse Semiconductor Div., Youngwood, Pa.; **D. P. Del Frate**—appointed Magnetic Products Sales Manager, Materials Mfg. Div., Blairsville, Pa.; **Robert M. Harris**—named Assistant Marketing Manager, Large Lamp Dept., Lamp Div., Bloomfield, N. J.

H. Kenneth Ishler—appointed General Manager, Transistor Div., Sprague Electric Co., Concord, N. H.

Albert O. Schmitt—appointed Sales Manager, AiResearch Manufacturing Div., The Garrett Corp., Phoenix, Ariz.

Bernard Mark—appointed Distributor Sales Supervisor, Alpha Wire Corp., New York, N. Y.

B. Mark

E. H. Tingley

Eugene H. Tingley—appointed Vice President, Sales and Advertising, Fusite Corp., Cincinnati, Ohio.

L. G. Crawford—appointed Industrial Sales Manager, J. W. Miller Co., Los Angeles, Calif.; **G. E. Hall**—appointed Distributor Sales Manager.

J. F. Johnson — appointed Marketing Manager, Micro-Radionics, Inc., Van Nuys, Calif.

L. L. Smith—appointed Eastern Area Sales Manager, Motorola Semiconductor Products, Inc., Phoenix, Ariz. Motorola Semiconductor also announces the following appointments: **Donald R. Lupfer**—appointed Eastern Area Distributor Sales Manager; **George F. Weiler**—named Midwest Regional Distributor Sales Manager; **Charles P. Shaw** — appointed Western District Sales Manager; **Herbert I. Ackerman** and **Robert Burns**—named Eastern Regional Sales Managers. **Willard Ross**—named Telephone Market Sales Manager, Motorola Communications and Electronics, Inc., Dallas, Tex.

Gordon M. Moodie—named President, Electric Typewriter Div., International Business Machines Corp., New York, N. Y. **George F. Kennard** — named President, IBM Data Systems Div., White Plains, N. Y.; and **William B. McWhirter**—named IBM Director of Organization. Also, **Leonard E. Clark** — appointed Vice President, Headquarters Operations, IBM Data Processing Div., White Plains; **Paul W. Knaplund** — appointed General Manager, Advanced Systems Development Div., Yorktown Heights, N. Y.; **John M. Norton**—appointed Assistant General Manager, Advanced Systems Development Div.; and **Edward A. Kelleher**—appointed World's Fair Operations Manager.

Henry C. Egerton — appointed Vice President, General Time Corp., and General Manager of its Stromberg Div., Thomaston, Conn.

Douglas Hembrough — appointed Director of International Marketing, Librascope Div., General Precision, Inc., Glendale, Calif.

Joseph W. Yuhas—named Distributor Sales Manager, Astron Sales Corp., East Newark, N. J.

J. W. Yuhas

D. J. Horan

Daniel J. Horan—appointed Vice President and General Manager, Kelvin Electric Co., Van Nuys, Calif.

Daniel J. Crowley—named Marketing Manager, Eastern Operation, Sylvania Electronic Systems, Waltham, Mass., a division of Sylvania Electric Products, Inc.

Kenneth W. Bilby—elected Executive Vice President, Radio Corp. of America, New York, N. Y. Also **Robert George Dee**—appointed Manager, Industry Marketing Operations, RCA Electronic Data Processing.

Dr. George L. Haller — named Vice President-Advanced Technology Services, General Electric Co., Schenectady, N. Y. Also, **Olaf F. Vea**—appointed General Manager of GE's Large Generator and Motor Dept., Schenectady; **Richard L. Shetler**—named General Manager, Command Systems Div.; and **Gerald A. Hoyt** — appointed General Manager, Defense Electronics Div. All the above GE units are new ones, except the last.

PERSONALS

Dr. Charles D. Bradley, President of Bradley Semiconductor Corp.—selected to receive the 1962 American Success Story Award of the Free Enterprise Awards Assn.

Roy W. Ballard—named Manager, Systems Techniques Dept., Data Systems Div., Litton Systems, Canoga Park, Calif.

