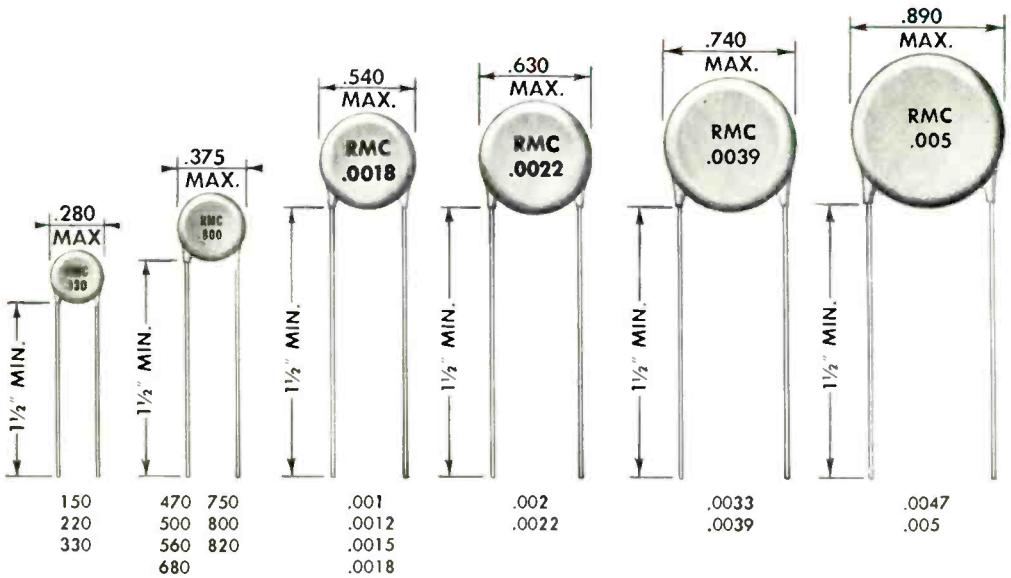
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

JULY 1962

RMC
TEMPERATURE STABLE
DISCAPS TYPE JL



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 phenalic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megahms
AFTER HUMIDITY LEAKAGE RESISTANCE:
Guaranteed higher than 1000 megohms
CAPACITY TOLERANCE: ±10% ±20%
+80 −20% at 25° C

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.
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Circle 1 on Inquiry Card

ELECTRONIC INDUSTRIES

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

Automation —Friend or Foe?

THERE is a lot of discussion these days about the necessity for modernizing American manufacturing plants in order to remain competitive on an international basis. Businessmen are constantly recommending faster, and higher rates of tax write-offs as a means of avoiding obsolescence of production capacity.

Charles H. Brower, President of Batten, Barton, Durstine and Osborn, in a recent address before the Association of Industrial Advertisers meeting in Toronto, Canada made some interesting comments on this. He pointed out that ours is the only country, of twenty leading countries, whose government has failed to take any steps to make sure that business is not drained of the necessary funds to stay alive. Ten of the leaders permit an additional write-off in the first few years of the life of the property as an incentive to modernization. In Great Britain, Belgium, Holland and Sweden this amount is between 30 and 33½%. In one case it is 50%. In eight nations entire plants are permitted to be re-evaluated to allow for inflation. In five, depreciation is allowed to exceed cost. He also points out that in 1950 we exported $3.63 worth of finished manufactured goods for every dollar's worth we imported. By 1954 this margin had fallen to $3.39 and by 1960 to $1.99.

In any talks about modernizing manufacturing facilities the word "automation" is now most unpopular. The public is wary of it because somehow indirectly it signifies machines replacing men and hence less jobs. Labor Unions hold similar fears, namely, that their rank and file memberships will be adversely affected. The government doesn't care for it either because of its political implications. Yet, automation, properly implemented in laboratories, offices, and factories offers the only real solution to our international dilemma. And we are still the world leader in this capability.

As a case in point, the General Electric Company recently held an all afternoon press seminar in which they summarized their activities in this area. Managers of nine different departments explained what they had been doing with manufacturing facilities within their own company and what had been developed for outside customers. They discussed: Sensors in Industry, Automation in the Cement Industry, Automation in the Steel Industry, Computers for Power Plant Automation, Numerical Control of Machine Tools, Bank Automation, and Information System Automation. In each case they told how a higher-quality more-uniform product could be produced at greater efficiency. They compared the costs of such modern production equipment with annual savings each system could produce to determine payback time, and this in turn ranged about one to three years in most instances.

Harold A. Strickland, Jr., Vice President and General Manager of the Industrial Electronics Division by way of summary pointed to their concern that some of our most advanced automation systems are being purchased by offshore producers and not by our own American manufacturers. The British, for instance, will have the most modern automated hot mill in the world. The Japanese, who are the world's largest ship builders, are already working to adapt a computer to the controls for such a ship. The Russians have developed an Institute to promote the use of automation.

Strickland said "We do not believe that America is any more anxious to be buried by its friends than by its enemies, but unless we become more aggressive in modernizing our own plants this possibility of economic decline may be nearer than we think." "Productivity in many foreign countries is rising more rapidly than wages. Between 1953 and 1960, United States productivity rose 15%. In the same period British productivity rose 29%, German 53%, Italian 58% and Japanese 71%."

These are sobering figures which should interest government, labor, and industry. It is true that if automation concepts were to be generally adopted, our industry would supply much of this equipment and find many new markets.

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ELECTRONIC INDUSTRIES

Vol. 21, No. 7 **July, 1962**

FRONT COVER Artist's concept of the operation of a multiple-beam klystron. The vertical elements represent the electron beams; the horizontal waves, the r-f power built-up in the interaction area. The bottom wave, lowest amplitude, would be that in the input cavity; amplitude increases in the penultimate or center cavity; and, is maximum in the top wave which would be the output cavity.

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

BPA NBP

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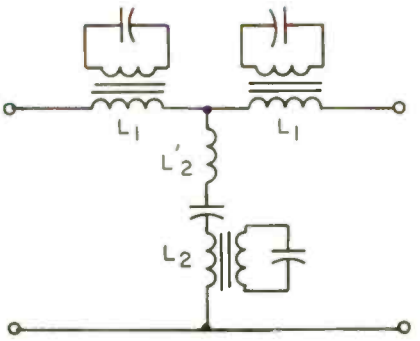
Highlights of this issue



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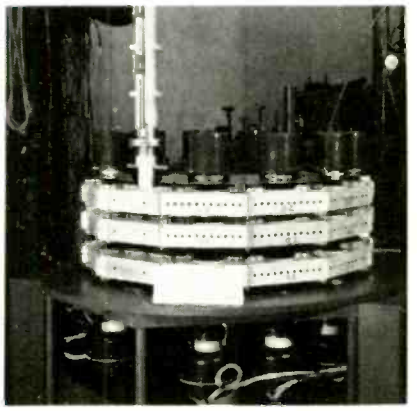
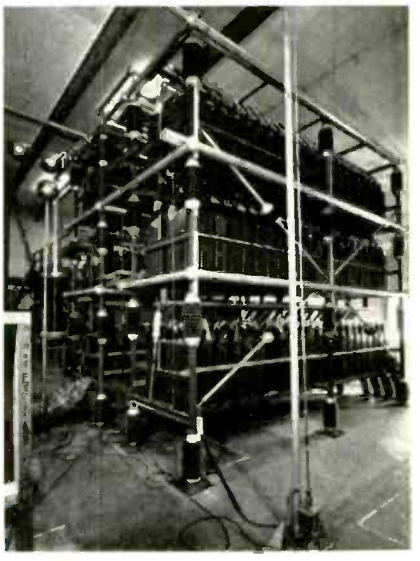


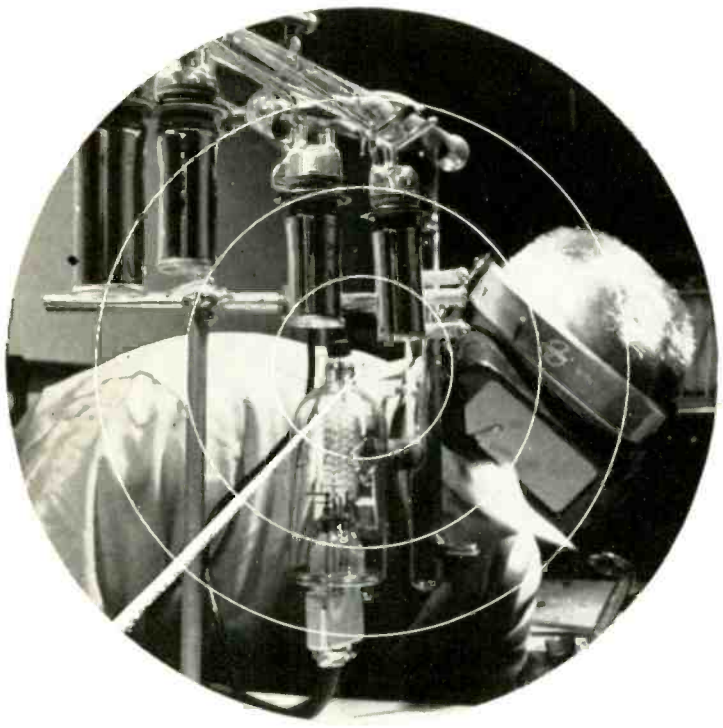
Multiple Beam Klystron

Power Supplies

High Power Transmitter



RADARSCOPE



SENSITIVE IR TUBES

These new infrared tubes, developed by Minneapolis-Honeywell, are said to be 10,000 times more responsive to infrared radiation than previous detectors. Here during pilot production at the company's Research Center, a scientist prepares to seal off the tubes from the vacuum pump. This is the final test before testing.

THE TECHNICIAN SHORTAGE is fairly well recognized, but few agencies seem to be doing anything about it. Dr. Frank Lee, Manager of Training for Raytheon, points out that "there are only 7 technicians for every 10 engineers in the U. S.; and of those 7 only 4 have been trained in technical institutes. The balance of them trained on the job in companies." Engineers are also the losers, because they are assigned jobs that should be handled by trained technicians.

ELECTRONIC EXPORTS during 1961 reached $635.4 million, nearly 32% higher than 1960. At the same time, there was a rise of $50 million in electronic imports into the U. S.

ALL-CHANNEL TV SETS will mean great expansion of TV service to municipalities, as well as to education and entertainment, says Newton N. Minow, Chairman of FCC. Part of the emphasis will come from the bill passed last month which provides $32 million in federal grants-in-aid for educational television. Minow predicted that school districts, colleges and civic educational organizations will within a few years develop a full blown, non-commercial, high quality network spanning the nation.

THE TARIFF WALL of the European Common Market is beginning to haunt U. S. industry. In 1960 the U. S. accounted for 39% of West German imports of radio equipment, while Italy supplied 4%. With the lowering of EEC internal tariffs, the Italian share rose to 25% while the U. S. share dropped to 20%. The figures are being released to support Government requests for the Trade Expansion Act which would permit the President to negotiate for lower tariffs.

FM STEREO BROADCASTING is making significant strides. The Consumer Products Division of EIA reports that there are now 81 FM stations which have converted to stereo, and they are broadcasting on an average of 66½ hours a week. This study also reveals that 70 million people are in range of at least one of these FM stereo broadcasts.

AN OPTICAL LASER has been experimentally pumped with the energy of an exploding wire. The new technique offers promise for pulsed lasers with extremely high power output. The experiment, at Westinghouse Research Lab., used the exploding wire as a source of light. It is capable of extremely high energy inputs. A major problem is the shock waves set up by the exploding wire at high energy levels. The laser rod is surrounded by plastic and glass to help absorb the shock and filter out extraneous radiation not useful for pumping.

POWERFUL LASER

At GE's engineering laboratory, Schenectady, N.Y. a laser beam cuts a hole in diamond in .0002-sec. The impact generates temperatures in the order of 10,000°F. Laser beam is focused onto diamond by lens at left, in front of which is protective plate.

JAPANESE ELECTRONICS PRODUCTION totaled $1,022 million during the first nine months of 1961. This represents a 19% increase over the $857 million in the corresponding period of 1960. The rate of growth, however, is decreasing; from 1959 to 1960 the growth rate was 31%. Consumer electronic products accounted for 56% of 1961 production with TV and radio receivers alone totalling $486 million or 48%. Gains were reported in the production of radio phonographs, recorders, hi-fi amplifiers, capacitors, transformers, computers and industrial measuring and control equipment.

THE NUMBER OF SCIENTISTS AND ENGINEERS employed in U. S. industry increased by about 6% between January 1960 and January 1961, according to the National Science Foundation. This is about the same percentage increase recorded between 1959 and 1960. About 35% of the engineers and scientists were engaged in research and development.

A UNIQUE CLOSED CIRCUIT TV arrangement is being used in New York City to flash pictures of the criminals "in the morning line-up" to other police stations around the city. The equipment which was built and installed by Teleglobe uses a unique scrambler, working over UHF station WUHF channel 31. The experimental broadcast will determine the feasibility of extending the technique further. Teleglobe has assured the police department that no unauthorized persons will be able to unscramble the transmission.

RECORD COUNTERFEITERS are the target of a new bill before the House. The bill would subject recording counterfeiters to maximum penalties of $10,000 fine and 10 years in prison. Also it would authorize civil remedies for infringement of mechanical rights in copyrighted music. EIA Consumer Products Division is backing the bill strongly, pointing out that the counterfeiters' records are as a rule inferior products and the record buying public is being unwittingly mulcted. Invariably the consumer blames the reproducing instrument—the phonograph—for the poor reproduction.

FACTORY SALES of the electronics industry are expected to hit $13.85 billion in 1962, of which almost 60% will go to the U. S. Government. The electronics industry today ranks fifth, or possibly fourth, among manufacturing groups in the U. S. In releasing this optimistic prediction, the Electronic Industries Association also pointed out certain problems they foresee: the precedent of government intervention in free enterprise system, as exemplified by the recent passage of the bill that requires TV Manufacturers to produce all channel TV sets, also threats to the American patent system from both the legislative and executive branches of government.

A COMMISSION on scientific research and development, similar to the Hoover Commission, has been recommended by Representative George Meader (Rep. of Mich.). Meader said the commission is necessary because congressional committees can not be expected to acquire a sufficiently sizable and competent staff to penetrate the difficult and complex problems involved in relationships between the federal government, institutions of higher learning and industry, with respect to scientific R and D.

THE FIRST COLOUR VISUAL FLIGHT SIMULATOR is being demonstrated by Great Britain's Redifon Ltd., to international airlines and the military. The system uses an EMI Electronics colour TV camera, a Rank-Cintel large screen projector and a 3-D coloured model of an airport and adjacent countryside. As the pilot flies the simulator, the EMI camera is automatically controlled so that the correct aspect of the scene is viewed. The result is an entirely natural and convincing impression of landing and take-off.

HEALTHY SIGN is a bill proposed to the Senate that would authorize National Bureau of Standards to appoint scientists to their staff on a temporary basis, at reasonable salaries, with their travel costs reimbursed. The bill would also permit discretionary use of gifts and bequests. The bill, in effect, allows NBS to obtain the short term services of highly qualified scientists who are unwilling to enter the career civil service.

MOON ROCKET CHECK-OUT

Martin Company engineers check out instruments on the control panel of a simulated spacecraft. During a "flight" to the moon, the crew navigator will sit in the center seat with the crew captain on his left and the craft's engineer on the right.

SPRAGUE HYREL® ST CAPACITORS ACHIEVE MINUTEMAN GOAL OF ULTRA-HIGH RELIABILITY

Failure rate of .001%/1000 hours has now been reached!*

- Following comprehensive life tests, Sprague HYREL ST Capacitors have now attained Minuteman's component development objective.

- Minuteman quality means reliability *100 times greater* than that of former "highly reliable" capacitors. This standard allows *only one failure in 202,000 units per 1000 hours of test* under Minuteman use conditions.

- Behind this achievement is an unequalled test history of more than 130 million unit-hours. Backing this performance is Sprague's record of pioneering in highly reliable capacitors, which earned us the opportunity to participate in the Air Force's Minuteman Component Development Program at Autonetics, a division of North American Aviation, Inc.

- All of the special processes and quality control procedures that make HYREL ST Capacitors the most reliable in the world can now help you in your Military electronic circuitry. A tantalum capacitor engineer will be glad to discuss the application of these capacitors to your missile and space projects. Write to Mr. C. G. Killen, Vice-President, Industrial and Military Sales, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

*At 60% confidence level by accelerated qualification tests.

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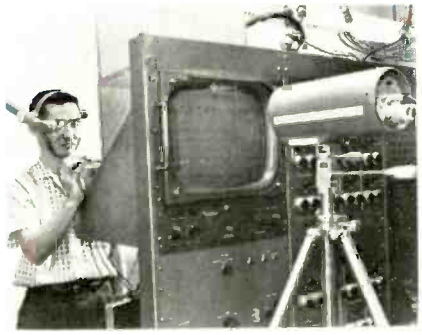
As We Go To Press...

ELECTRONIC VIEWER



Electrocular TV device, used to speed work in industry is demonstrated by Hughes Co. engineer R. Kiyan. Adjustments are being made on rear of panel, while viewing results furnished to Electrocular unit by closed-circuit TV camera trained on screen on front of panel. Camera may be located in any area to give information necessary to accomplish task. Display was developed and is manufactured by Hughes Aircraft Co., Fullerton, Calif.

"Traffic Will Swamp Communication Satellites"

The planned communications satellite system will rapidly become unable to handle snowballing communications traffic and will have to be expanded much sooner than the 20 years generally forecast, predicts Robert P. Haviland, of GE's Missile and Space Vehicle Dept.

He predicts the system will be used increasingly for such things as world-wide telephone traffic, transmission of business and other records by telegraph, teletype and other means, and transmission of business data by new means, such as international clearance of funds using bank computers.

Republic to Build Project Fire Spacecraft

Two spacecraft capable of 25,000 mph re-entry speeds will be constructed for NASA by Republic Aviation Corp. under a $5 million contract. The craft are to be launched during the second half of 1963 as part of NASA's Project Fire.

Each capsule will weigh about 200 lbs. and include a blunt shield, heat measuring instruments and telemetering equipment to radio information to Atlantic Missile Range data acquisition stations. Heat effects and effects on communications during re-entry will be measured.

Switching System Development Announced

ITT Kellogg Div. of International Telephone and Telegraph Corp., Chicago, Ill., has announced development of a fully electronic solid-state communication switching system for voice-frequency transmission.

This system, available in a number of sizes, incorporates the speed, efficiency and reliability required in military, commercial and industrial applications. A 200-line unit fits into a space occupied by one or two file cabinets, compared with present-day equipment that fills a room. It can be installed in several hours instead of several weeks and its modular plug-in construction permits repair or maintenance in minutes.

The system is available in two versions. One version is designed to meet military and governmental requirements. The other version is designed chiefly for industrial and commercial telephone switching applications.

Electronics Industry Failures Hit New High

The U. S. electronics industry set a 28-year high in financial embarrassments during the 12-month period ending last April 30, states an EIA report.

On a national basis, there were approximately 17,000 credit failures involving 56 manufacturers, compared with 15,450 involving 42 manufacturers the year before. This record was surpassed only during the depression peak of 1932.

NEW METHOD

IBM chemists Dr. A Reisman (l), and M. Berkenblit, who developed a new low-temperature method of synthesizing cadmium selenide directly from the elements, mount a sample in apparatus used in their studies of the Cd—Se system. New method produces ultra-pure, fully reacted CdSe, a compound whose photoconductive properties are of current interest.

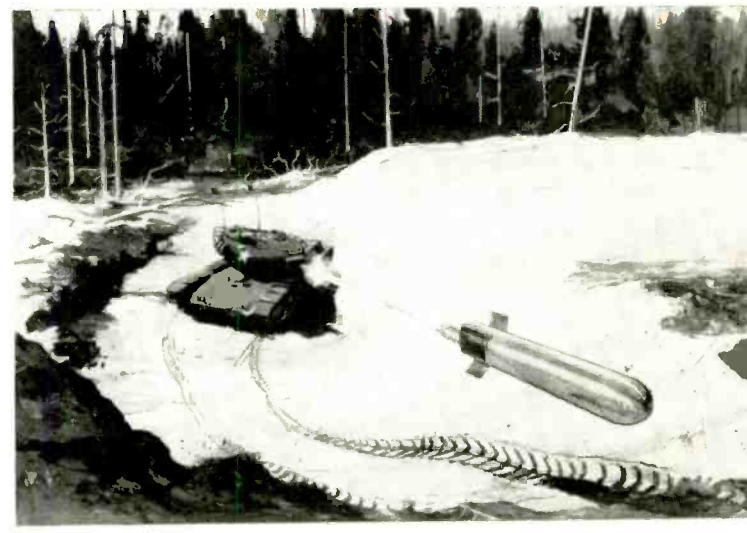
Test for Metal Devised

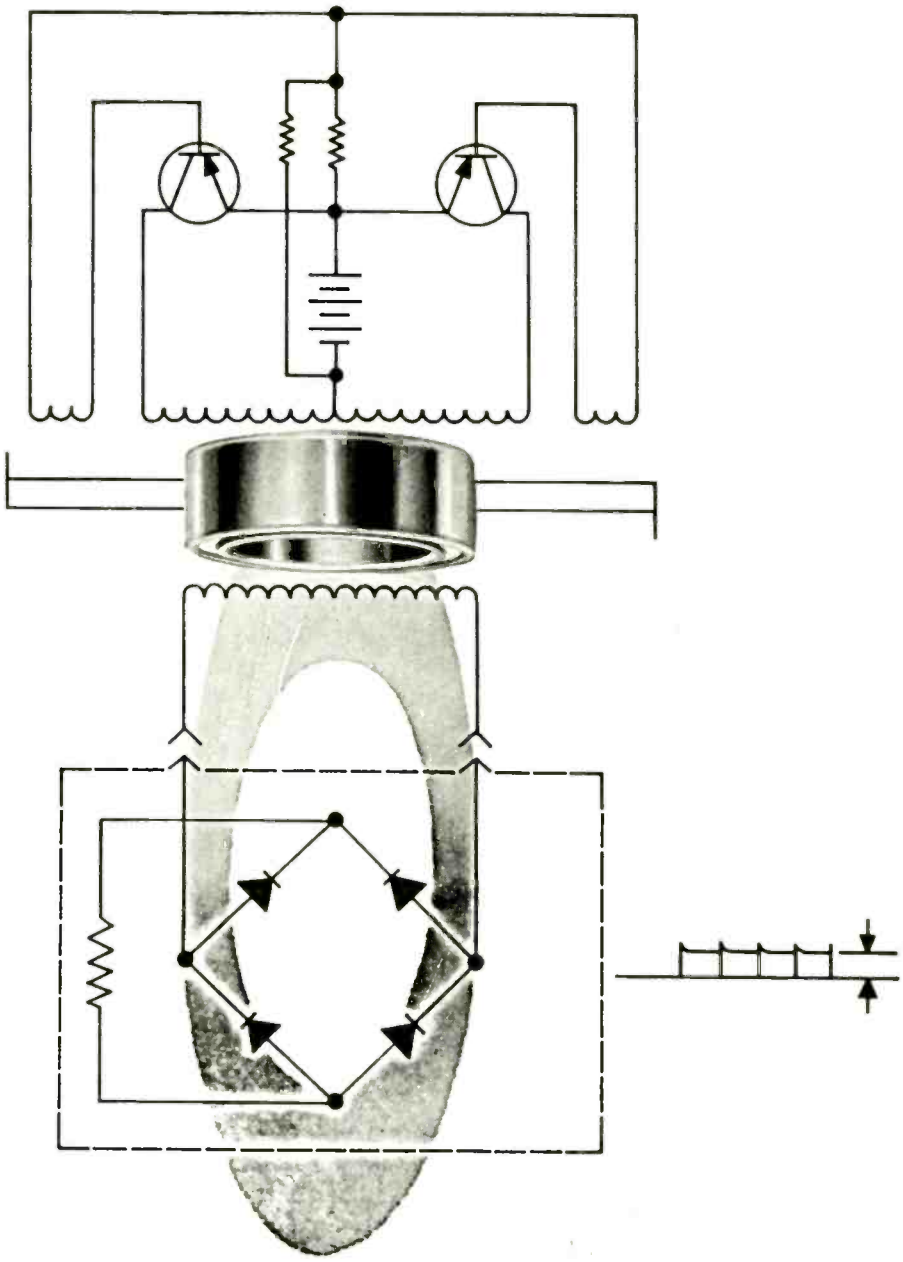
A booklet now available from the Department of the Interior's Bureau of Mines explains to Prospectors the Bureau's new easy-to-make field test to detect germanium. For copies, send 10 cents to the Supt. of Documents, U. S. Govt. Printing Ofc., Washington 25, D. C. Ask for Bureau Report No. 5907, "Field Test for Germanium."

More on Page 9

SHILLELAGH

Artist's concept shows Shillelagh surface - to - surface guided missile system. Missile is being developed by Ford Motor Co.'s Aeronutronic Div., Newport Beach, Calif. Army Ordnance Missile Command at Redstone Arsenal, Ala., supervises development of the missile and the Ordnance Tank - Automotive Command, Detroit, Mich., is responsible for system development.





How to design a static converter/inverter

Basically a magnetic coupled multivibrator, the square wave output of this static converter/inverter can be delivered as a-c directly to a load. Or, it can be rectified (full wave) to supply d-c voltages higher or lower than battery supply voltage. Ideal for highly portable equipment, the circuit has all the advantages of solid state devices. And, because transistors are the switches, replacing mechanical vibrators, potential maintenance problems are eliminated.

A Magnetics Inc. tape wound core is the *key* to perfect switching operation. The rapid change in core impedance in going from the unsaturated to saturated state forces the transistor switching. Thus, *a properly selected core* and the number of turns of wire on it become important, since this determines the operating frequency of the inverter.

Core material is important, too. For example, Magnetics Inc. Orthonol,® is ideal for most power applications where a given voltage and frequency are required. Where the design calls for a high voltage at low power levels, such as a d-c supply for photo tubes, Geiger tubes, or where high efficiencies are required under light loads, Magnetics Inc. Permalloy 80 should be selected.

Since power requirements, wire size, and frequency influence core size, Magnetics Inc. has a complete range of sizes and alloys available for complete design freedom.

To help you choose the core you need . . . and for more details on this circuit, write for bulletin "Designing d-c to d-c Converters" to Magnetics Inc., Butler, Pa.

MAGNETICS inc.®

ASESA Functions To Be Relocated

Armed Services Electro-Standards Agency (ASESA), located at Ft. Monmouth, N. J., will soon be integrated within the Defense Electronics Supply Center, Dayton, Ohio.

ASESA was established as a joint activity of the Military Services in 1946. Its mission is the standardization of electronic component parts in equipment required by one or more of the services. It also prepares and revises specifications and standards for parts and materials used in electronic communications and associated electrical equipment. It conducts qualification testing programs to provide qualified sources of supply.

All of the functions of the ASESA will be physically relocated at Dayton.

Scientists Will Study Soft X-Rays

Soft X-Rays, a part of the light spectrum just below the ultra-violet in wave length, will be studied next Summer by scientists using Aerobee rockets launched by NASA from Wallops Island, Va.

This kind of light, which is emitted by the stars, will be observed by means of photon counters placed aboard the rockets. The counters are now being built by Lockheed's physics organization.

SLOW-SCAN VIDICON

Westinghouse engineer shows new TV camera tube called a slow-scan vidicon, Type 7290, alongside camera in which it is used. Slow-scan system produces one picture every eight seconds. Pictures can be sent over phone lines, stored on a consumer-type tape recorder, or broadcast by radio such as a mobile two-way unit.

Electronic SHORTS

A contract to produce stable platforms for the USAF Minuteman missile's airborne guidance system has been awarded to Sperry Gyroscope Co., Great Neck, N. Y. by North American Aviation Co. Heart of the missile's guidance system, the platform provides a reliable reference point against which the slightest change in the missile's course can be measured. It is inertially stabilized by gyroscopes to maintain its position in space relative to the earth, regardless of the missile's movement.

Development of a new technique for joining thin refractory metal sheet without the resultant brittleness caused by recrystallization from the heat of existing welding methods, has been announced by the Martin Co. The method will permit wider use of refractory metals and alloys in missile and space vehicles. Technique consists of thermo-chemically depositing a filler of the base metal between the metal sheets to be joined. This provides a firm bond in which the base metal grain structure is not recrystallized by high welding temperature.

Electronic Control Products, Dunellan, N. J., has completed installation of a refueling control system at O'Hare International Airport, Chicago. Known as the mark IV Supervisory/Control System, it will control the field's new $5 million remote refueling complex. It is being used to send information at the rate of 360 bits/sec. over a single pair of telephone lines from nine satellite pumping stations to a control house. Information indicates fuel levels, pressure, and pump status. It also checks the overall function of the entire satellite area and will shut down affected areas in case of fire or other emergency.

Atomic Energy Commission has awarded Martin Co. a contract to study the application of space-age miniaturization to the development of small, light-weight nuclear power plants for use in remote areas of the earth. The study will focus on a 1000 kw plant in which each fuel element would include thermionic converters. In thermionic conversion, high temperatures cause electrons to "boil off" one metal plate and collect on another cooler one, creating a continuous flow of electricity.

A lightweight portable anti-tank missile for boosting firepower of the G.I., is being developed by Hughes Aircraft Co., Culver City, Calif. The missile, known as TOW, is electronically controlled in flight by a trailing wire which carries guidance signals. The missile is intended for use on vehicles as well as by infantry troops. Technical supervision of the project will be administered by the Army's R&D Div. of the office of Chief of Ordnance.

U. S. Naval Ordnance Lab in White Oak, Md., has developed a method of recalling to the surface selected test mines as late as two years after they are planted on the ocean floor, a mile under the sea. By means of explosive charges fired in a preselected time sequence from a plane or a ship, any one of 15 moored mines and its mooring cable can be raised without affecting the other 14. Key to the new method is a unit called an underwater Coded Command Release System (UCCRS). UCCRS is composed of a receiving hydrophone, several batteries, a time coder and an explosive driver.

The Perkin-Elmer Corp. has been awarded a contract by NASA's G. C. Marshall Space Flight Center, to develop a series of long range theodolite instruments. They will be used to align the inertial guidance systems of SATURN space rockets prior to launch. The theodolites will be capable of measuring and correcting azimuth deviation angles of ± 1 minute or more with 5 second accuracy—a measuring accuracy roughly equal to the thickness of a 50-cent piece across the length of a football field.

Emphasizing its new quality assurance program, NASA has awarded a long range test program contract to Associated Testing Labs, Inc., Wayne, N. J. Contract is for preflight evaluation of both semiconductor and component parts for guidance and control equipment of the Saturn booster series. Prime purpose of the test program is to insure that component parts will be capable of sustained operation under the severe conditions required of space flight.

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NEW Fibremat® BRAND ELECTRICAL INSULATIONS

THE SECRET IS IN THE WEB

The construction of "Fibremat" is entirely different from ordinary insulations. It's formed from a web of non-woven polyester fibers and uses no adhesives or any other bonding agent.

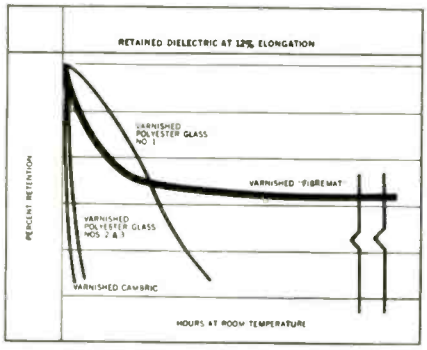
This unique non-woven construction gives "Fibremat" many important advantages. It has built-in stretch to conform snugly to irregular shapes and thus eliminate gapping and voiding in coil wrapping. It wraps faster and easier and looks neater. The random distribution of polyester fibers gives equal strength in all directions and assures elongation flexibility without breakdown.

Ordinary woven materials when stretched create points of stress where filaments cross each other. Elongation produces a scissor-like action that weakens the structure, tends to tear the film and rupture the insulation coating. Unsupported areas of varnish "floating" between the weaves are particularly apt to be weakened and give way.

"Fibermat", because the pattern of fibres is non-woven, will not result in a scissoring action when stretched. And because the fibers are distributed throughout the web the entire insulating film is supported.

"FIBREMAT" RETAINS ITS ELECTRIC STRENGTH

There's a vast difference between the electric strength of materials "in the carton" and "on the job." The important factor is the effective electric strength of the material after it's been stretched and stressed during application.



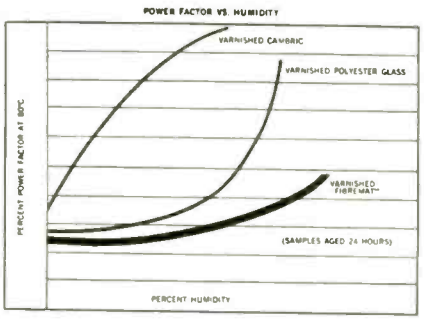
At 12% elongation "Fibremat" retains a substantially greater percentage of its original electric strength than either woven cambric or polyester-glass materials. This basic ability to retain electric strength means less insulation thickness is needed with "Fibremat" to attain the same electrical performance achieved with heavier layers of old style materials. Less insulation and less labor is required to finish a component. Insulation costs are reduced!

"FIBREMAT" RESISTS SOLVENT ATTACK

Solvents generally used in impregnating or dipping process can often cause insulation failure. This is particularly true with woven fabrics where relatively large areas are left unsupported and the varnish film tends to swell and flake away from the base fabric. The uniform dispersion of fibers in "Fibremat," however, provides support for all areas of the varnish film and prevents this solvent-caused breakdown.

"FIBREMAT" IS MOISTURE RESISTANT

There's no prebaking to drive out moisture when you use "Fibremat". The non-hygroscopic polyester base fabric in "Fibremat" resists moisture and the non-woven web construction prevents moisture absorption from wicking. Continuous filament woven fabrics act as wicks and offer a direct path for moisture to follow. In moist or humid environments "Fibremat" outperforms varnished cambric or polyester-glass materials.



"FIBREMAT" MEANS DEPENDABILITY

Today, "Fibremat" is being successfully used on all types of automatic taping machines and has proven itself outstanding on hand-taping operations requiring extra tensile strength. It can be impregnated with varnishes, epoxies and other liquid insulators; resists salt water, acids, alkalies, alcohols, hydrocarbons, and oils; is non-corrosive. Use "Fibremat" for wrapping form wound coils, layer and phase insulation, slot liners, and high voltage cables. **For complete information, write: 3M Co., Electrical Products Division, St. Paul 6, Minn., Dept. ECO-72, or phone and ask for "Fibremat" at any branch office listed below.**

ATLANTA, 451-1661; BOSTON, HI 9-0300; BUFFALO, TX 4-5214; CHICAGO, GL 8-2200; CINCINNATI, EL 1-2313; CLEVELAND, CL 2-4300; DALLAS, DA 7-7311; DETROIT, 875-7111; LOS ANGELES, RA 3-6641; PHILADELPHIA, PI 2-0200; NEW YORK, OX 5-5520; ST. LOUIS, WY 1-1320; ST. PAUL, PR 6-8511; SAN FRANCISCO, PL 6-0800; SEATTLE, MU 2-5550.

Irvington Division

3M MINNESOTA MINING & MANUFACTURING CO.

"FIBREMAT" IS A REGISTERED TRADEMARK OF 3M COMPANY, ST. PAUL 1, MINN.

Circle 3 on Inquiry Card

Coming Events in the electronic industry

JULY

July 1-20: Telephone Eng. Conf.; Michigan State Univ., E Lansing, Mich.

July 8-14: Int'l Cong. on Glass, ACS; Sheraton-Park Hotel, Washington, D. C.

July 8-15: Reliability Training Conf., ASQC; Princeton Inn., Princeton, N. J.

July 9-13: 5th Annual Inst. Tech & Industrial Communications, Colo. State Univ., Ft. Collins, Colo.

July 17-18: Data Acquisition & Processing in Medicine & Biology, IRE (PGBME), AIEE, ISA; Whipple Audit., Strong Memorial Hosp., Rochester, N. Y.

July 17-19: Lunar Mission Mtg., ARS; Pick-Carter & Statler-Hilton Hotels, Cleveland, O.

July 25-29: Int'l Sound Fair, SORD, CMA, INHFM, ARMADA, MRIA; Cobo Hall, Detroit, Mich.

AUGUST

Aug. 5: Industrial Rsrch. Conf., Columbia Univ.; Arden House, Harriman, N. Y.

Aug. 5-8: 5th Nat'l Heat Transfer Conf. & Exhib, ASME, AIChE; Houston, Tex.

Aug. 6-10: 7th Annual Tech. Symp., SPIE; Statler-Hilton Hotel, New York, N. Y.

Aug. 8-10: 1962 Standards Lab. Conf., NBS; Boulder Labs., NBS, Boulder, Colo.

Aug. 10-11: The Future of Manned Vehicles in Air & Space, IAS; Olympic Hotel, Seattle, Wash.

Aug. 13-16: Pacific Energy Conversion Conf., AIEE; Fairmont Hotel, San Francisco, Calif.

Aug. 13-16: Nat'l West Coast Mtg., SAE; Biltmore Hotel, Los Angeles, Calif.

Aug. 14-16: 1962 Int'l Conf. on Precision Electromagnetic Measurements, IRE (PGI), NBS, AIEE; Boulder Labs., NBS, Boulder, Colo.

Aug. 14-16: Cryogenic Eng. Conf., Univ. of Calif., Los Angeles, Calif.

Aug. 15-16: 1962 Low Pressure Plastics Show & Clinic, Hastings Plastics, Inc.; Santa Monica Civic Audit., Santa Monica, Calif.

Aug. 15-17: 3rd Electronic Packaging Symp.; Univ. of Colorado, Boulder, Colo.

Aug. 16-18: Joint Western Regional Aircraft & Missiles Conf., ASQC; Benjamin Franklin Hotel, Seattle, Wash.

Aug. 20: Tech. Symp., Applications & Reliab. of Precision Potentiometers, PPMA; Statler-Hilton, Los Angeles Calif.

Highlights '62

WESCON Western Electronic Show and Conf., Aug. 21-24, IRE, WEMA; Memorial Sports Arena and Statler-Hilton Hotel, Los Angeles, Calif.

NEC, Nat'l. Electronics Conf., Oct. 8-10, IRE, AIEE, EIA, SMPTE; McCormick Place, Chicago, Ill.

NEREM, Northeast Research and Eng. Mtg., Nov. 5-7; IRE; Boston, Mass.

Aug. 21-24: Western Electronics Show & Conf. (WESCON), IRE, WEMA; Memorial Sports Arena & Statler-Hilton Hotel, Los Angeles, Calif.

Aug. 23-24: AEEC Summer Mtg.; Hotel Benjamin Franklin, Seattle, Wash.

Aug. 26-29: Nat'l Mtg., AICE; Denver-Hilton Hotel, Denver, Colo.

Aug. 27-29: Summer APS Mtg. in West; Seattle, Wash.

Highlights '63

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

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

NEC, Nat'l. Electronics Conf., Oct. 28-30, IRE, AIEE; McCormick Place, Chicago, Ill.

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

Aug. 27-29: Conf. on Metallurgy of Semiconductor Materials; Ben Franklin Hotel, Phila., Pa.

Aug. 27-31: Joint Mathematical Summer Mtg., AMS, MAA & SIAM; Univ. of British Columbia Vancouver, Canada.

Aug. 28-30: 4th EIA Conf. on Maintainability of Electronic Equip., EIA, Dept. of Defense; Univ. of Colo., Boulder, Colo.

Aug. 29-Sept. 5: 5th Int'l Cong. on Electron Microscopy; Univ. of Penna., Phila., Pa.

Aug. 30-Sept. 5: Annual Conv., APA; Chase-Park Plaza Hotels, St. Louis, Mo.

Aug. 31-Sept. 3: ARRL Nat'l Conv.; Portland-Sheraton Hotel & Memorial Coliseum, Portland, Ore.

Aug. 31-Sept. 9: 1st World's Fair of Music & Sound, 20th Century Fair of Music, Inc.; McCormick Place Expos. Ctr., Chicago, Ill.

SEPTEMBER

Sept. 1-3: ARRL Delta Div. Conv.; Jung Hotel or Fountainbleu Motel, New Orleans, La.

Sept. 4-7: 1962 ACM Nat'l Conf. & Int'l Data Pressing Exh.; Hotel Syracuse & War Memorial Audit., Syracuse, N. Y.

Sept. 4-8: Reaction Mechanisms Conf. Brookhaven Nat'l Lab., Upton, N. Y.

Sept. 9-14: Nat'l Tech. Conf., IES; Statler-Hilton Hotel, Dallas, Tex.

Sept. 9-14: 142nd Mtg., ACS; Atlantic City, N. J.

Sept. 9-14: Petroleum Industry Conf., AIEE, ISA; Carter Hotel, Cleveland, Ohio.

Sept. 9-14: Semi-Annual Mtg., ASP; Chase-Park Plaza Hotels, St. Louis, Mo.

Sept. 12-15: Enamel Div. Fall Mtg., ACS; French Lick-Sheraton Hotel, French-Lick, Ind.

Sept. 11-13: EIA Mtg.; Biltmore Hotel, N. Y. C.

Sept. 13-14: Nat'l Topical Mtg. on Plutonium as a Power Reactor Fuel; Richland, Wash.

Sept. 13-14: 6th Nat'l Symp. on Eng. Writing and Speech, IRE (PGEWS); Mayflower Hotel, Washington, D. C.

Sept. 13-14: Joint Eng. Management Conf., ASME; Roosevelt Hotel, New Orleans, La.

INTERNATIONAL

July 22-28: 8th Int'l Cancer Congress, IUC; Moscow, USSR.

Aug. 5-11: 2nd Int'l Cong. of Radiation Rsrch., ARR; Harrogate, Yorkshire, England.

Aug. 26-Sept. 1: 10th Int'l Cong of Radiology, ISR; Montreal, Quebec, Canada.