Armand Klein—named Manager, Special Products Div., Melpar, Inc., Falls Church, Va.

Dr. John Gelb — appointed Research Specialist, Mincom Div., Minnesota Mining & Mfg. Co., Los Angeles, Calif.

George R. Tallent—appointed Director of Reliability & Quality Control, Motorola Semiconductor Products, Inc., Phoenix, Ariz.; also **Harold R. Mumma**—named Manager, Distributor Service Dept., Motorola Semiconductor.

Martin Boyajian—named Works Manager, Calibration Standards Corp., Alhambra, Calif.

M. Boyajian

J. Walovich

John Walovich — named Director of Engineering, Stancor Electronics, Inc., Chicago, Ill.

Dr. Alan G. Stanley—appointed Manager of the new Micro-Circuitry Div., Transitron Electronic Corp., Wakefield, Mass.

Jack L. Elsley — appointed Manager, New Product Development, Cinch Mfg. Co., Chicago, Ill.

Edmundo Gonzalez—named Manager, Special Products Operation, Lansdale, Div., Philco Corp.

James J. Kelly—named Manager of the La Verne, Calif., Plant, Taylor Corp., Valley Forge, Pa.

Gerald A. Kirk—named Reliability and Quality Control Manager, Eastern Connector Div., Amphenol-Borg Electronics Corp., Fair Lawn, N. J.

James T. Murphy, Jr.—appointed Senior Staff Engineer, Dynatronics, Inc., Orlando, Fla.

"SCEPTRON"

(Continued from page 131)

Sceptron will process the signal.

The Sceptron permits decisions to be made as fast as information is received. Incoming signals have simultaneous access to all Sceptrons in a system. There is no limit to the size a Sceptron memory can be and yet retain this feature.

It has a wide range of frequency, now 100 cps to 20,000 cps. This can be extended in either direction.

The active elements in a Sceptron are several hundred to several thousand 0.002 in. diameter optic fiber beams of various lengths and therefore various frequencies. These are conventional fiber optics, quartz fibers which transmit light by internal refraction. However, unlike other fiber-optic devices announced to date, the fibers in a Sceptron are separated from each other and allowed to move independently at their free end. It is through the recording of eight patterns during this movement and later comparison with other patterns that the Sceptron works.

An audio frequency driver unit, or loud speaker, is used to excite the fiber arrays. However, any one of a number of electromechanical devices, including piezoelectric ceramics, may be used.

new
WINSLOW
portable
TENSILE TESTER

Model WTE-201
=26 thru =16 wire
50 lbs. capacity

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=16 thru =10 wire
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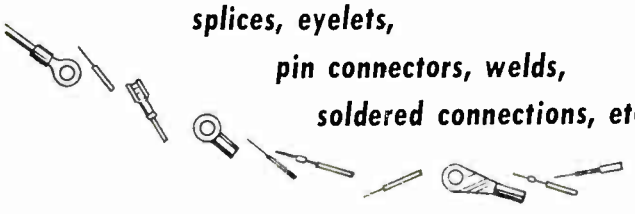
. . . for instantaneous on line testing of all types of wire terminals, splices, eyelets, pin connectors, welds, soldered connections, etc.



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FULL VALUE TRIAD TRANSFORMERS FOR EVERY JOB

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ELECTRONIC INDUSTRIES Advertisers – January 1963

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NEWS OF MFRS. REPRESENTATIVES

REPRESENTATIVES WANTED

Manufacturer of epoxy-compounded resins for electronics uses wants representatives in the following areas: West, Midwest, Southern Canada. Box 1-1, Editor, ELECTRONIC INDUSTRIES.

Cerruti Pflieger Corp., San Diego, Calif.—appointed California representative by Industrial Electronics Div., Dallons Laboratories, El Segundo, Calif. Dallons makes industrial graphic recorders, sonar test instruments, insulation testers, temperature monitors and oscilloscope X-Y calibrators.

O. F. Masin, Inc. — appointed New York and New Jersey representative for Viking Industries, Canoga Park, Calif., electrical connector manufacturer.