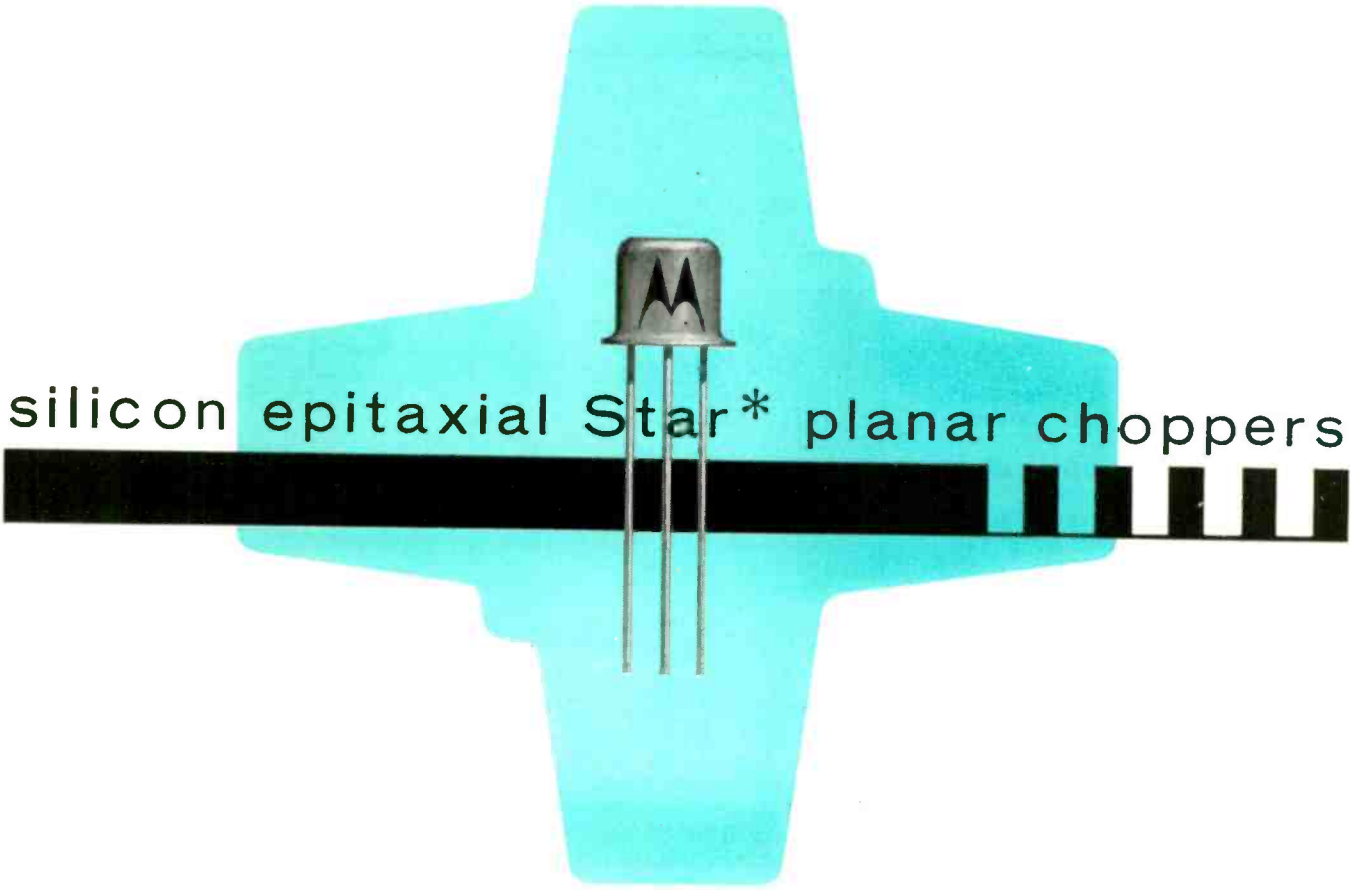
Aug. 27-Sept. 1: 2nd Int'l Cong. on Information Processing, IFIPS; Munich, Germany.

Aug. 27-Sept. 1: 3rd Int'l Cong., ICAS; Stockholm, Sweden.

Sept. 7-12: Int'l Conf. on Crystal Lattice Defects (including section

(*Continued on page* 13)

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



silicon epitaxial Star* planar choppers

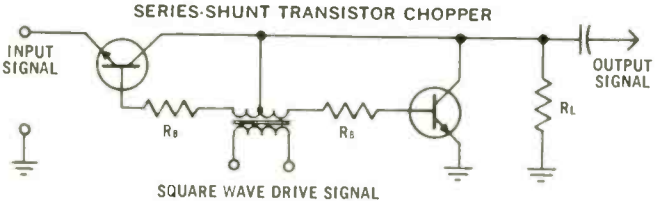
with parameters virtually insensitive to temperature from +25°C to +85°C

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.

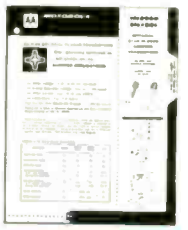
Matched pairs of each type are available on special request for "quasi" push-pull chopper circuit applications. Pairs can be matched with respect to offset voltage, (V_{off}), to within 50 or 100 microvolts.

*STAR is a trademark of Motorola Inc.



Characteristics*	Symbol	Min.	Typ.	Max.	Unit
		2N2330 (TO-5) P_D = 0.8 Watts		2N2331 (TO-18) P_D = 0.5 Watts	
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. 1967

5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

Circle 4 on Inquiry Card

Coming Events

(*Continued from page* 11)

on radiation damage), PSJ; Kyoto, Japan.

Sept. (date not specified): Conf. on Components for Microwave Circuits, IEE (British); Savoy Place, London, England.

Sept. 3-7: Int'l Symp on Information Theory, IRE (PGIT); Free Univ. of Brussels, Brussels, Belgium.

Sept. 10-19: 1st Int'l TV Program & Equip. Fair, Lyons Int'l Fair, R.T.F.; Lyons, France.

Sept. 13-14: Symp. on Advanced Gas-Cooled Reactors, BNEC; London, England.

"CALL FOR PAPERS"

3rd Quantum Electronics Conference, Feb. 11-15, 1963, Paris, France. Resumes of papers to be submitted by **November 1, 1962,** to: Madame Cauchy, Secretaire 3eme Congrès d'Electronique Quantique; 7, Rue de Madrid—Paris VIIIe. Manuscripts themselves should be given the first day of the conference.

1963 PGMTT (IRE) Nat'l. Symp., May 20-22, 1963, Miramar Hotel, Santa Monica, Calif. Papers should represent original contributions in the field of microwave theory and techniques. Only papers not published or presented prior to the symposium will be considered. Any approval necessary from cognizant authority must be granted prior to submission of the paper. The following materials should be submitted by **Jan. 5, 1963:** a 100-word abstract, in duplicate, with title, name and address; a 1000-word summary, in duplicate, with title, name and address. Forward to Dr. Irving Kaufman, Chairman, Technical Program Committee; Space Technology Laboratories, Inc.; 1 Space Park, Redondo Beach, Calif.

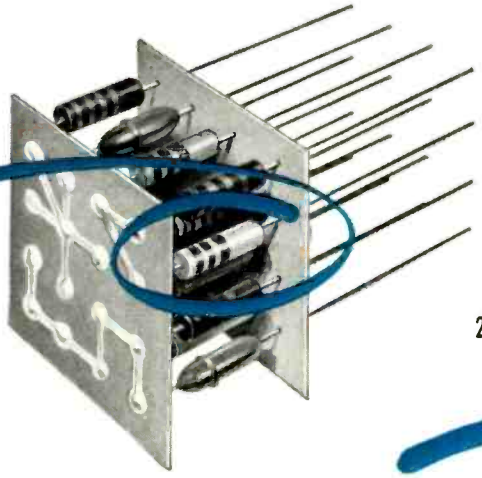
ENGINEERING EDUCATION

Short courses of interest to engineers.

Maintainability Conference

The Fourth EIA Conference on Maintainability of Electronic Equipment will take place **Aug. 28-30** at the University of Colorado, Boulder, Colo. Theme of meeting is "Design Guidance for Maintainability." Workshop sections will be featured. A field trip to the Boulder Laboratories, National Bureau of Standards, will be held **Aug. 27,** the day preceding the conference. For additional information, write: Engineering Office, Electronic Industries Association; Room 2260, 11 W. 42nd St.; New York 36, New York.

New from Sprague!



Module and components 2x actual size

SUBMINIATURE CERAMIC CAPACITORS ESPECIALLY DEVELOPED FOR "CORDWOOD" PACKAGING

Sprague's ALL-NEW Type 252C Tubular Ceramic Capacitors give you a combination of features found in no other single capacitor!

- TINY! Only ¼" long, and less than ⅛" in diameter
- Size is compatible with diodes and resistors for "cordwood" packaging
- Can be furnished on lead tape for automatic insertion
- Extremely stable – very little capacitance change with temperature
- High insulation resistance, high dielectric strength
- Stand up under extreme humid atmospheric conditions
- Available now in standard ratings from 5 pF to 360 pF, 100 vdc
- Operating temperature range, -55 C to +85 C
- Standard capacitance tolerances; ±20%, ±10%, ±5%

For complete technical data on Type 252C Ceramic Capacitors, write for Engineering Bulletin 6151 to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE COMPONENTS

CAPACITORS	INTERFERENCE FILTERS	HIGH TEMPERATURE MAGNET WIRE
TRANSISTORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
MAGNETIC COMPONENTS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	FUNCTIONAL DIGITAL CIRCUITS
MICROCIRCUITS	TOROIDAL INDUCTORS	ELECTRIC WAVE FILTERS

43-417

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and '②' are registered trademarks of the Sprague Electric Co.

As We Go To Press . . .

"VOICEPRINTS"

L. G. Kersta, Bell Telephone Labs scientist who is investigating voiceprint identification, speaks into microphone to make a print of his own voice. Voiceprints are "pictures" of one word of a person's speech. Pictures reveal the patterns of voice energy in the various levels of pitch.

Semiconductor, Tube Sales Strong in '61

Despite a slight decline in total sales due to increased competition at home and abroad, electronic tube and semiconductor sales in the U. S. continued strong through 1961.

Total factory sales were $1.225 billion, compared with $1.271 billion in 1961. Weak spots were in the receiving tube industry, where total sales dropped from $332 million to $311 million, and in the diode and rectifier field, where sales fell from $224 million to $200 million.

Radar May Solve Zero Visibility Problem

Inexpensive lightweight radar equipment now being tested may erase the zero visibility problem which sometimes confronts control tower operators trying to see airport runways.

Developed by the Air Force System Command's Electronic Systems Div., the radar transmitter, receiver and antenna weigh only about 160 lbs. combined. The 3-ft. tall control tower console weighs somewhat less. Five of the new sets are now being tested at Air Force bases in the U. S.

EPRA Discontinued

The Electronics Production Resources Agency of the Department of Defense has been discontinued. Its essential functions are being integrated into the Defense Electronics Supply Center, Defense Supply Agency, Dayton, Ohio.

New Circuitry Concept In Semiconductor Chopper

A new circuitry concept has been developed by National Semiconductor Corp. in its new INCH-integrated chopper. The new semiconductor component performs the functions of low voltage, low current relays and mechanical choppers.

Its more obvious applications are telemetering and chopping uses for the space programs, as well as industrial automatic control.

The INCH looks like a four-lead transistor, but is actually a functional block. It achieves great reduction in volume while exceeding in performance its cumbersome mechanical or semiconductor counterparts, the company states.

Solar Power Systems

The Bendix Corp. has begun a program to develop non-propulsive power supplies, some using solar energy, for satellite communications and control systems. Six Bendix divisions will cooperate in the project, which is also expected to produce power units for automotive, industrial and defense uses.

West Increases Output

The West is continuing to increase its share of the nation's total electronics output. This year it will account for nearly $3.3 billion in sales. Western firms will produce 25% of the estimated U. S. total of $13.2 billion in electronic sales during 1962.

ATLAS SITE TV CAMERA

Camera, TRW-Dage RCS-10, is part of system ordered by USAF, one of the largest orders ever placed for closed-circuit TV systems. Camera is at Wallops Island, Va., NASA missile site. AF has ordered more than 200 RCS-10 closed-circuit systems from General Dynamics/Astronautics to equip 10 Atlas sites. The system is already used at many AF and other military installations.

Electronic Radiation Monitor Demonstrated

The nation's first electronic monitor for guarding entire communities from dangerous levels of nuclear fallout has been demonstrated at St. Joseph's College, Phila., Pa.

Designed for the protection of school areas, hospital buildings, small industrial complexes and municipal shelters, the basic device can be expanded to cover any American city. Even family fallout shelters could be integrated with the system.

Developed by the Decker Corp., of Bala Cynwyd, Pa., in cooperation with scientists at St. Joseph's, the monitor automatically sounds an alarm the instant radioactivity reaches a pre-set level. Its various sensors will immediately show the fallout pattern.

LASER RADAR

Lightweight radar zeroed in on tank above is being developed by Orlando Div., the Martin Co. Called laser-ranger, it is similar to conventional radar, but uses high intensity light, not microwaves, to pinpoint targets. Weighs 35 lbs.

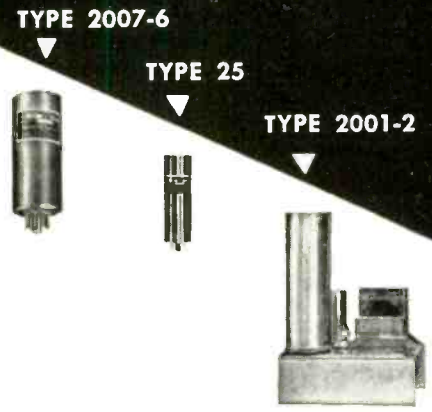
FREQ STDS.

AND PRECISION FORK UNITS 1 TO 40,000 CYCLES

TYPE 10
1⅜"x1⅜"x⅜"

This frequency standard (360 or 400 cycles) is accurate to ± 50 parts per million at 10° to 35°C. Aging has been greatly minimized.

External power of 1.4 volts at 6 microamperes powers the unit.

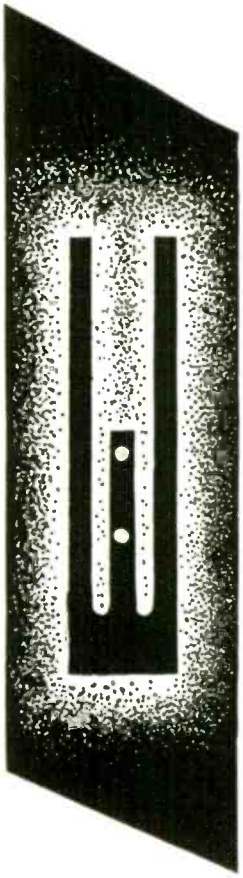


TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± 0.2% (—50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (—65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2 FREQUENCY STANDARD

Size, 3¾" x 4½" x 6" H., Wt., 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at +20° to +30°C
Output: 5V at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V, at 5 to 10 ma.
Accessory Modular units are available to divide, multiply, amplify and power this unit.



TYPE K-5A FREQUENCY STANDARD

Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, —55° to +71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave at 115V into 4000 ohm load (approx. 4W)

TYPE 25 PRECISION FORK

Size, ⅝" dia. x 2⅞"
Weight: 2 ounces
Frequencies: 200 to 1000 cy.
Accuracies:
R-25T and R-25V ± .002% (15° to 35°C)
25T and 25V ± .02% (—65° to 85°C)
For use with tubes or transistors.

INQUIRIES INVITED

For over 20 years we have made frequency standards and precision fork units for applications where consistent accuracy and rugged dependability are vital. Shown are just a few typical examples.

Some users integrate our products with instruments of their own manufacture. In other cases we develop complete assemblies to meet special needs.

You are invited to submit any problems within the area of our activity for study by our engineering staff.

ATP

AMERICAN TIME PRODUCTS
DIV. OF BULOVA WATCH COMPANY, INC.
61-20 Woodside Ave., Woodside 77, L. I., N. Y.
WESTERN OFFICE, 234 N. LAKE AVE., PASADENA, CALIF.

optical systems and components

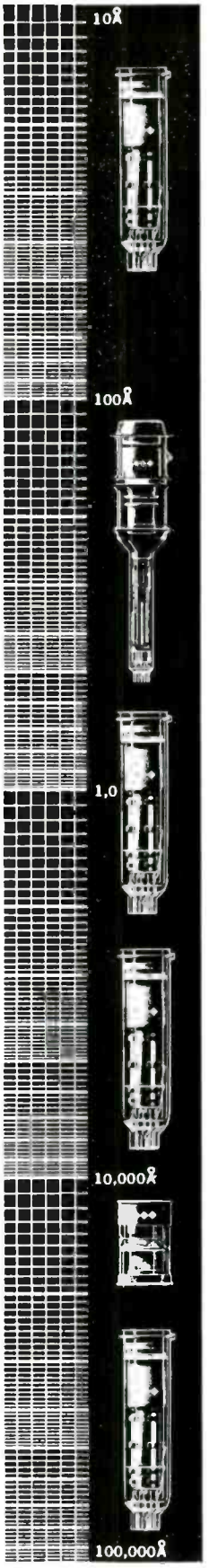
FOR VISIBLE, ULTRAVIOLET AND INFRARED RADIATION

ASTRON ∏ OPTICS Division can supply custom designed optical systems and components to meet the most rigid specifications.

Components are available in any material including all known optical glasses, synthetics, germanium, silicon, and beryllium.

Systems and components assembly is performed in strict clean-room environment.

for new brochure, write Astron ∏ Optics Division.

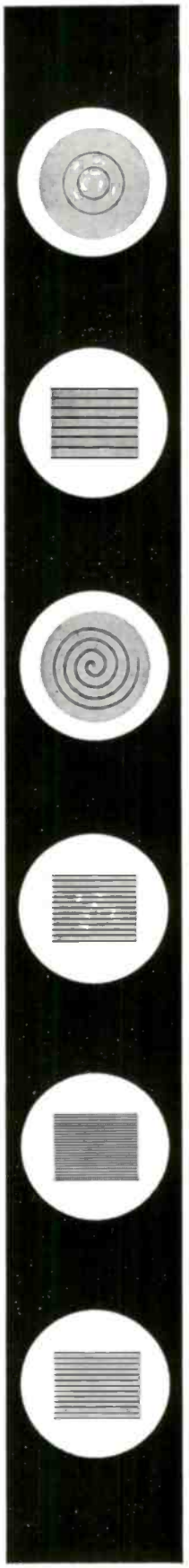


GEC vidicon camera tubes

GEC offers the highest sensitivity image pick-up tubes having the widest coverage of the spectrum.

Available are a variety of Ubicons, Ebicons, Vidicons, and Special Purpose imaging tubes.

A wide choice of other tube parameters including slow scan characteristics, magnetic focus and deflection, electrostatic focus and deflection, electrostatic focus and magnetic deflection and return beam multiplication is available from GEC.



GEC scan conversion systems

Transistorized with printed circuit modular components, GEC Scan Conversion Units incorporate the most advanced technological developments available for controlled conversion from one scanning mode to any other.

Conversion of PPI to TV, TV standards conversion, storage and integration of video information, time-coordinate transformation, digital to analog, TV conversion, and conversion of slow scan narrow band systems to standard TV or vice versa are available.

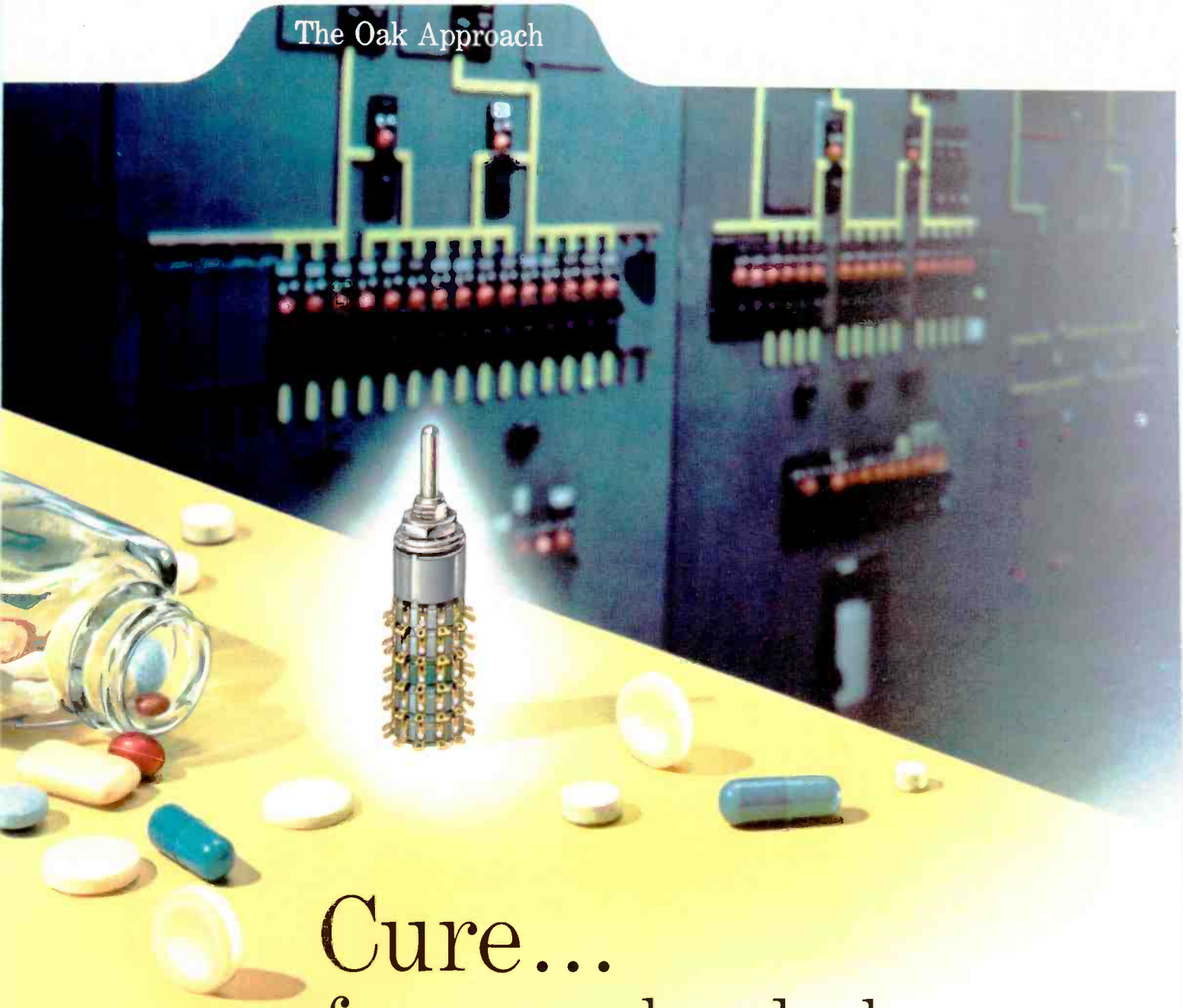
Information on GEC Monoscope Video Signal Generators, monitoring systems and slow scan TV cameras for use with GEC Scan Converters is available on request.

For integrated systems employing either optics, sensors or processing electronics, or any combination to meet your requirements, write or call

GENERAL ELECTRODYNAMICS CORPORATION

4430 FOREST LANE • GARLAND, TEXAS • BROADWAY 6-1161

The Oak Approach



Cure... for space headaches

new ultracompact half-inch switch cuts space problems down to size!

It's become almost axiomatic in electronics that "thinking big" requires thinking *small*. And, of course, when circuit proportions shrink, the demand for smaller switches mounts correspondingly. Imagine how many tight places are presently crying for the advantages of this new *half-inch diameter, multisection rotary switch:* the *very first of its kind,* functionally equivalent to a regular-size rotary — physically smaller than your index finger!

Obviously rotary switches have "gone small" before; but this is far-and-away the first *multisection,* 12-position design able to match the versatility of its more sizable counterparts. Up to 5 sections per switch; 3 poles per section! And small size doesn't imply delicateness. Half-inch Oak rotary switches shrug-off environmental extremes . . . withstand 50-hour salt spray; feature reliable double-wiping, self-cleaning contacts.

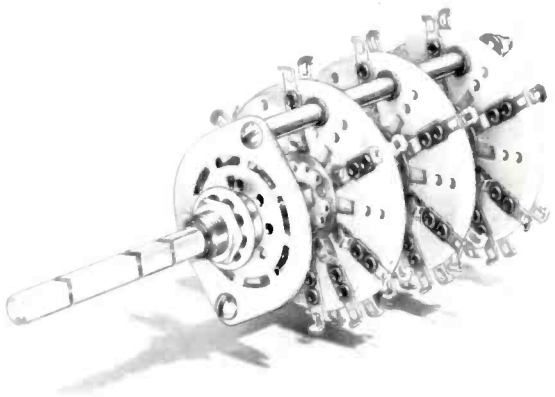
Even if your present requirements are apart from this sort of diminutive design, Oak application engineers still offer you a vital service. Their experience ranges through all sorts of switching problems involving function, environment, space and costs. And Oak capabilities also encompass production of precision subassemblies, made to your exact specifications.

For further information, contact your Oak representative. Or, feel free to phone us direct any time that we can be of help.

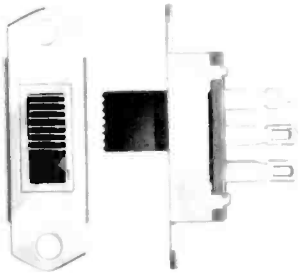
SWITCH SHOWN ACTUAL SIZE

Where creativity pays practical dividends

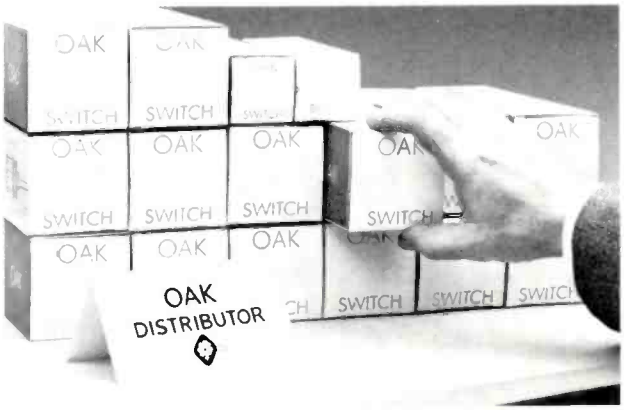
OAK rotary Power-Rated Switch — New compact design, with trim profile. Lowest-cost of all rotary power switches! Actually brings savings of one-third to one-half, compared to other alternatives. And the new Oak rotary Power-Rated Switch is just one current offspring of *New Product Engineering* — the department at Oak now given the full-time assignment of creating and improving product design. Rotary power switches can be had with one, two or three sections; provide up to 12 positions. UL listed for 125 vac, 6 amps; inductive rated at .75 PF; tested to 60,000 makes-and-breaks — or *ten times UL* requirements!

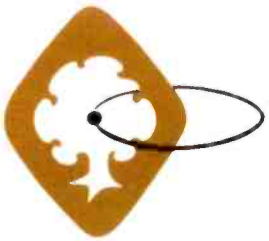


OAK space-saver slideswitch — 30% slimmer than prior designs, with seven fewer parts. Width savings so significant as to suggest literally hundreds of uses in equipment where space is at a premium! Economical too — you'll find this trim, new slideswitch *priced lower* than bulkier, ordinary models. Series-200 Oak slideswitches are obtainable in 11 different switching configurations. Rated 3 amps; available with or without UL listing. Double-wiping, self-cleaning contacts. Operation thoroughly tested, proven more reliable and longer-lasting than even its popular forebears.



OAK also helps you save time! A new program now means distributors nation-wide will carry more than 130 types and sizes of Oak rotary switches, right on their shelves! You'll find superior replacements for many common makes; plus special configurations not available from stock *anywhere else*. Also component parts for assembling your own style of switch, from one to four sections, two to 23 positions. Quality is fully equivalent to our custom switch runs. Call collect for the name of your nearest Oak stock-switch distributor: Area code 815; 459-5000—request *Oak operator 10*.





OAK MANUFACTURING CO.

CRYSTAL LAKE, ILLINOIS • Telephone: Area Code 815; 459-5000; TWX: CRYS LK 2350-U;
Plants in Crystal Lake, Illinois • Elkhorn, Wisconsin

Subsidiaries: OAK ELECTRONICS CORPORATION, Culver City, Calif. · DELTA-f, INC., Geneva, Ill. · McCOY ELECTRONICS CO., Mt. Holly Springs, Pa.

ROTARY AND PUSHBUTTON SWITCHES • TELEVISION TUNERS • VIBRATORS • APPLIANCE AND VENDING CONTROLS • ROTARY SOLENOIDS • CHOPPERS • CONTROL ASSEMBLIES

SPERRY microwave memo

Sperry offers 60-day delivery on a low-cost K band reflex klystron

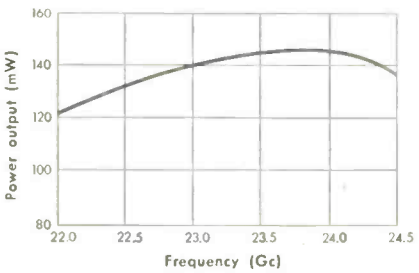
The SRK-291, a new low-cost K band reflex klystron oscillator offering dramatic cost savings in microwave systems, is now available from Sperry Electronic Tube Division within 60 days from receipt of your order! Sperry's new tube operates at frequencies ranging from 21 to 24.5 Gc. Within these frequency limits, it offers a 1½ Gc mechanical tuning range and a low temperature coefficient. The SRK-291 is priced at only $1495.

PARAMETRIC PUMPING APPLICATIONS

The SRK-291 is specially suited to the requirements of parametric amplifier pumping, since its power output — 80 mW minimum — is more than adequate for parametric amplifier pumping demands. Its low price, wide bandwidth, and inherent stability remove the technical and economic limitations that formerly hindered the use of parametric amplifiers in many systems.

OTHER APPLICATIONS

Sperry's versatile new tube also shows great desirability for application in short range communications systems, beacons, and microwave links. Extreme mechanical ruggedness, light weight (only 3½ oz.), and small size, make the tube ideal for airborne as well as ground-based installations.



SRK-291, typical P out vs. Freq.

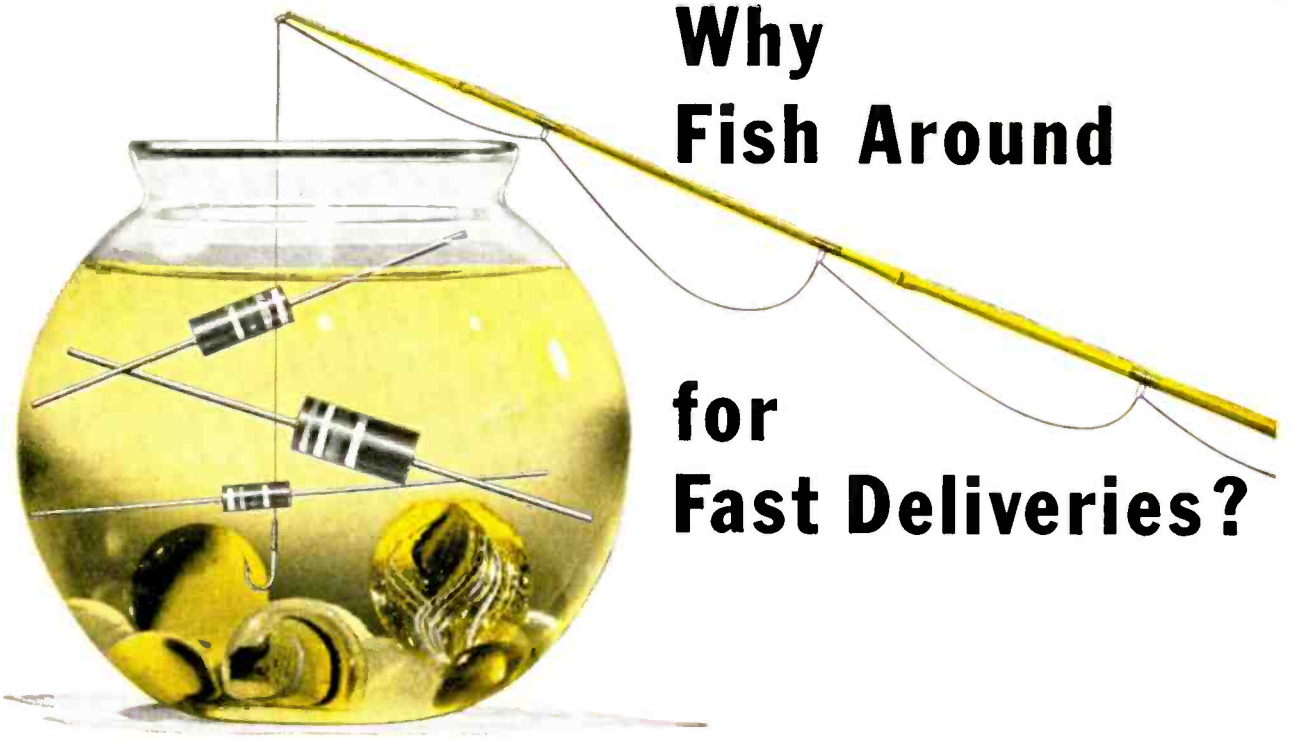
NEW, FREE BROCHURE

A new, free brochure describes the capabilities of the SRK-291 in greater detail. For your copy, write to Sperry Electronic Tube Division, Sec. 136, Gainesville, Florida.

Since the SRK-291 is available within 60 days, it represents an *immediate* solution to your present problems, whether you are designing a new system or concentrating on improved performance for an operational one. Cain & Co., which represents Sperry nationally, has a sales engineer near you. He'll be happy to help you work out specification details. Call him today.

SPERRY ELECTRONIC TUBE DIVISION

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



Why Fish Around for Fast Deliveries?

. . . Hook Up with

Need resistors *on the double* for small runs, military prototypes, production emergencies, or hurry-up design and engineering projects? Get them from Stackpole Distributors—*in 24 hours or less!*

Today's handsomest resistors, Stackpole Coldite 70+ are just as good as they look. Performance meets and beats latest MIL-R-11 requirements — pays extra load-life and moisture-resistance bonuses. And exclusive solder-coated leads stay tarnish free for fastest soldering. Order Coldite 70+ Fixed Composition Resistors in 2-watt (RC-42), 1-watt (RC-32), and ½-watt (RC-20) sizes — in all standard values and tolerances — right from Distributors' stocks.

STACKPOLE
Coldite 70®+
FIXED COMPOSITION
RESISTORS

Available in 24 hours or less

. . . from these Leading Distributors!

ALABAMA
OPELIKA—Southern Electronics Corp.
CALIFORNIA
GLENDALE—R. V. Weatherford, Co.
LONG BEACH—Deans Electronics
LOS ANGELES—Rising's, Inc.
OAKLAND—Brill Electronics
PASADENA—Wesco Electronics
COLORADO
DENVER—Denver Electronics Supply Co.
CONNECTICUT
WATERBURY—Bond Radio Supply Co., Inc.
DISTRICT OF COLUMBIA
WASHINGTON—Electronic Wholesalers, Inc.
FLORIDA
MELBOURNE—Electronic Wholesalers, Inc.
MIAMI—Electronic Wholesalers, Inc.
TAMPA—Thurow Electronics, Inc.
WEST PALM BEACH—Goddard Dist. Inc.
GEORGIA
ATLANTA—Specialty Dist. Co., Inc.
INDIANA
INDIANAPOLIS—Radio Dist. Co.
KANSAS
WICHITA—Interstate Elect. Supply Corp.
KENTUCKY
LOUISVILLE—P. I. Burks Co., Inc.
MARYLAND
BALTIMORE—Electronic Wholesalers, Inc.
Kann-Ellert Electronics, Inc.
MASSACHUSETTS
BOSTON—Sager Electrical Supply
WATERTOWN—Northeast Elect. Dist., Inc.
N. WILBRAHAM—Industrial Comp. Corp.
NEWTON—Cramer Electronics
MICHIGAN
BATTLE CREEK—Electronic Supply Corp.
MISSOURI
ST. LOUIS—Interstate Ind. Electronics, Inc.
NEW JERSEY
MOUNTAINSIDE—Federated Purchaser, Inc.
WHIPPANY—State Electronics Parts Corp.
NEW YORK
BROOKLYN—Electronic Equipment Co., Inc.
Quad Electronics, Inc.
BUFFALO—Summit Dist., Inc.
HEMPSTEAD—Hempstead Electronics
LYNBROOK—Peerless Radio Dist. Co.
MINEOLA—Adelphi Electronics, Inc.
Arrow Electronics, Inc.
NEW YORK—Electronics Center, Inc.
Harvey Radio Corp.
Milo Electronics Corp.
Sun Radio & Elect. Co., Inc.
ROCHESTER—American Electronics, Inc.
SYRACUSE—Harvey Elect.—Syracuse, Inc.
Morris Electronics of Syracuse
WHITE PLAINS—Westchester Electronic Supply Co., Inc.
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PHILADELPHIA—Almo Radio Co.
Philadelphia Elect., Inc.
SCRANTON—Fred P. Pursell
SOUTH CAROLINA
FLORENCE—Southern Electronics, Inc.
TEXAS
DALLAS—Wholesale Electronic Supply
VIRGINIA
ROANOKE—Peoples Radio & TV Supply Co.
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SEATTLE—C & G Electronics Co.
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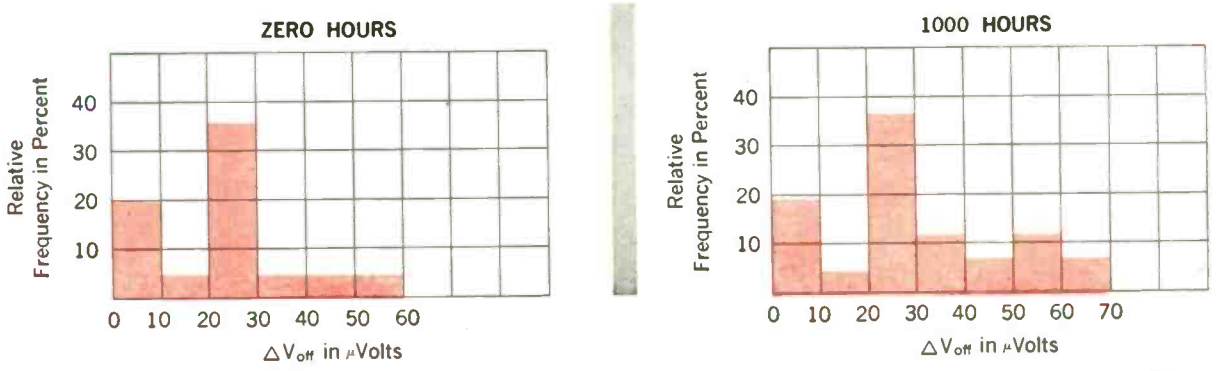
56 Distributors—PLUS . . .
and G-C/STACKPOLE, TOO!

Attractively packaged by G-C Electronics for service replacement uses, Coldite 70+ Resistors are also available through over 800 G-C distributors.

PHILCO CHOPPERS
MATCH AND STAY MATCHED

DISTRIBUTION OF DIFFERENTIAL OFFSET VOLTAGE DURING LIFE TESTS



New Philco drift-free design and the Philco SPAT™ manufacturing process result in silicon choppers that match and stay matched. Inherently durable matching, verified by highly accelerated aging tests, is documented in the data shown above.

Philco chopper transistors also offer industry's most useful combination of chopper parameters, i.e. lower "on" resistance, for highest data handling accuracy, and higher voltage to make switching speed more usable.

For multiplex and analog switching, commutating, and other low level applications, be sure to specify Philco SPAT choppers. For complete data, write Dept. EI762.

PHILCO SILICON MATCHED CHOPPER PAIRS†

	2N2187	2N2275	2N2277	2N2279	2N2281
V_{CB}	−30V	−25V	−15V	−15V	−10V
I_{CBO} (max.)	1na	3na	3na	1na	3na
ΔV_{off} (max.)*	0.05 mv	0.1 mv	0.1 mv	0.05 mv	0.1 mv

† Philco SPAT choppers also are available in single units.
* Offset voltage for the matched pair, ΔV_{off}, is held within maximum limits, within a specified temperature range.

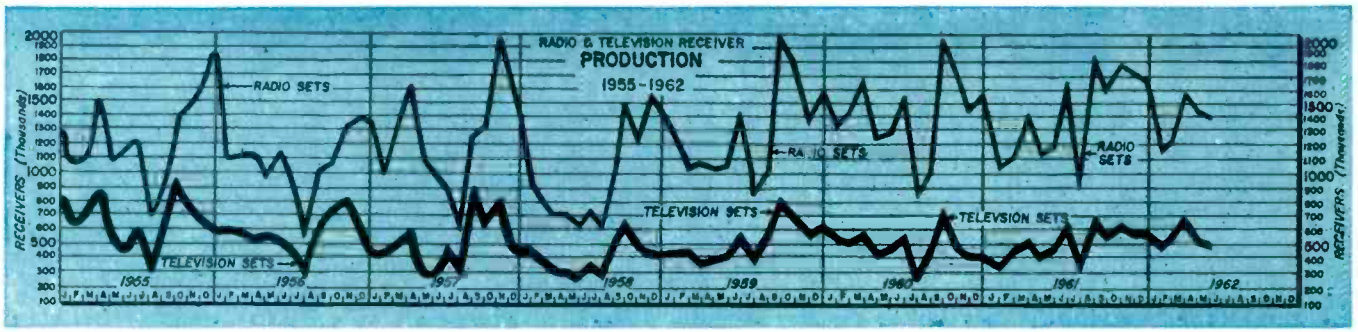
All Philco silicon choppers are available today from your Philco Industrial Semiconductor Distributor

PHILCO®
A SUBSIDIARY OF Ford Motor Company
LANSDALE DIVISION, LANSDALE, PA.

SOLID-STATE CENTER U.S.A.