T. J. Ray Co., Tulsa, Okla.—appointed Oklahoma representative by Hitemp Wires Co., Westbury, L. I., N. Y.

Comp Rep Associates, Inc., Needham, Mass.—appointed New England representative by Drake Mfg. Co., Chicago, Ill. Drake makes lampholders and indicator light assemblies.

H. C. R. Folmer Co., Ft. Lauderdale, Fla.—appointed Florida representative for Trent, Inc., Philadelphia, Pa., manufacturer of electrically heated industrial equipment: **George Crossley & Assoc.**, Atlanta, Ga. — named representative to cover Georgia, Alabama and East Tennessee.

Computer Service Center, Ltd., Calgary, Alb., Canada—named Canadian representative for California Computer Products, Inc., Anaheim, Calif. CalComp manufactures plotters, plotting systems and associated equipment.

ECRA, Inc.—appointed Southeastern sales representative for silicon and selenium rectifiers, zener diodes and tantalum capacitors by IFT Components Div., Clifton, N. J.

Roy Attaway Co., Huntsville, Ala.—appointed representative by PRD Electronics, Inc., Brooklyn, N. Y., to cover Alabama, Georgia, and Florida; **Brooks-Feeger Assoc.**, Albuquerque, N. Mex.—appointed representative in Arizona, New Mexico, Colorado, Montana, Nevada, Utah, Wyoming, and Idaho; **Thunderbird Engineering Sales and Services, Inc.**, Wichita, Kans.—appointed Kansas and Missouri representative. PRD produces microwave and electronic test equipment.

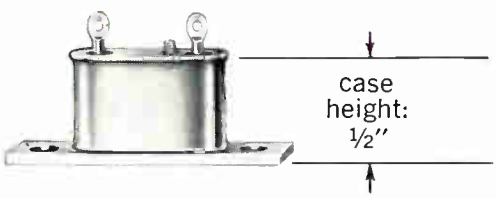
Spacetronics Co., Dallas, Tex. — pointed representative by Wavel Inc., Caldwell, N. J., to cover Tex Oklahoma, New Mexico and Louisiana Waveline manufactures waveguide test equipment and special waveguide plumbing assemblies.

L. H. Schwartz & Assoc., Dayton, Ohio—named representative by Raytheon Co. for spectrum analyzers, L-C filters and delay lines. The Schwartz firm will cover Ohio, Indiana, Michigan and Western Pennsylvania.

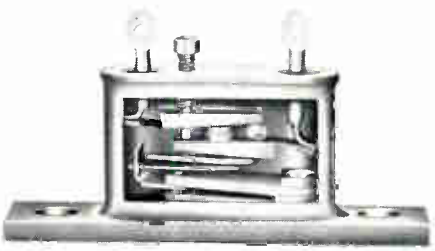
Dynamic Associates, Burlingame, Calif. —appointed Northern California representative by Electronic Associates, Inc., Long Branch, N. J., manufacturer of solid-state digital voltmeters, plotters and accessories.

EQUIPMENT, MATERIALS, PARTS & COMPONENTS

Brand new and cut down to size !



An entirely new design concept in a miniature thermostat provides greater precision and reliability plus minimum drift at control point. The New G-V Series VE Thermostat*— a temperature operated switch in crystal can size — has more than **twice** the contact motion and more than **twice** the moving force ordinarily found in units of this size. All resonances below 2,000 cps have been eliminated so the Series VE operates with stability at rated loads up to 10 g vibration at frequencies up to 2,000 cps. Vibration at 30 g up to 2,000 cps and shocks of 50 g, 11 ms or 200 g, 4 ms do not damage the unit.



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G-V field engineers and G-V applications engineers at the factory are available to discuss your requirements and to recommend particular types of thermostats. For complete assistance, literature or detailed test data under various operating conditions, write for Product Data Bulletin PD-1017 today or call (Area Code 201) 992-6200, Mr. Paul Abrams.

* Patent applied for.