Facts and Figures Round-Up
July 1962

ELECTRONIC INDUSTRIES TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

Accelerometers	1,986,551
Actuators	29,925
Amplifiers	1,211,676
Analog-to-Digital conversion system	175,800
Analyzers	508,094
Antennas	691,989
Cable assemblies	495,700
Cable, coaxial	72,652
Cable, RF	40,044
Cable, special purpose	64,053
Cable, telephone	8,138,870
Capacitors	29,000
Cavity assembly	31,520
Chaff, countermeasures	3,259,300
Communications equipment	1,770,864
Computers	29,992
Connectors	691,274
Controls	1,107,386
Converters	2,790,369
Coordinate data set	390,000
Counters	94,090
Coupling units	453,599
Detecting set	1,192,723
Discriminators	468,571
Electronic digital voltmeter system	194,556
Exciter system, vibration	81,144
Frequency controller	50,280
Generators, time code	83,526
Gyroscopes	4,542,140
Headset	282,226
Indicators	1,476,585
Intercommunication equipment	90,233
Interrogation sets	460,000
Loudspeakers	166,182
Magnetic tape	37,500
Memory cores	59,534
Meters	760,839
Microwave, digital, geodetic, subsystem	750,000
Monitoring system, radiation	46,615
Navigation equipment	2,563,457
Oscillators	113,000
Oscillograph	115,928
Oscilloscope	676,598
PCM Conversion system	55,519
Photoelectric cell	140,804
Power supplies	337,343
Printed circuit boards	89,360
Printers	44,105
Radar	2,994,695
Radiacmeter	165,905
Radio set	30,665
Ratiometer	31,610
Receivers	1,272,808
Recorder	251,140
Recorder/Reproducer	740,038
Recording systems	104,927
Relay armature	108,453
Relay systems, UHF voice	461,000
Relays	436,116
Resistors	255,889
Selector unit, transmitter	342,569
Semiconductors	274,700
Sequencer	43,750
Signal generators	161,689
Simulators	828,252
Sonar	2,090,562
Sonobuoys	985,711
Spectrophotometer	59,236
Standards	610,859
Switchboard	3,466,926
Switches	452,243
Switching system	713,090
Synchronizers	126,230
Synchros	227,958
Tape, recording	20,535
Target detecting device	430,090
Telephone equipment	1,245,334
Test equipment	470,306
Test set	985,370
Transceivers	2,390,046
Transducer	88,290
Transmitters	1,796,004

(Continued on page 52)

Shipments of Electrical Measuring Instruments, Comparative Periods, 1960-61
(Quantities expressed in units and corresponding values in thousands of dollars)

EPRA/BDSA Reporting Categories	Full Year				Fourth Quarter			
	1960		1961		1960		1961	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
AC Panel, not ruggedized or sealed	481,223	4,420	424,002	3,833	103,142	1,071	122,065	1,011
Military	51,538	703	60,182	654	14,059	198	18,848	187
Nonmilitary	429,685	3,717	363,820	3,179	89,084	873	103,217	824
DC Panel, not ruggedized or sealed	2,460,564	23,150	2,402,894	20,850	595,863	5,238	663,869	5,562
Military	225,557	4,516	174,612	3,271	55,038	972	43,754	824
Non Military	2,235,007	18,634	2,228,282	17,579	540,825	4,266	620,115	4,734
AC Panel, ruggedized or sealed	101,980	13,156	111,457	14,425	27,911	3,583	27,842	3,775
DC Panel, ruggedized or sealed	322,354	12,822	265,837	9,381	67,800	3,343	72,656	2,583
Military	197,213	9,150	141,224	5,506	41,048	2,491	41,589	1,540
Nonmilitary	125,141	3,672	124,593	3,875	26,752	852	31,067	1,043
AC and DC Panel, with control or signal initiating means, including instrument relays	121,713	6,973	88,193	5,501	31,209	1,460	22,238	1,135
AC and DC Switchboard	107,688	8,878	101,409	8,042	26,356	2,031	27,995	2,238
AC and DC Portable	72,792	6,210	42,541	6,001	9,283	1,329	10,481	1,481
Recording	99,168	43,636	114,853	73,982	23,809	11,490	32,132	21,631
Sub-Total[1]	.....	119,245	.....	142,015	.....	29,545	.....	39,416

[1] Does not include "miscellaneous" shipments which include items reported, but which cannot be published because of regulations concerning disclosure of individual company data.

Source: Business and Defense Services Administration, U. S. Dept. of Commerce.

THERMOFIT

THERMOFIT TFE is a new TEFLON* insulation tubing available in nine sizes at considerable savings over other teflon tubing. It is thin-wall (.004"), flexible and water-clear with all normal characteristics of polytetrafluoroethylene. TFE shrinks at 621°F in 3 to 5 seconds but will not shrink under operating temperatures up to 500°F (260°C). Shrinkage in diameter (none in length) is to one-quarter of the original dimension, therefore extreme variations in contour may be encapsulated tightly.

CLEAR • NO PIN HOLES

NO SHRINKING TO 260°C

SHRINKS TO ¼ ORIGINAL DIAMETER

NO CHANGE IN LENGTH

FLEXIBLE • THIN WALL

NEW

TFE

SIZE	MIN. EXP. I.D.	MAX. REC. I.D.	NOM. WALL EXPANDED	*PRICE/C FT.
5/64"	.078"	.025"	.004"	21.45
1/8"	.125"	.037"	.004"	22.00
1/4"	.250"	.063"	.004"	31.90
3/8"	.375"	.096"	.004"	40.70
1/2"	.500"	.144"	.004"	73.50
5/8"	.625"	.177"	.004"	98.70
3/4"	.750"	.219"	.004"	120.75
1"	1.000"	.274"	.004"	155.00
1 1/4"	1.250"	.342"	.004"	222.00

*REG. DUPONT

*25M FT. QUANTITY

*TEFLON TUBING

UP TO 70% SAVING

NEW

THERMOFIT

TFE

RAYCLAD TUBES
INCORPORATED

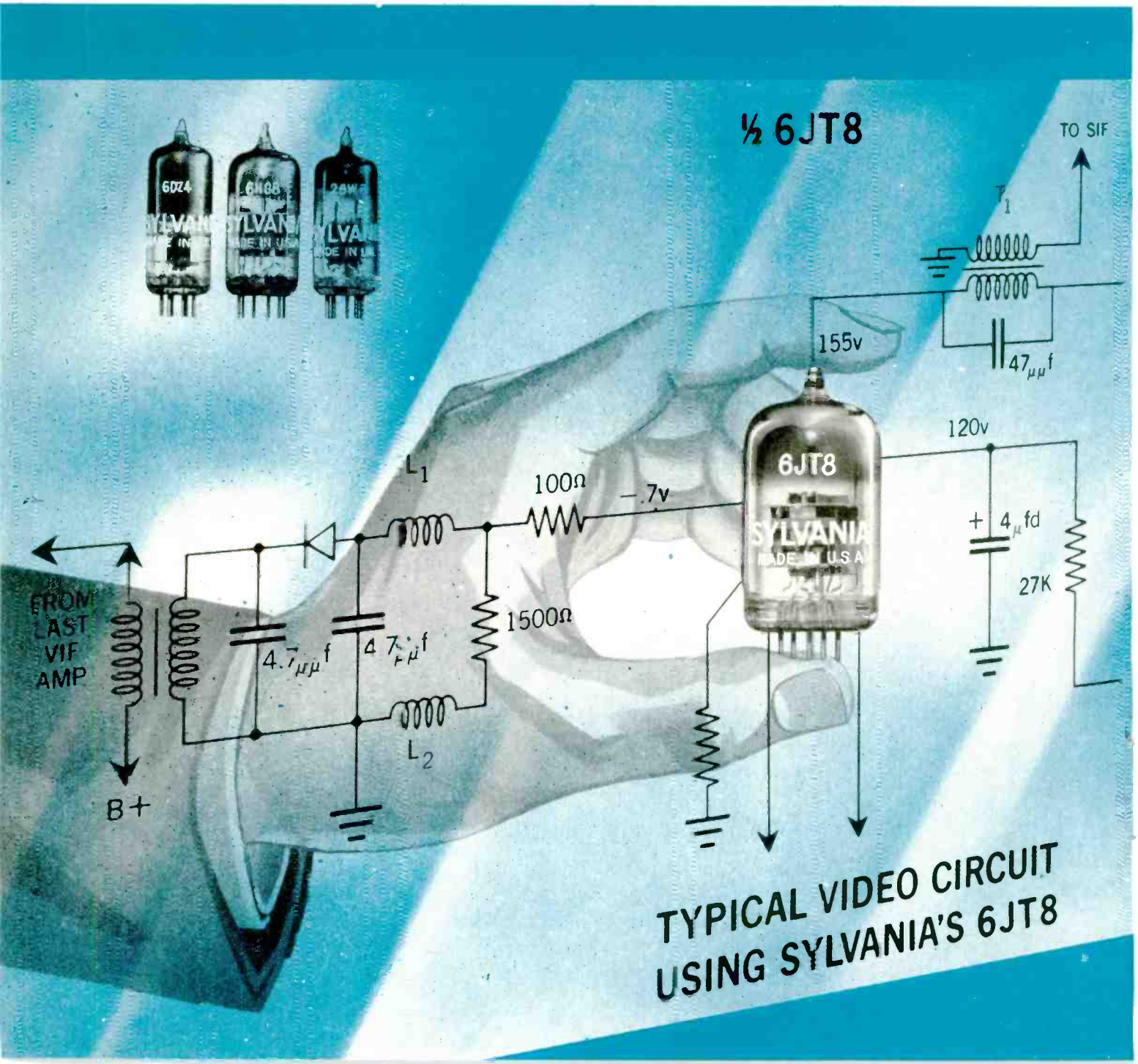
A SUBSIDIARY OF
RAYCHEM
CORPORATION

If simplifying TV design while maintaining picture contrast seems a formidable challenge—if high performance and high cost seem to go hand-in-hand—take heart! Sylvania offers four practical solutions, four competitively priced tube types offering sustained high performance. Tube parameters such as Gm to Ib, gain, noise levels are appreciably improved.

Sylvania-6JT8 combines a video pentode and medium-mu triode in the Sylvania-originated 9-T9 bulb, offering space and cost economies. The pentode section mates Strap Frame Grid with Bikini Cathode, a pre-cast emissive film bonded to the two major sides of the cathode sleeve. This design provides high sensitivity, high peak plate current, lower tube capacitances and lower knee voltages. Compared with other video pentodes currently available, the Sylvania 6JT8 provides a 20% increase in video output at a 40% decrease in input signal. Use it to improve video performance or to eliminate one IF stage.

Sylvania-6HG8, triode-pentode for oscillator-mixer applications, features rugged Strap Frame Grid in the

New from Sylvania—four practical



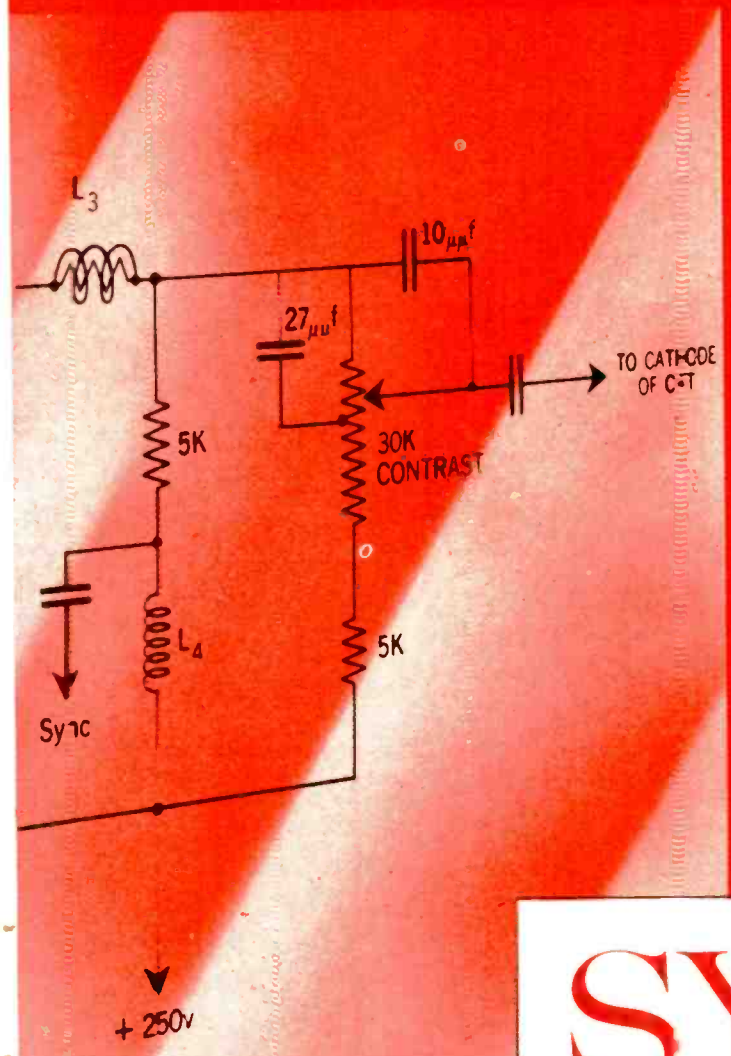
pentode section. Frame grid enhances structural integrity of 6HG8 and reduces possible microphonics. Sylvania-6HG8 provides as much as 6db higher gain than comparable types.

Sylvania-2/3/6DZ4, 7-pin miniature UHF oscillator offers new improved performance over extended life. This can be attributed almost entirely to a major Sylvania improvement, the powder metal cathode. Use of powder metal cathode base material substantially enhances cathode life, eliminates emission slump, stabilizes insulation resistance. Result:

Sylvania-6DZ4, in 1500-hour life tests with 130V line supply, shows a 1% failure rate compared with a 13% failure rate of previous UHF oscillator types.

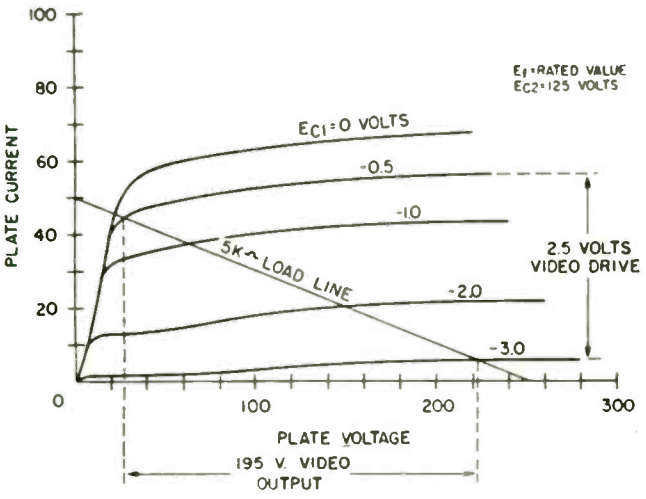
Sylvania-2/3/4/6GW5 is designed for use in grounded grid circuitry as a VHF RF amplifier with a low B+ of 135V. A 7-pin miniature triode, it offers a Gm of 15,000 μmhos and Gm: Ib of 1300. Design features of Sylvania-6GW5 include: Strap Frame Grid; partial shield between grid and plate for reduced capacitance; dual grid leads for higher input impedance and reduced grid inductance.

solutions for TV circuit designers



Video circuit using pentode section of 6JT8

Sylvania-6JT8 — Plate Family



If you'd like to learn more about the design and sales advantages of new Sylvania tubes for TV circuits, contact your Sylvania Sales Engineer. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, New York.

SYLVANIA

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GENERAL TELEPHONE & ELECTRONICS

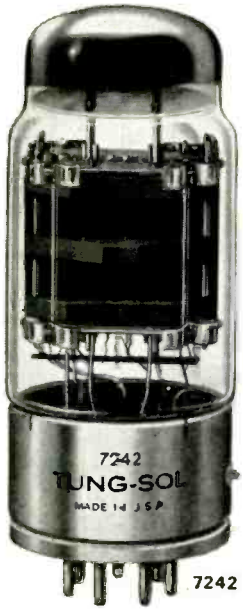
GENERAL SYSTEM

Circle 12 on Inquiry Card


8193

7802WB

6528



7242

TUNG-SOL SERVICE-DESIGNED SERIES REGULATOR TUBES

☐ FROM 14 WATTS TO 100 WATTS

☐ FROM 100 MILLIAMPS TO 1 AMP

Designed and developed expressly for use as passing tubes in series regulated power supplies (not adaptations of other tube types). Each of these mechanically rugged devices exhibits minimum tube drop when run "wide open", thereby assuring peak-efficiency operation. High current capability per tube plus a variety of power levels makes paralleling of tubes unnecessary. In addition, these series regulators possess the important advantage of requiring little grid-voltage swing to control current. All feature zirconium coated graphite anodes which, while lighter than similar metal anodes, remain warp-free and provide one of the best known methods of gas gettering. Use of hard glass envelopes permit the tubes to be outgassed at high temperatures during the exhaust process. This allows the tubes to be operated at very high temperatures without internally generating harmful gas. Gold-plated molybdenum wires are used in the rugged grid structures. Flexible metal vibration snubbers support the tube mount on its rugged button stem to insure maximum shock and vibration resistance. Stringent environmental and life tests guarantee reliable, long, trouble-free tube life.

Pictured are a family of medium Mu (μ=9), 6.3 volt heater, high environmental regulators. Also available are low Mu tubes, various heater voltage versions, and lower cost commercial counterparts.

TYPICAL VALUES FOR REGULATOR SERVICE PER TUBE

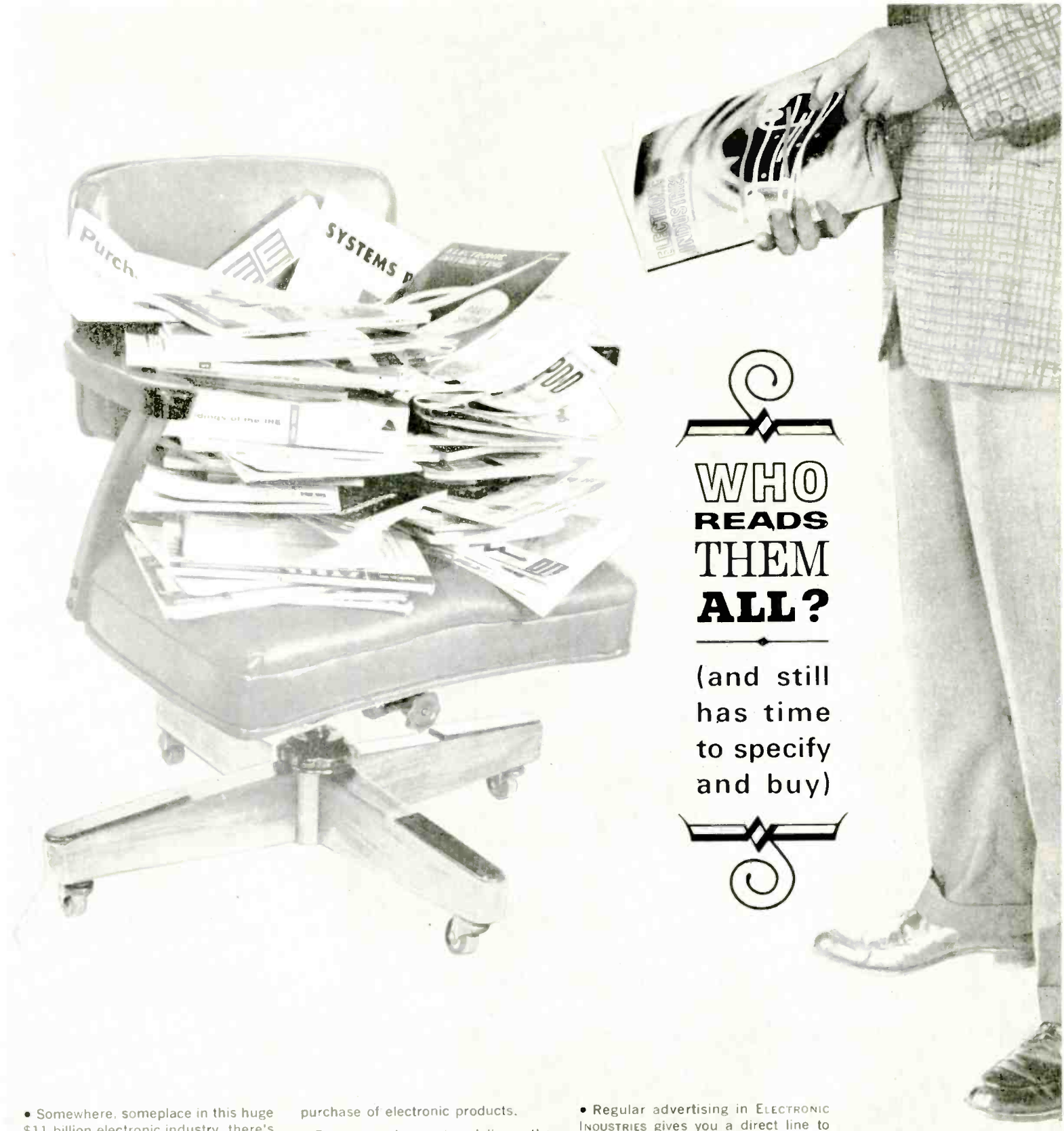
Type	Total Plate Current (Milliamperes)	Range of Tube Voltage Drop (Volts)	Minimum Tube Drop (Volts)	Grid Voltage Swing (Volts)
8193	75 50	110 180	80 60	15 25
7802WB	200 100	65 220	60 40	8 35
6528	400 200	65 225	70 45	10 35
7242	600 250	80 335	70 40	13 45

POWER DISSIPATION CHART OF TUBE TYPES

Total Plate Dissipation	14W	26 to 30W	60W	100W
Low Mu	6877	6AS7G 6080WB	6336A	7241
Medium Mu	8193	7802WB	6528	7242

Write for new series regulator portfolio. Complete technical information about all Tung-Sol series regulator tubes—the most supplied by any manufacturer—is contained in this handy reference kit. It's yours upon request. Just write: Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193. Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Seattle, Wash. CANADA: Abbey Electronics, Toronto, Ont.

TUNG-SOL®



WHO READS THEM ALL?

(and still has time to specify and buy)

• Somewhere, someplace in this huge $11 billion electronic industry, there's probably some anonymous soul who does. They're good publications all. Each has its own special niche.

• But with one publication—ELECTRONIC INDUSTRIES—you get monolithic coverage of 6100 electronic plants. These account for over 96% of total annual purchase of electronic products.

• ELECTRONIC INDUSTRIES delivers the largest group of engineering decision-makers in the industry. These men read ELECTRONIC INDUSTRIES each and every month in depth because it's edited to provide them with the useful theory and applied engineering that solves their everyday problems.

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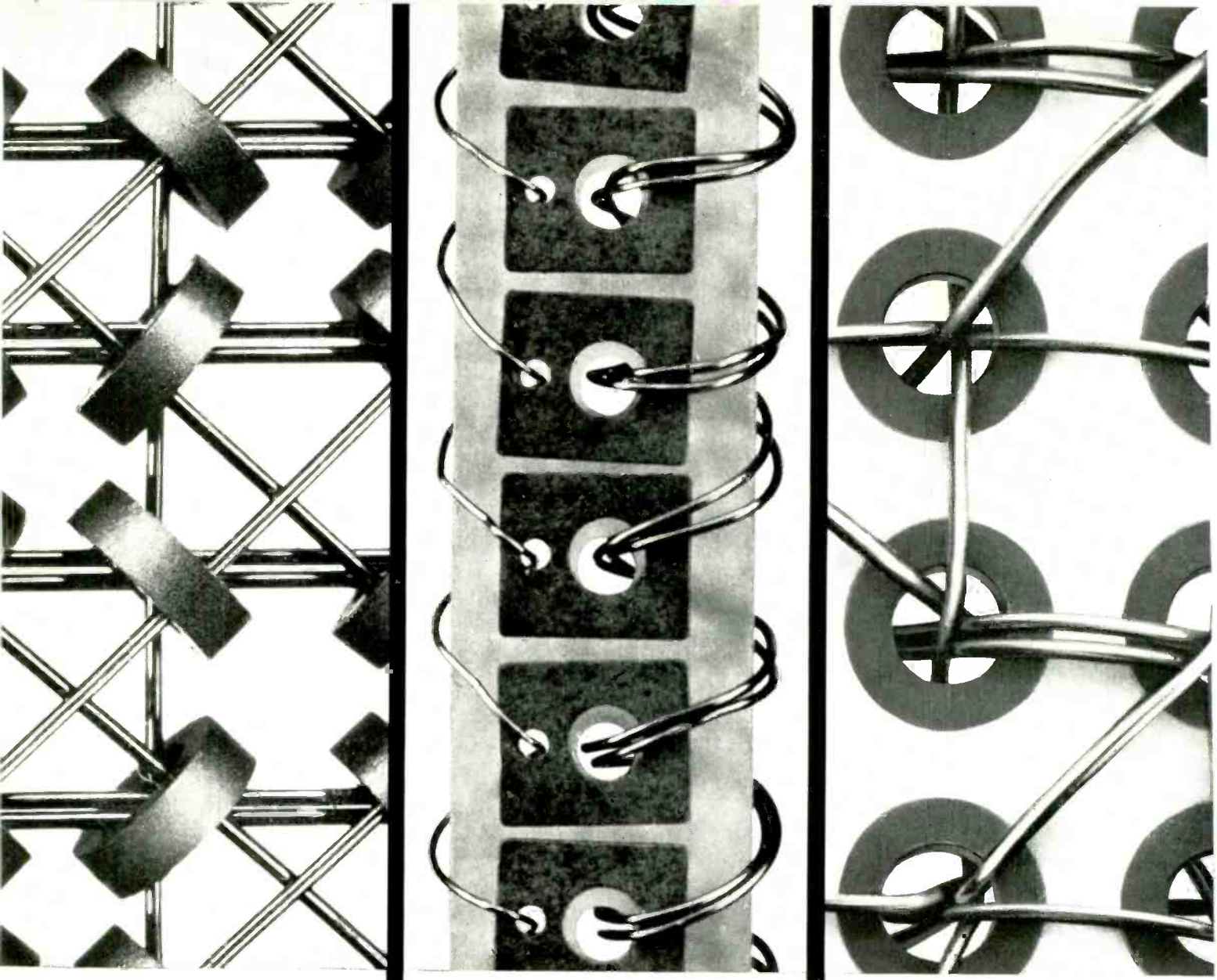


2.

3.

PRODUCTS PHOTOMACROGRAPHED APPROXIMATELY 30 TIMES ACTUAL SIZE

close-up of maximum reliability

Lockheed Electronics' in-house capability produces ferrite cores, multi-aperture devices, printed circuit boards, memory planes and stacks, plug-in circuit modules, and fabricated metal casings. Every step from design through test is under one management to assure maximum quality control and minimum cost.

The enlarged photos above show three of the many types of memory plane assemblies produced by Lockheed Electronics.

1. Standard commercial open frame ferrite core memory plane utilizing either coincident current or linear select wiring.

2. Lockheed designed memory array using multi-aperture cores to provide non-destructive readout. This unique method of mounting and wiring provides the necessary rigidity for severe environmental applications.

3. Memory plane with conventional ferrite cores using imbedded assembly and wiring techniques to meet exceptionally high environmental shock and vibration requirements of military specifications.

For further information on Lockheed cores, memory planes and stacks, or printed circuitry to fill your particular requirements, write: Lockheed Electronics Company, 6201 East Randolph Street, Los Angeles 22, California.

LOCKHEED ELECTRONICS COMPANY

Circle 19 on Inquiry Card

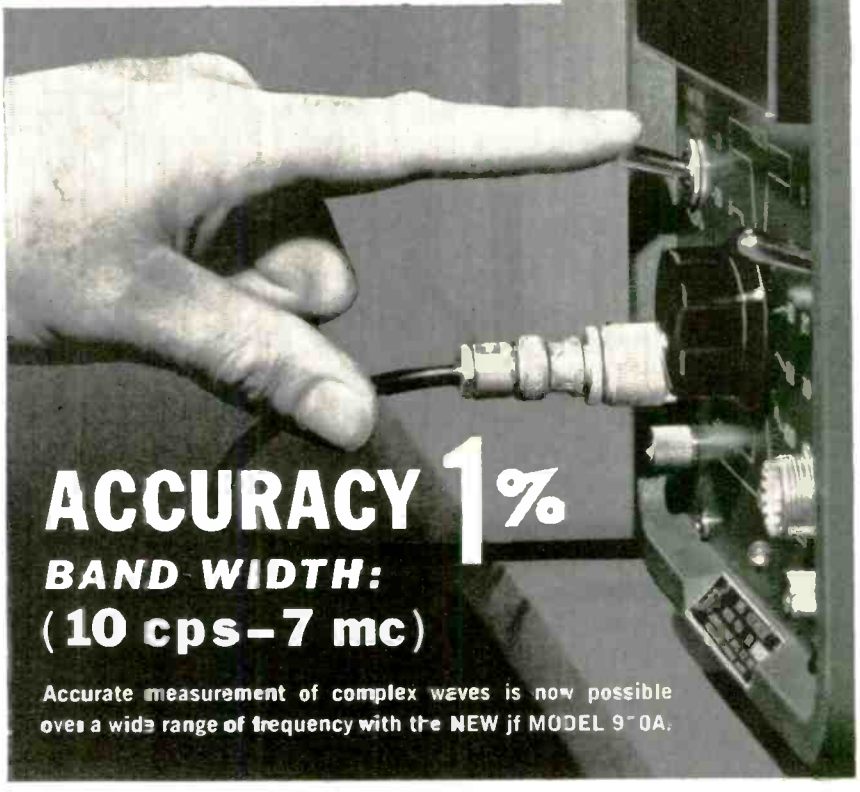
A DIVISION OF THE LOCKHEED AIRCRAFT CORPORATION

THIS IS A... TRUE RMS VOLTMETER

THIS VOLTMETER DOES NOT

- ... respond to the average voltage and multiply by 1.1
- ... respond to the peak voltage and divide by 1.414
- ... use a diode matrix to approximate a square law response

IT DOES... RESPOND to TRUE RMS and IT READS TRUE RMS!



ACCURACY 1%

BAND WIDTH:

(10 cps–7 mc)

Accurate measurement of complex waves is now possible over a wide range of frequency with the NEW jf MODEL 910A.

MODEL 910A

For the *first time* one instrument provides 1% midband accuracy, 10 cps to 7mc bandwidth, plus 100 u v sensitivity. For added versatility an amplifier output is provided for simultaneous oscilloscope or recorder monitoring.

Model 910A employs a thermocouple located in the feedback loop of a sensitive DC amplifier to measure the actual heating effect of the input waveform. This circuit arrangement is the key to the rapid response and high calibration accuracy of the Model 910A and also prevents any error in reading due to ambient temperature variation. Isolation of the thermocouple from the input terminals by a high gain, ultra stable AC amplifier provides high input impedance and completely protects the thermocouple from burnout under any condition of overload.

Model 910A is ideal for measuring AC currents in non linear devices, total harmonic content of distorted waveforms, noise, average power of pulse trains, and other measurements that involve waveforms which are not necessarily pure sinusoids.

Partial Specifications—jf MODEL 910A

Voltage Range:	1 MV to 300V (full scale readings)
Decibel Range:	−72 to +52 dbm
Frequency Response:	10 cps to 7Mc
Accuracy:	± 1% of full scale 50 cps to 800 KC ± 2% of full scale 20 cps to 2Mc ± 3% of full scale 20 cps to 3.5 Mc ± 5% of full scale 10 cps to 7 Mc
Input Impedance:	10 megohms shunted by 30 pf for 0.3 volt range and below. 10 megohms shunted by 15 pf for 1.0 volt range and above.
Crest Factor:	3 at full scale, proportionately higher for readings less than full scale.
Price:	Cabinet Model—$545.00 Rack Model—$565.00 Prices f.o.b. factory.

Prices and data subject to change without notice.

A more complete description will be sent to you upon request.

FLUKE

JOHN FLUKE MFG. CO., INC.
P. O. Box 7428 Seattle 33, Washington

Circle 20 on Inquiry Card

EI's International News

Subsidy Program For Canadian Research

U. S. companies with Canadian subsidiaries can now accomplish proprietary industrial research projects for outlays of about 25¢ on the dollar under a new Canadian government subsidy program.

Canadian affiliates of American companies, as well as Canadian firms, are eligible for industrial research grants of close to 50% of the research costs. The research, however, must be done in Canada.

The additional 25% saving accrues to the companies because research costs are now fully deductible for Canadian corporate income tax purposes.

No discrimination will be made between American-owned and Canadian-owned companies in approving requests. Flexible standards will be used by the Industrial Research Committee in impartially approving grants.

Certain conditions which must be met, however, include the following: (1) That the work be done in Canada, either in company laboratories or contract research facilities. (2) That competent personnel and equipment be used. (3) The projects must be of a true scientific nature, not design innovation, trouble shooting or

(*Continued on page 36*)

EUROPE

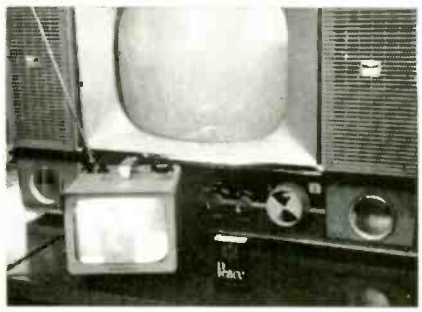
London—An agreement to work together in developing techniques and equipment for all-weather operation of airliners has been reached by Elliot Automation Ltd. and the American Bendix Corp. Both firms are leading developers of all-weather aviation equipment in their countries.

London—A new type of pay TV system involving use of central billing exchanges and coaxial cable is being considered here for adoption in the United Kingdom. Designed by Marconi's Wireless Telegraph Co. Ltd., it was recently previewed before government officials and entertainment industry heads. A central billing exchange would register all programs seen in a method similar to that for billing phone calls.

London—A machine developed here makes capacitors using interleaved sheets of metallized paper. Plessey Co. Ltd. developed it from a machine for fabricating packets of interleaved cigarette papers. Chief advantages gained are a reduction in self-inductance and better heat dissipation.

Oslo—The U. S. Navy's "Bullpup" air-to-surface missile will be built for NATO by European NATO nation manufacturers. The Norwegian firm of Kongsberg Vapenfabrikk will be prime European contractor. The Martin Company, U. S. prime contractor, and the Navy will render technical assistance.

TINY JAPANESE TV



Pictured above is one of several makes of tiny Japanese TV sets which may soon hit U.S. market. This one, manufactured by Mitsubishi Electric Manufacturing Co., is dwarfed by 14-in. set in BG, seems small compared with pack of cigarettes. Set has 6-in. screen, 23 transistors, weighs 6 lbs. Another set developed almost at same time by Sony Corp. features 5-in. screen, 24 transistors, weighs 8 lbs. Still another, a 10-in. set produced by Tokyo Electric Co., is already being sold here.

ASIA

Tokyo — The Mitsubishi Electric Manufacturing Co. Ltd. and General Precision Equipment, Inc., of the United States, have formed a new firm. The new company, known as Mitsubishi Precision, Inc., will make precision electronic equipment.

New Delhi—A contract to produce what is believed to be the first computer for India has been awarded by the India Supply Mission here. The award went to Electronic Associates, Inc., Long Branch, N.J. The computer, a PACE 231R general purpose analog system, will be installed at the Defense Ministry here.

Tokyo — Three or four Japanese communications satellites will be orbiting by 1964 in time for Olympic Games reportage from here if research proceeds as expected. A 105-lb. cylinder-shaped satellite is being developed by Nippon Electric Co., Ltd., under a Science and Technology Agency grant. The satellite will be put in orbit by a U. S. rocket to minimize cost to Japan. Both the vehicles used and the orbits will probably be decided by NASA.

AFRICA

Monrovia — Liberia has awarded RCA a $2,860,000 contract to install long-distance telephone links within

(*Continued on page 36*)

DUTCH ELECTRONIC PRODUCTION

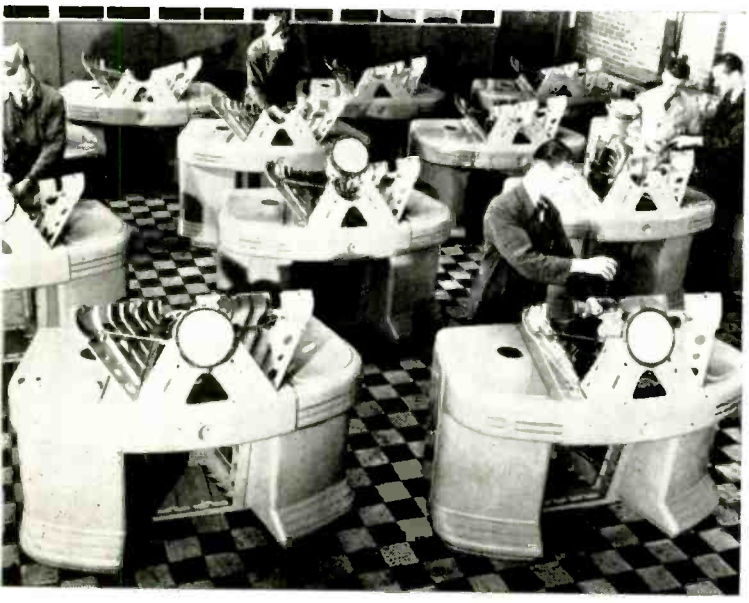
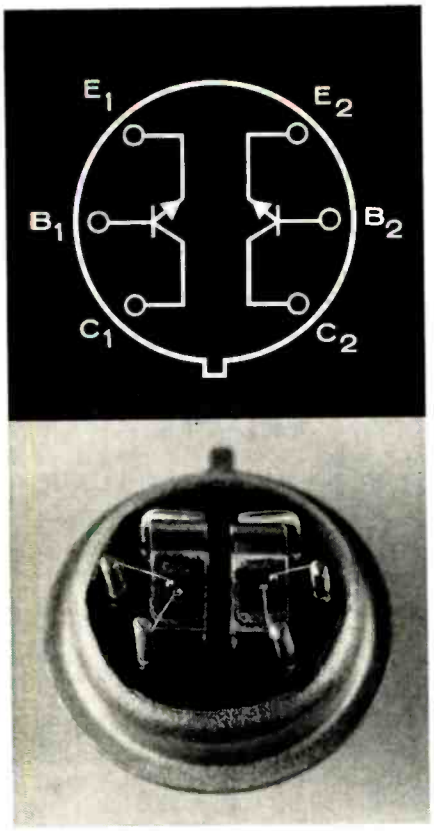


Photo at left shows ultra-modren electron microscope under construction at factory in Holland. Holland now ranks fourth among World's nations in exporting electrical and electronic products to other nations, with 7% of all exports in these fields in 1960.

DUAL TRANSISTORS



IN A SINGLE TO-5 PACKAGE

- All leads isolated
- Improved thermal tracking
- Less board space
- A wide range of Fairchild Silicon Planar or Silicon Planar Epitaxial transistors
- Fairchild Planar reliability

FAIRCHILD TRANSISTORS AVAILABLE IN DUALS

Similar Types	Dual	Similar Types	Dual	Similar Types	Dual
2N708	SP8300	2N916	SP8306	2N2297	SP8312
2N709	SP8301	2N995	SP8307	2N2368	SP8313
2N910	SP8302	2N1132	SP8308	2N2369	SP8314
2N911	SP8303	2N1613	SP8309		
2N914	SP8304	2N1711	SP8310		
2N915	SP8305	2N1893	SP8311		

MATCHED AMPLIFIER TYPES AVAILABLE

2N2060†	2N2223†	2N2223A†	SP8305A (2N915)*	SP8306A (2N916)*

*Matched Beta within 10% at I_c = 1 mA, and V_{CE} = 5 V; $V_{BE1} - V_{BE2}$ (absolute values) ≤ 0.005 V.

†See data sheets for matching specifications.

For complete information, check your Fairchild Sales Representative.

FAIRCHILD SEMICONDUCTOR

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A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

Circle 27 on Inquiry Card

International News

(*Continued from page 34*)

the fast-growing nation and connect it with the rest of the world through telephone and telegraph systems.

AUSTRALIA

Canberra — The world's first completely transistorized radio navigation beacon has been developed by an Australian firm and is now being tested. This is particularly important for this country, where many small, infrequently used airports now lack navigational aids due to their high cost. The Beacon was developed for the Dept. of Civil Aviation by Standard Telephone & Cables Pty Ltd., of Sydney, an IT&T affiliate.

NORTH AMERICA

New York—News was transmitted at 1,000 wpm. recently over a test circuit from New York to London by the New York Times. A high-speed voice circuit and a Digitronics Dial-o-verter System were used. The test means that the Times may soon be able to transmit some 60,000 words it needs for its International edition, published in Paris, in an hour.

Subsidy (*Continued from page 34*)

empirical experiments.

The extent of Canadian government subsidies will about equal the cost of the salaries of scientific personnel involved, roughly half the cost of a research project. The initial appropriation is $1 million, but additional sums will be made available when the extent of industrial interest can be appraised.

It is anticipated that the program will make long-range research in Canada competitive with, or even cheaper than, research conducted in Europe by American companies. Few American firms have had incentive to use Canadian research in the past because its cost has been comparable with that in the U. S.

Among the program's objectives, from the Canadian point of view, are (1) Building up Canada's internal research facilities. (2) Encouraging scientists and technicians to stay in Canada. (3) Encouraging young people to take up scientific careers. (4) To make the conduct of industrial research economically more feasible for small companies.

News Briefs

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

EAST

BURROUGHS CORP., ELECTRONIC COMPONENTS DIV., Plainfield, N. J., has announced construction of a plant addition which will double their present engineering and manufacturing facilities. Occupancy is slated for October 1962.

KULKA ELECTRIC CORP., Mt. Vernon, N. Y., and **HERMAN H. SMITH, INC.**, Brooklyn, N. Y., have merged and are now known as **KULKA SMITH ELECTRONICS CORP.** The merger was effected by an equal exchange of Kulka Class "A" stock for Smith common stock.

BREEZE CORPORATIONS, INC., Union, N. J., has received a $1 million contract for slip ring assemblies from the **SPERRY GYROSCOPE DIV., SPERRY-RAND CORP.**

ORTRONIX INC., Orlando, Fla., has been awarded a contract, totaling $122,000 for the design and manufacture of 6 SSB FM airborne telemetry systems, from NASA's Marshall Space Flight Center, Huntsville, Ala. The systems are to be used aboard both current and future Saturn missiles.

ACCURACY, INC., Waltham, Mass., has acquired **RAYTRON ELECTRONICS, INC.**, Hicksville, L. I., N. Y. Raytron will operate as a subsidiary and will be the potentiometer div. of Accuracy.