G-V CONTROLS INC.

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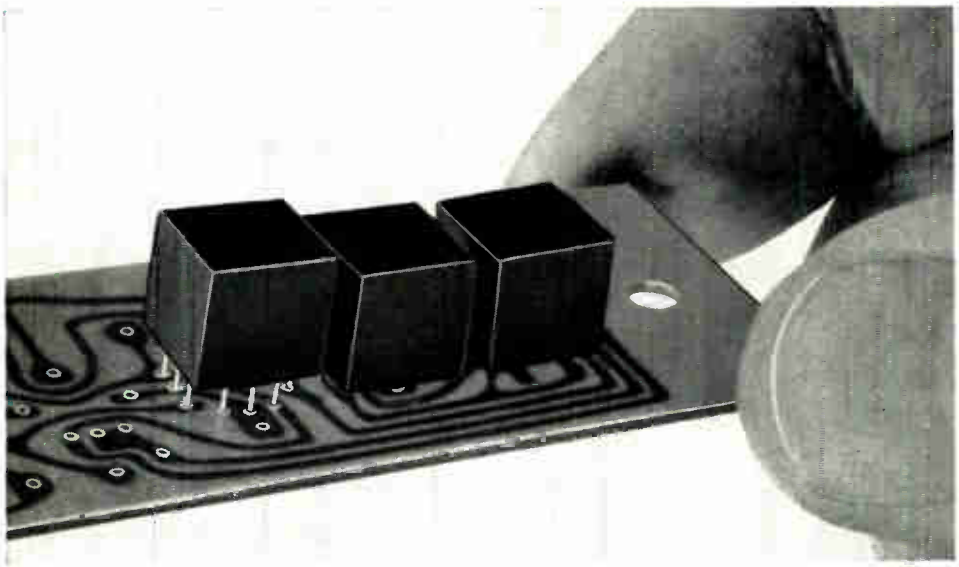
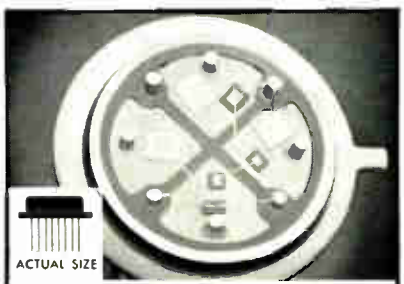


RCA Micromodules Offer Proved Reliability Backed By Over 100 Million Element-Hours of Life-Test Experience

Today's only high-density packaged circuits with this kind of life-test experience. Failure rates for RCA Micromodules are now less than 0.02% per 1000 hours at full ratings. Your *digital*, *analog*, or *linear* circuits can be supplied as RCA Micromodules... you can get working samples in a matter of days, quantity deliveries within 2 to 3 weeks. For example, RCA engineers converted one aircraft electronic package from conventional printed board construction to 16 working Micromodules in just 76 hours.

RCA Minimodules Offer Conventional-Component Economy in High-Density Format

Low-cost RCA Minimodules are precision built using reliable, conventional components, closely-packed, interconnected and encapsulated to meet the mechanical and environmental requirements of MIL specifications. RCA Minimodules can be supplied in the quantity you require, in the format you need, with terminal arrangements to meet your assembly requirements. Minimodules are available now for immediate delivery.



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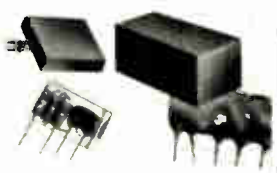
RCA OFFERS MADE-TO-ORDER CUSTOM PACKAGING SERVICE

If your requirements call for special configurations, RCA packaging specialists—drawing on RCA's broad background in miniature packaging and using RCA's wide range of facilities—will develop special versions of RCA's standard packages, new advanced packaging techniques for your circuit designs, or new solid state circuit packages to solve your packaging problems.



For complete information on RCA's broad circuit packaging capability call your RCA Field Representative. For further technical data, write RCA Semiconductor & Materials Division, Commercial Engineering, Section MJ-1, Somerville, New Jersey.

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