KEARFOTT DIV., AEROSPACE GROUP, GENERAL PRECISION, INC., Little Falls, N. J., has received a $225,000 contract from the Dept. of the Navy, Bureau of Ships. The contract is a 2-phase program: Phase I covering feasibility study and Phase II to design and build a "breadboard" model of a Sun/Moon Tracker. Intended for ship applications, the Sun/Moon Tracker will provide sun or moon angular direction information.

DEFENSE and ENGINEERING PRODUCTS GROUP, GENERAL INSTRUMENT CORP., Westwood, Mass., and Hicksville, L. I., N. Y., has been awarded a prime letter contract by the U. S. Navy's Bureau of Weapons, to design and develop oceanographic instrumentation and to conduct underwater studies for the Polaris program.

GENERAL ELECTRIC CO. has announced plans for a $3 million expansion of its Electronic Specialty Capacitor plant, Irmo, S. C. About $1.5 million will be used for a 40% increase in manufacturing and research space and the other $1.5 million will be spent on new equipment.

HUGHES AIRCRAFT CO.'s SEMICONDUCTOR DIV., Newport Beach, Calif., has moved its Long Island, N. Y., sales office from Garden City, to new quarters at 220 Old Country Rd., Mineola, N. Y.

MELPAR, INC., SUB. of WESTINGHOUSE AIR BRAKE CO., Falls Church, Va., has been awarded a $1.4 million letter contract from the USAF for the production of 9 GAM (Guided Air Missile), 83 A/B missile trainers. The GAM-83 is a supersonic air to surface missile carried by tactical jet aircraft capable of delivering a conventional warhead.

NASA's Office of Manned Space Flight has awarded a $115,000 development contract to the **SPACE SCIENCES LABORATORY** of **GENERAL ELECTRIC CO.'s MISSILE AND SPACE VEHICLE DEPT.**, Valley Forge, Pa. The contract is for the development of an experimental unit capable of continuously reclaiming, under space conditions, the bulk of oxygen consumed by a man.

TECHREP DIV., PHILCO CORP., Philadelphia, Pa., has received a $350,000 contract for maintenance of precision measuring equipment at the USAF's Vandenberg AFB, Calif.

POTTER INSTRUMENT CO., INC., Plainview, N. Y., has received an order for more than $130,000 from the **DIGITAL EQUIPMENT CORP.**, Maynard, Mass., for Potter Model 9061I, magnetic tape transports.

SYLVANIA ELECTRIC PRODUCTS, INC., Buffalo, N. Y., has received a $570,000 USAF contract for manufacture of components for the AN/APN-81 precision doppler radar navigation system for aircraft. The contract was awarded by the Air Force Aeronautical Systems Div., Wright-Patterson AFB, Dayton, Ohio.

INTERNATIONAL RESISTANCE CO., Philadelphia, Pa., has announced construction plans for a 12,500 sq. ft. extension of its **ST. PETERSBURGH, FLA., DIV.** facilities.

THE THOMAS & BETTS CO., INC., has announced construction of a new 67,000 sq. ft. addition at its main plant in Elizabeth, N. J. The additional floor area represents about a 20% expansion and will house expanded manufacturing and warehouse operations. Construction is expected to be completed by November 1962.

MIDWEST

SANGAMO ELECTRIC CO., Springfield, Ill., has announced plans to move its high reliability capacitor components production from Marion, Ill., to an enlarged plant, 276,000 sq. ft., in Pickens, S. C. Sales, engineering and executive offices remain in Springfield.

HALOGEN INSULATOR and SEAL CORP., Franklin Park, Ill., has announced plans for plant expansion that will add 50% to its previous output. The expansion plans include the moving of its molding department and test laboratory to new air conditioned facilities at Franklin Park.

TOWER COMMUNICATIONS CO., Sioux City, Ia., has announced that its wholly owned subsidiary **TOWER COMMUNICATIONS CO. LTD.**, Toronto, Canada, has been awarded a $2.5 million contract by the Canadian Government. The contract is for the design, fabrication and installation of long-wire antennas and towers for a high frequency communication system extending from the Pacific to the Atlantic Ocean.

URETHANE INDUSTRIES INTERNATIONAL INC., Evanston, Ill., has announced the purchase of **STAUFFER-HEWITT CO.**, from the **STAUFFER CHEMICAL CO.** The purchase price was in excess of $2 million. Stauffer-Hewitt's name will be changed to the **AMERICAN URETHANE DIV.** of Urethane Industries International Inc. American Urethane will continue to operate the two plants in Franklin and Newton, N. J.

ROHN MFG. CO., Peoria, Ill., has announced the completion of two new buildings at its tower manufacturing plant, having total floor space exceeding 10,000 sq. ft. The buildings are now in operation. Also added was additional warehousing areas.

CENTRALAB, THE ELECTRONICS DIV. of GLOBE-UNION, INC., Milwaukee, Wis., has established new headquarters for its **DISTRIBUTOR DIV.** The 16,000 sq. ft. facilities will house the division's sales, administrative, and stocking operations and is located in Menomonee Falls, Wis.

WEST

TEXAS INSTRUMENTS INCORPORATED has been awarded a subcontract of approximately $900,000 by **PHILLIPS PETROLEUM CO.**, for the fabrication of fuel for the Atomic Energy Commission's experimental organic cooled reactor. The reactor is under construction at the AEC's National Reactor Testing Station near Idaho Falls, Idaho. The fuel will be fabricated at the **NUCLEAR PRODUCTS GROUP** of TI's corporate division, **METALS & CONTROLS INC.**, Attleboro, Mass.

The **SYSTEMS DIV., BECKMAN INSTRUMENTS, INC.**, Fullerton, Calif., has opened a sales office in Atlanta, Ga., at 3240 Peachtree Rd., N.E. The office will service the southeastern United States.

FAIRCHILD SEMICONDUCTOR, Mountain View, Calif., has been given a repeat order of approximately $370,000 to supply transistors to the Boeing Co., Seattle, Wash., for use in the USAF's Minuteman weapon system.

FORD INSTRUMENT DIV., SPERRY RAND CORP., N. Y., has awarded a $300,000 contract to **PACKARD BELL COMPUTER CORP.**, Los Angeles, Calif., for two Nontrajectory Recording Systems for shipboard use. These digital data systems will be used as part of the Mobile Atlantic Missile Range System (MARS), in the tracking of missiles and satellites fired out over the AMR.

MOTOROLA SEMICONDUCTOR PRODUCTS INC., Phoenix, Ariz., has opened a new district sales office at 2136 El Cajon Blvd., San Diego, Calif. The new office brings to 18 the total number of field offices now operated in the United States.

THE BENDIX CORP., N. Hollywood, Calif., has been awarded a contract totaling approximately $300,000 by NASA's George C. Marshall Space Flight Center, Huntsville, Ala., for a telemetry playback system. The 18 racks of telemetry equipment will be delivered this summer to the Space Flight Center in Huntsville.

BOURNS, INC., has moved its **TRIMPOT® DIV.** into new 90,000 sq. ft. facilities at 1200 Columbia Ave., Riverside Industrial Park, Riverside, Calif.

PHOTOGRAPHIC INSTRUMENTATION DEVELOPMENT CO., Tarzana, Calif., has announced ground breaking plans for a new 15,000 sq. ft. manufacturing facility in Chatsworth, Calif. Photographic designs and manufactures integrated instrumentation recording systems for telemetry and ionospheric studies.

AiRESEARCH MFG. DIV., THE GARRETT CORP., Phoenix, Ariz., has received a $650,000 follow-on contract from the Army's Los Angeles Ordnance District for additional production of small mobile 30kw gas turbine generator sets. The sets are for use in the Army's Sergeant Missile launching system.

DATA SYSTEMS DIV., RADIO CORP. OF AMERICA, Van Nuys, Calif., has received a $1,928,000 contract from NASA's Marshall Space Flight Center, Huntsville, Ala., to provide 3 ground computer systems for support of the Saturn vehicle program.

WIANCKO ENGINEERING CO., Pasadena, Calif., has received a contract from NASA totaling $78,085 for pressure generating systems for the Saturn Program. The equipment will be used to checkout and calibrate pressure instrumentation and transducers prior to actual test firing.

EAI ANNOUNCES ALL-SOLID-STATE DIGITAL VOLTMETER UNDER $3000

EAI's outstanding solid-state digital voltmeters are now offered at volume production prices. Increased acceptance of the solid-state reliability and long-term stability of these precision instruments has enabled EAI to sharply increase output. Resulting manufacturing economies permit prices comparable to electro-mechanical digital voltmeters.

NO COMPROMISE WITH QUALITY...CHECK THESE OUTSTANDING FEATURES:

- All-solid-state reliability
- 0.01% plus 1 digit absolute accuracy with six-month stability
- 200 readings-per-second average
- "Full-Time" high input impedance
- Complete electrical outputs and system provisions

SERIES 5000 4 digits with automatic polarity, manual ranging

$2950

SERIES 5001 featuring automatic polarity, automatic ranging and 20% overrange

$3950

CALL YOUR EAI REPRESENTATIVE TODAY!

EAI
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ELECTRO SALES ASSOCIATES, INC.
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Dayton 513 CH 4-5551
Detroit 313 TU 6-2280

G. CURTIS ENGEL & ASSOCIATES, INC.
Ridgewood, N. J. 201 GI 4-1400
Philadelphia, Pa. 215 WA 2-3270
New York City, N. Y. 212 RE 2-0001

F. Y. GATES COMPANY
Salt Lake City 801 EL 9-1101
Albuquerque 505 CH 3-8010
Englewood, Colo. 303 SU 1-8566

HAWTHORNE ELECTRONICS
Portland, Ore. 503 BE 4-9375
Seattle 206 PA 5-1460

S.S. LEE ASSOCIATES, INC.
Orlando, Fla. CH 1-4445
Towson, Md. 301 VA 3-3434
Wheaton, Md. 202 LO 5-3066
Huntsville, Ala. 205 JE 6-0631
Winston-Salem, N. C. 919 PA 4-2406

G. S. MARSHALL COMPANY
San Marino, Calif. 213 MU 1-6781
San Diego 714 BR 8-6350
Redwood City 415 EM 6-8214
Scottsdale, Ariz. 602 946-5521

SOUTHWEST ELECTRONICS INDUSTRIES, INC.
Dallas 214 EM 3-1614
Houston 713 MA 3-5775

R. EDWARD STEMM, INC.
Chicago 312 ES 9-2700
Minneapolis 612 822-8404

THE HOWARD J. SCHUFT COMPANY
Newtonville, Mass. 617 LA 7-5304
New Haven, Conn. 203 UN 5-1365

ALLAN CRAWFORD ASSOCIATES, LTD.
Willowdale, Ontario, Can. 416 BA 5-7391

EAI

ELECTRONIC ASSOCIATES, INC. *Long Branch, New Jersey*

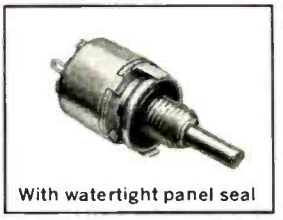
Analog/Digital Computers **Data Reduction** **Process Control** **Instruments** **Computation Service**

Space Restricted?
Application Severe?

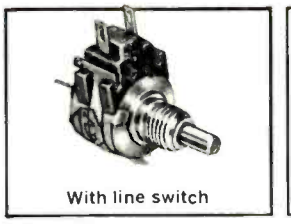
Allen-Bradley Miniature Hot Molded Variable Resistors Provide Smooth Control Which Improves With Use!

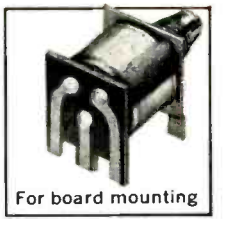
½" Diameter
Type G or Type L Control—enlarged 5 times.


With locking bushing


With watertight panel seal


With encapsulation


With line switch


For board mounting

The same reliability and superior performance of Allen-Bradley's famous hot molded construction is found in this "space-saving" size. The solid resistance element, collector track, terminals and insulating material are all hot molded—by A-B's *exclusive* process—into a single solid structure. Molded contact brushes eliminate sliding metal contacts. This assures exceptionally low "noise" initially, and this quality feature improves with use. Incidentally, the operational life exceeds 50,000 cycles with less than 10% resistance change.

These miniature controls are available as:

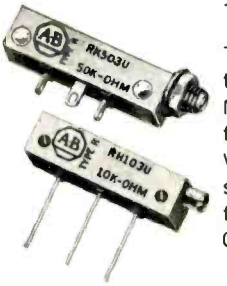
Type G—For use over ambient temperature range from −55°C to +120°C. Rated 0.5 watt at +70°C.

Type L—For use over ambient temperature range from −55°C to +150°C. Rated 0.8 watt at +70°C.

Both furnished in maximum resistances from 100 ohms to 5 megohms. For full details on these *quality* controls, please write for Technical Bulletin B5201.

ADDITIONAL A-B HOT MOLDED CONTROLS

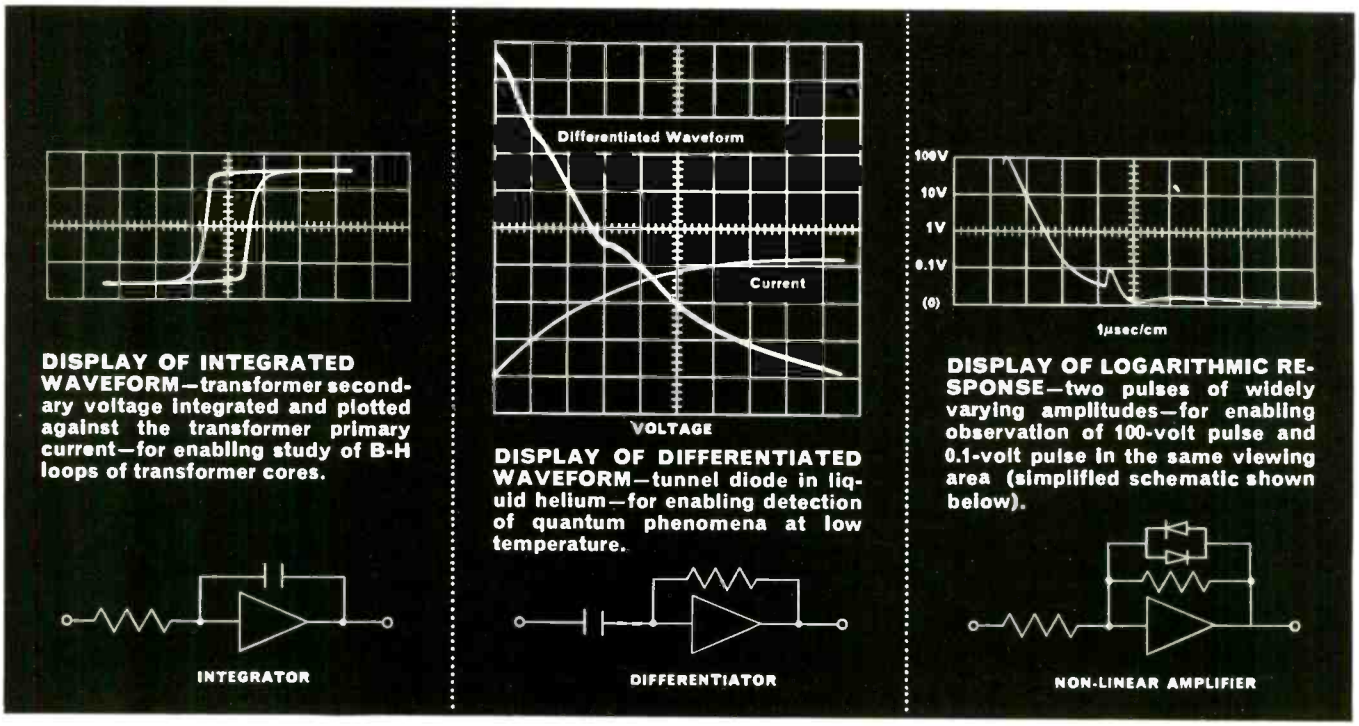
The Type F controls are especially designed for printed board mounting. Terminals fit 0.1 inch spacing. Type F temperature range −55°C to +120°C, rated 0.25 watt at +70°C. Type O temperature range −55°C to +150°C, rated 0.4 watt at +70°C.



Type R adjustable fixed resistors allow stepless adjustment. Moving element is self-locking for absolutely stable settings. Watertight case permits encapsulation. For continuous use from −55°C to +125°C, rated 0.25 watt at +70°C.

Allen-Bradley Co., 1342 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

ALLEN-BRADLEY | **QUALITY ELECTRONIC COMPONENTS**

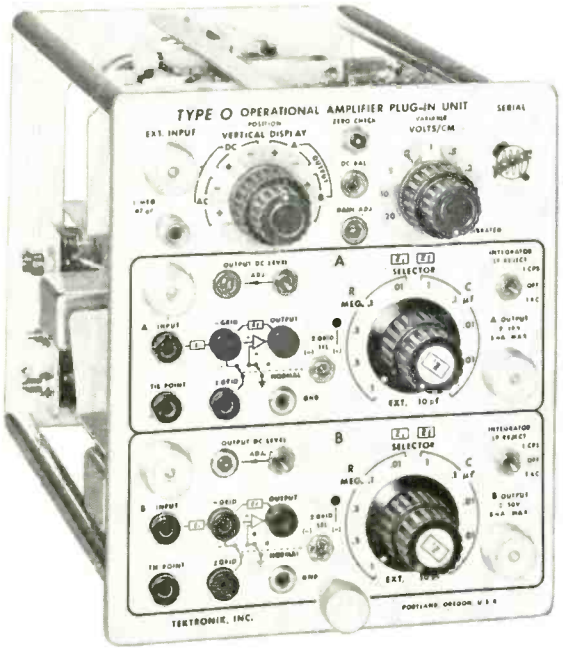


DISPLAY OF INTEGRATED WAVEFORM—transformer secondary voltage integrated and plotted against the transformer primary current—for enabling study of B-H loops of transformer cores.

DISPLAY OF DIFFERENTIATED WAVEFORM—tunnel diode in liquid helium—for enabling detection of quantum phenomena at low temperature.

DISPLAY OF LOGARITHMIC RESPONSE—two pulses of widely varying amplitudes—for enabling observation of 100-volt pulse and 0.1-volt pulse in the same viewing area (simplified schematic shown below).

New Operational Amplifier Plug-In Unit Permits Oscilloscope Measurements Under Dynamic Conditions



TYPE O UNIT U. S. Sales Price, f.o.b. Beaverton, Oregon $475

To arrange a demonstration of this highly-adaptable Operational Amplifier Unit in your Tektronix Oscilloscope, please call your Tektronix Field Engineer.

TYPE O UNIT—for Tektronix Oscilloscopes that accept letter-series plug-in units.

Using this new Operational Amplifier Unit in your Tektronix Oscilloscope, you can perform precise operations of integration, differentiation, function generation, linear and non-linear amplification.

You can accomplish many of these operations by simply manipulating the front-panel controls—for the Type O Unit features convenient *selection of precision input and feedback components.*

You can use the Type O Unit as a gated integrator . . . as a high-input-impedance amplifier . . . as a bandpass amplifier . . . as a constant-current-drive amplifier . . . as a peak-memory amplifier . . . as a function generator . . . as a capacitance-measuring device . . . as a low-current measuring device . . . and for many and varied other specialized operations—some performed *with* external circuitry and some *without.*

CHARACTERISTICS

The Type O Unit contains two complete operational amplifiers and one complete vertical preamplifier.

Each operational amplifier features 15 mc open-loop gain-bandwidth product, open-loop dc-gain of 2500, selectable input and feedback impedances, drift rejection for ac integration. The output of one operational amplifier can be applied to the input of the other for combined operations.

The vertical preamplifier can be used independently or to monitor the output of either operational amplifier. In a Tektronix Type 540-Series Oscilloscope, the passband is dc-to-25 mc, the risetime is 14 nsec, and the maximum calibrated sensitivity is 50 mv/cm.

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

TEKTRONIX FIELD OFFICES: Albuquerque, N. Mex. · Atlanta, Ga. · Baltimore (Towson) Md. · Boston (Lexington) Mass. · Buffalo, N.Y. · Chicago (Park Ridge) Ill. · Cleveland, Ohio · Dallas, Texas · Dayton, Ohio · Denver, Colo. · Detroit (Lathrup Village) Mich. · Endicott (Endwell) N.Y. · Greensboro, N.C. · Houston, Texas · Indianapolis, Ind. · Kansas City (Mission) Kan. · Los Angeles, Calif. Area (Encino · Orange · Pasadena · West Los Angeles) · Minneapolis, Minn. · New York City Area (Albertson, L.I., N.Y. · Stamford, Conn. · Union, N.J.) · Orlando, Fla. · Philadelphia (Bala-Cynwyd) Pa. · Phoenix (Scottsdale) Ariz. · Pittsburgh (Monroeville) Pa. · Portland, Ore. · Poughkeepsie, N.Y. · San Diego, Calif. · San Francisco, Calif. Area (Lafayette · Palo Alto) · Seattle, Wash. · Syracuse, N.Y. · Washington, D.C. (Annandale, Va.).

TEKTRONIX CANADA LTD: Montreal, Quebec. · Toronto (Willowdale) Ontario

ENGINEERING REPRESENTATIVES: Kenyon Hawaii Ltd., Honolulu, Hawaii. Tektronix is represented in twenty-five other countries by qualified engineering organizations.

European and African countries, the countries of Lebanon and Turkey, please contact TEKTRONIX INTERNATIONAL A.G., Terrassenweg 1A, Zug, Switzerland, for the name of your local engineering representative. Other Overseas areas, please write or cable directly to Tektronix, Inc., International Marketing Department, P. O. Box 500, Beaverton, Oregon, U.S.A. Cable: TEKTRONIX.

Ceramic-to-metal seals from one integrated source

ALITE — with its completely equipped facilities for producing high quality, vacuum-tight, ceramic-to-metal seals — is geared to meet all your requirements for high alumina ceramic-metal components. From design to finished assembly, every manufacturing step — including formulating, firing, metalizing and testing—is carefully supervised in our own plant. Result: effective quality control and utmost reliability.

Hermetic seals and bushings made of high alumina Alite are recommended for electromechanical applications where service conditions are extremely severe or critical. Alite has high mechanical strength and thermal shock resistance. It maintains low-loss characteristics through a wide frequency and temperature range. It resists corrosion, abrasion and nuclear radiation. Its extra-smooth, hard, high-fired glaze assures high surface resistivity.

To simplify design problems and speed delivery, Alite high voltage terminals, feed-throughs and cable end seals are available in over 100 standard sizes. However, when specifications call for special units for unusual applications, you can rely on expert assistance from Alite engineers to help you take full advantage of Alite's superior properties.

Write us about your specific requirements today.

WRITE FOR HELPFUL FREE BULLETINS

Bulletin A-8 gives useful comparative data. Bulletin A-40-R describes Alite facilities and complete line of Alite Standard Bushings.

ALITE DIVISION

U. S. STONEWARE

BOX 119 ORRVILLE, OHIO

141-H

Circle 33 on Inquiry Card

RAYTHEON 1N3728 CUTS DIODE COSTS IN HALF

New high reliability 1N3728 (formerly Rheem RD250) is direct replacement for more than 250 general purpose and high voltage silicon diodes.

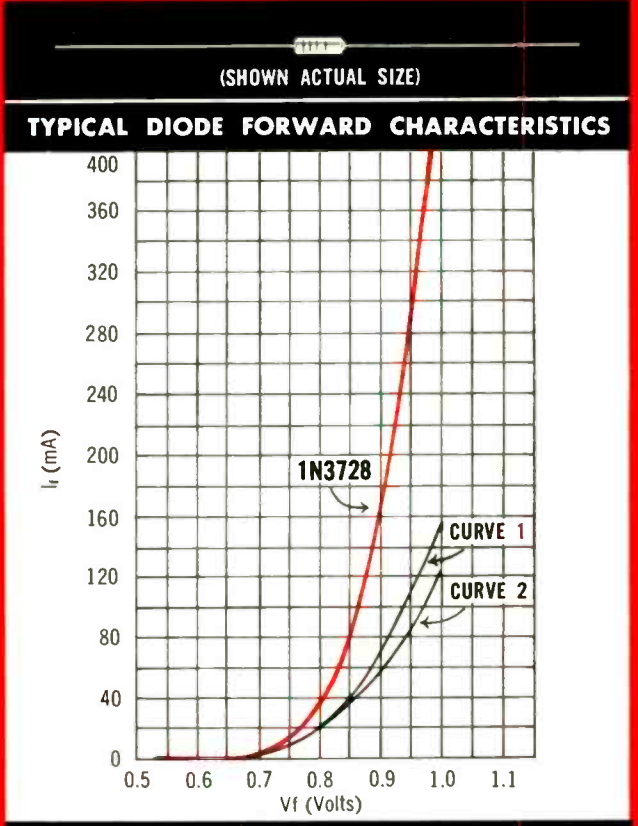
Now you can reduce qualification and specification expenses, lower inventory costs, and obtain higher reliability with the Raytheon/Rheem 1N3728 *Universal* silicon diode. It is priced at less than one-half the average of manufacturer's published prices for the diodes it replaces, and meets or exceeds all tests and specifications for these units.

The 1N3728 features very high voltage with very low leakage. Reverse leakage is specified at nine points, forward current at ten. Replacement of standard 100 and 200 volt diodes with the low cost 550-volt 1N3728 greatly increases the safety margin of the reverse characteristic, substantially reducing the major point of diode failure. Dependable performance is assured by more than two years of testing and field use.

For complete data of the 1N3728, please contact the Raytheon Field Office nearest you, or write Semiconductor Division, 900 Chelmsford Street, Lowell, Massachusetts.

MAXIMUM RATINGS @ 25°C		1N3728	UNIT
Peak rectified current	i_F	650	mA
Average rectified current	I_0	200	mA
Surge current (1 sec.)	i_F (surge)	1000	mA
Pulse current (2μsec. 1% duty cycle)	i_F (pulse)	2000	mA
Power dissipation (derate 1.4 mw/°C)	P_t	250	mW
Operating temperature	T_A	−65 to +200	°C
Storage temperature	T_{stg}	−65 to +200	°C

SPECIFICATIONS	MIN.	TYP.	MAX.	UNIT
Forward Voltage @ 1 mAdc	.61	.64	.68	V
@ 10 mAdc	.72	.75	.80	V
@ 100 mAdc	.84	.87	.98	V
@ 200 mAdc	.88	.92	1.09	V
@ 400 mAdc	.92	.98	1.20	V
Reverse Current @ 20 Vdc				
@ 25°C		.0005	.005	μAdc
@ 100°C		.050	.100	μAdc
@ 150°C		1.00	2.0	μAdc
Reverse Current @ 175 Vdc				
@ 25°C		.010	.025	μAdc
@ 100°C		.150	.500	μAdc
@ 150°C		2.0	5.0	μAdc
Reverse Current @ 400 Vdc				
@ 25°C		.085	.100	μAdc
@ 100°C		.500	1.00	μAdc
@ 150°C		4.0	10.0	μAdc
Saturation Voltage −65°C to +200°C @ 100 μA	500	—	—	Vdc
Saturation Voltage @ 25°C @ 100 μA	550	650	—	Vcc



TYPICAL DIODE FORWARD CHARACTERISTICS

TYPES REPLACED BY 1N3728

Some of the currently-used types replaced by the 1N3728/RD250 are such general purpose, high voltage silicon diodes as:

Type	*Curve*	*Type*	*Curve*	*Type*	*Curve*	*Type*	*Curve*
1N456	2	1N461	2	1N482	1	1N485	1
1N456A	1	1N461A	1	1N482A	1	1N485A	1
1N457	2	1N462	2	1N482B	1	1N485B	1
1N457A	1	1N462A	1	1N483	1	1N486	1
1N458	2	1N463	2	1N483A	1	1N486A	1
1N458A	1	1N463A	1	1N483B	1	1N487	1
1N459	2	1N464	2	1N484	1	1N487A	1
1N459A	1	1N464A	1	1N484A	1	1N488	1
				1N484B	1	1N488A	1

SEMICONDUCTOR DIVISION

LOWELL, MASSACHUSETTS

RAYTHEON

DC MEASURE
Without Breaking Leads

428A

428B

DC CURRENT METERS

Measure and record dc current, 0.1 ma to 10 amps without breaking leads or loading circuit

428A/B current meters make fast, accurate measurements in circuits where conventional current-measuring devices would alter conditions to such an extent that the desired measurement would no longer be accurate!

In any application, 428A/B current meters are without equal for ease and speed of operation. Just clip the jaws of the probe around a bare or insulated wire and read dc—even in the presence of equally strong ac on the same wire. These current meters are also valuable for measuring sums and differences of currents in separate wires. When the probe is clipped around two wires carrying current in the same direction, their sum is indicated on the meter; when one of the wires is reversed, their difference is measured.

Models 428A and 428B are almost identical except for their current measurement range. 428B has three more ranges than 428A to give it full scale readings from 1 ma to 10 amperes. 428B also has a recorder/oscilloscope output, dc to 400 cps, to make it easy to record dc levels as well as analyze ground bus, hum and ripple currents on an oscilloscope—all without circuit loading.

SPECIFICATIONS

Current range:	428A, 3 ma to 1 amp full scale in 6 ranges 428B, 1 ma to 10 amp full scale in 9 ranges
Accuracy:	±3%, ±0.1 ma
Probe inductance:	Less than 0.5 μh introduced into measured circuit
Probe induced voltage:	Less than 15 mv into measured circuit
AC rejection:	AC with peak value less than full scale affects meter accuracy less than 2% at frequencies above 5 cps and different from the carrier (40 KC) and its harmonics. (On 428B 10 amperes range, ac is limited to 4 amperes peak.)
Output:	428B approximately 1.5 volts and 1 ma max. for full scale
Probe insulation:	300 v maximum
Probe tip:	½" x 9/32". Aperture diam. 3/16"
Size:	Cabinet, 7½"x11½"x14¼"; rack mount, 19"x7"x13" behind panel
Weight:	Cabinet, 19 lbs.; rack mount, 24 lbs.
Price:	428A, $500.00 (cabinet); 428AR, $505.00 (rack mount) 428B, $600.00 (cabinet); 428BR, $605.00 (rack mount)

Accessory Probes for the 428A/B DC Current Meters

New 3529A Magnetometer Probe—Useful anywhere magnetism is found and an accurate measurement of the magnetic field strength is desired: i.e. orientation of components for minimum magnetic interaction. Features direct conversion of milligauss to milliamps, so that 428 meters read magnetic field directly. Accuracy 3% ±0.1 milligauss. Accuracy also depends on calibrating the probe with the specific 428 meter being used. $75.00.

New 3528A Clip-On DC Current Probe—2⅝" aperture for large conductors: wires, pipes, multi-conductor cables (including lead-sheathed), ground straps, waveguide testing, waveguide circulating dc current testing. Accuracy obtainable equal to that of 428 meters. $350.00.

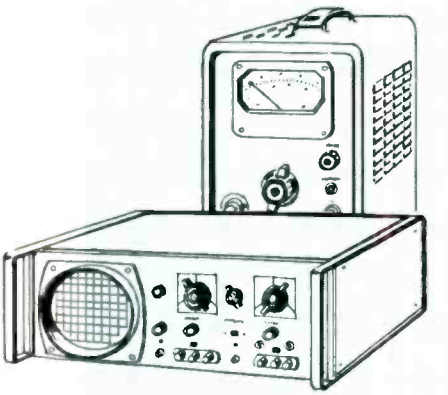
CURRENT AC
Without Loading Circuit

456A AC CURRENT PROBE

Converts ac current to ac voltage directly! 1 amp = 1 volt for reading on your scope or voltmeter

Measure ac current with an ac voltmeter with the 456A AC Current Probe. Useful in observing current waveforms with an oscilloscope or measuring signal current in vacuum tubes or transistors. May also be used with electronic counters to measure frequency.

Just clamp the 456A probe around the wire under test and view or read ac current directly on your scope or voltmeter. Model 456A's 1 ma to 1 mv unity conversion permits direct readings up to 1 ampere rms. No direct circuit connection is required; there is no loading, no appreciable impedance change in the circuit under test, and the impedance of the test circuit is immaterial.



SPECIFICATIONS

Sensitivity:	1 mv/ma ±1% at 1 KC
Frequency response:	±2%, 100 cps to 3 MC ±5%, 60 cps to 4 MC —3 db at 25 cps and greater than 20 MC
Maximum input:	1 amp rms; 1.5 amp peak. 100 ma above 5 MC
Maximum dc current:	DC up to 0.5 amp has no appreciable effect
Input impedance:	Probe adds to test circuit only approx. 0.05 ohms in series with 0.05 μh
Power:	Two Mallory Battery Co. TR 233R and one TR 234 batteries. Life approximately 400 hours. AC power supply optional at extra cost
Size:	5" wide, 6" deep, 1½" high
Price:	456A with batteries, $190.00; with ac supply installed, $210.00; ac supply for field installation, $40.00

AC-21F CURRENT PROBE

AC-21F probe with 100-ohm terminations permits measurement and observation of ac currents on your scope or voltmeter without breaking circuit or inserting a resistor. The probe clamps around the wire and forms a transformer with a single-turn primary. Output is 1 mv per ma. Maximum current is 10 amps above 20 KC. Below 20 KC current capacity is reduced proportional to frequency and is 1 amp at 2 KC. DC current up to 0.5 amp has no appreciable effect on probe's operation. $100.00.

Two 100-ohm terminations are available for use with AC-21F Current Probe: AC-67B Feed-Through Termination, 2,500 cps to 30 MC bandpass, $17.50; AC-67C Compensated Termination, 1,400 cps to 30 MC bandpass, $30.00.

Data subject to change. Prices f.o.b. factory.

HEWLETT-PACKARD COMPANY

1501 Page Mill Road, Palo Alto, California, Area Code 415, DA 6-7000

Sales and service representatives in all principal areas:
Europe, Hewlett-Packard S.A., 54-54bis Route des Acacias, Geneva;
Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand Street, Montreal

7755R

Tele-Tips

ELECTRONIC "QUACKERY" got another blast from the Food and Drug Administration. Seven types of exotically named—but worthless — electronic diagnosing and treatment devices were banned by the Federal Court, and the manufacturer, Electronic Instrument Inc., Tiffin, O., was permanently enjoined from further shipment of the devices. The gaudy machines, carrying an impressive array of lights, rows of switches, control knobs and electrodes, carried such names as "Neurolinometer," the "Electron-O-Ray 51," the "Radioclast Model 40." All were found completely ineffective in the treatment of any diseases, though they were selling for $1,000 per unit.

FCC MONITORING stations cooperated with the Post Office Dept. by making recordings of fraudulent advertising broadcast in English from Mexican broadcast stations located near the U. S. border. The advertising was promoted by U. S. citizens and beamed to the U. S. in an attempt to avoid restrictions applying to U. S. broadcasters. One of the Mexican stations involved has since gone off the air.

RECENT STOCK MARKET fluctuations bring to mind these definitions we came across a few weeks back:

Growth - Company — Company losing money and therefore forced to issue stock in order to support its management in the style to which it is accustomed.

Non-profit Company—A growth company that does not issue stock.

THE U. S. AND JAPAN are making their first joint flight effort in the scientific exploration of space. Cooperatively, the two nations will launch the first of three planned Nike-Cajun sounding rockets from the NASA Wallops Island Station, Virginia. The flight is probing the ionosphere by the simultaneous use of different techniques which were developed independently in the two countries.

(*Continued on page* 48)

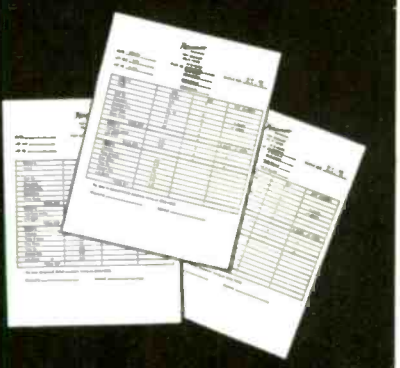
Why engineers are specifying VK® Capacitors for CK Capacitor requirements...

VITRAMON, INC. SUPPLIES

PROOF

OF PERFORMANCE

with every shipment



The "proof of performance" for all CK Capacitors ("VK" Capacitors purchased against MIL-C-11015/18 or /19) is enclosed with your order! Automatically and voluntarily, "Vitramon" supplies copies of Acceptance Testing Data — with every shipment.

And test results are impressive! Where absolute conformance to military specifications is essential, CK Capacitors adhere closely to requirements. In critical areas where specifications may be surpassed, CK Capacitors offer reliability "above and beyond." Here's how they measure up:

DISSIPATION FACTOR

MIL. REQUIREMENT	ACTUAL PERFORMANCE
2.5% *for all values*	1.5% *for values thru 680 mmf.*
	2.5% *for values 820 thru 10,000 mmf.*

TEMPERATURE COEFFICIENT

MIL. REQUIREMENT	ACTUAL PERFORMANCE
+30% −56% *for all values*	±10% *for values thru 680 mmf.*
	±15% *for values 820 thru 10,000 mmf.*

CK Capacitors are checked 100% for dissipation factor and capacitance, and to insure that the parts stay within tolerance, only 2/3 of the available capacitance band is used. Parts are checked for Insulation Resistance after being subjected to a seal test consisting of exposure in live steam for 2½ hours under 15 p.s.i. Parts are also gauged 100% for physical dimensions.

MIL PARTS NOW IN STOCK!

VK® Micro-miniature CERAMIC CAPACITORS

Conforms with MIL-C-11015/18/19

VK 30
case size:
0.3" square
lead spacing:
0.2"

VK 20
case size:
0.2" square
lead spacing:
0.2"

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

Vitramon®
INCORPORATED
P.O. Box 544
Bridgeport 1, Connecticut

Tele-Tips

(*Continued from page* 46)

NASA has available a new hour-long color motion picture, "The Mastery of Space." The film, which includes footage not previously available, shows the Astronauts' training program, scenes inside a spacecraft during flight, wind-tunnel tests to determine the shape of the Mercury capsule, and highlights of Alan Shepard's Freedom 7 flight. It is now available to schools, clubs, organizations and TV stations from the regional film centers of Association Films Inc.

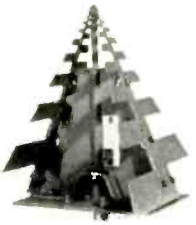
THE INCREASED ELECTRONIC gear available for marine navigation is making mariners take another look at an old standby—their nautical charts. Anticipating the changes that will come with satellite navigation, the Coast & Geodetic Survey is considering a number of new features. One, for instance, is to replace the traditional "sounding" with "bottom contours." Ships equipped with electronic depth recording equipment, for example, can navigate "by ear" using "bottom contours."

"DO-IT-YOURSELF" KITS will be featured in the U. S. trade exhibition in Yugoslavia which will be held in September. The electronic industries contribution will be hi-fi and radio kits. Theme of the exhibit will be "Constructive Use of Leisure Time."

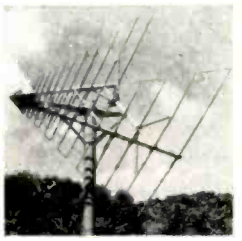
FCC received a complaint from the Pacific Tel. and Tel. Co. that its carrier current system operating on a VLF was receiving interference from radio telegraph signals. The complainant was quickly informed that the signal was originating from a U. S. government station. Since carrier current communication does not enjoy protection from a radio transmission on an unauthorized frequency, the telephone company will have to modify its equipment or the mode of its operation in order to eliminate the interference.

TOTAL ANTENNA CAPABILITY

creates the solutions to your antenna problems



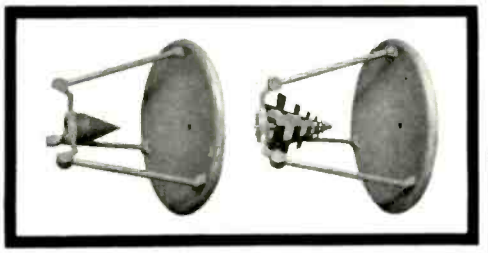
PYRAMIDAL LOG PERIODICS beam maximum (APN-100 Series) and "Null" types (APN-300 Series) . . . models from 0.05 to 11.0 Gc



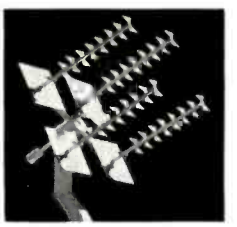
HF AIR SUPPORTED MONOPOLE ANTENNAS . . . models from 3 to 60 mc . . . complete with automatic pressurization system

CONICAL HELICES beam maximum (ALN-100 Series) and "Null" types (ALN-300 Series) . . . models from 0.05 to 11.0 Gc

HF LOG PERIODIC MONOPOLE . . . 3 to 30 mc Developed and constructed by AEL for ship-to-shore communication link



PARABOLIC REFLECTORS with Conical Helix and Log Periodic Feeds . . . models available in 18" and 36" reflectors for operation from 1.0 to 11.0 Gc



DISC-ON-ROD ANTENNA ARRAY . . . VHF—UHF—SHF Bands

PLANAR LOG PERIODIC . . . Model APN-107A from 50 to 1100 mc

CONICAL SPIRAL . . . ALN-200 Series models from 0.05 to 11 Gc

"OPTIMUM" LINEAR HORNS . . . H5000 Series models from 1.0 to 12.0 Gc

CIRCULARLY POLARIZED HORNS . . . H6000 Series models from 8.2 to 40.0 Gc

OMNIDIRECTIONAL SLOT ARRAY . . . ASW-100 Series models from 16 to 40 Gc

MANY MODELS SHOWN HERE ARE IMMEDIATELY AVAILABLE

specializing in broadband antennas

Our extensive experience gained as a pioneer in the field of broadband antennas can be put to work for you. AEL has been built on technical capability, and we welcome the opportunity to dig into the most complex and sophisticated custom designs.

Virtually every type and size of broadband antenna is included in our experience . . . from 4-inch conical helices to 180-foot log periodic monopoles. The scope of our capabilities is indicated by the accompanying illustrations.

Your requirements may best be met by an antenna from our extensive line of standard stock models. Or, we will custom-develop and produce an antenna structure to meet your specific requirements.

AEL builds antennas to meet both military and commercial environmental conditions. Other developments include radomes, antenna pedestals and related devices.

Let us put our specialized experience to work for you. Send us your specific antenna requirements for our recommendations.

American Electronic Laboratories, Inc.

RICHARDSON ROAD, COLMAR, PENNSYLVANIA

just north of philadelphia

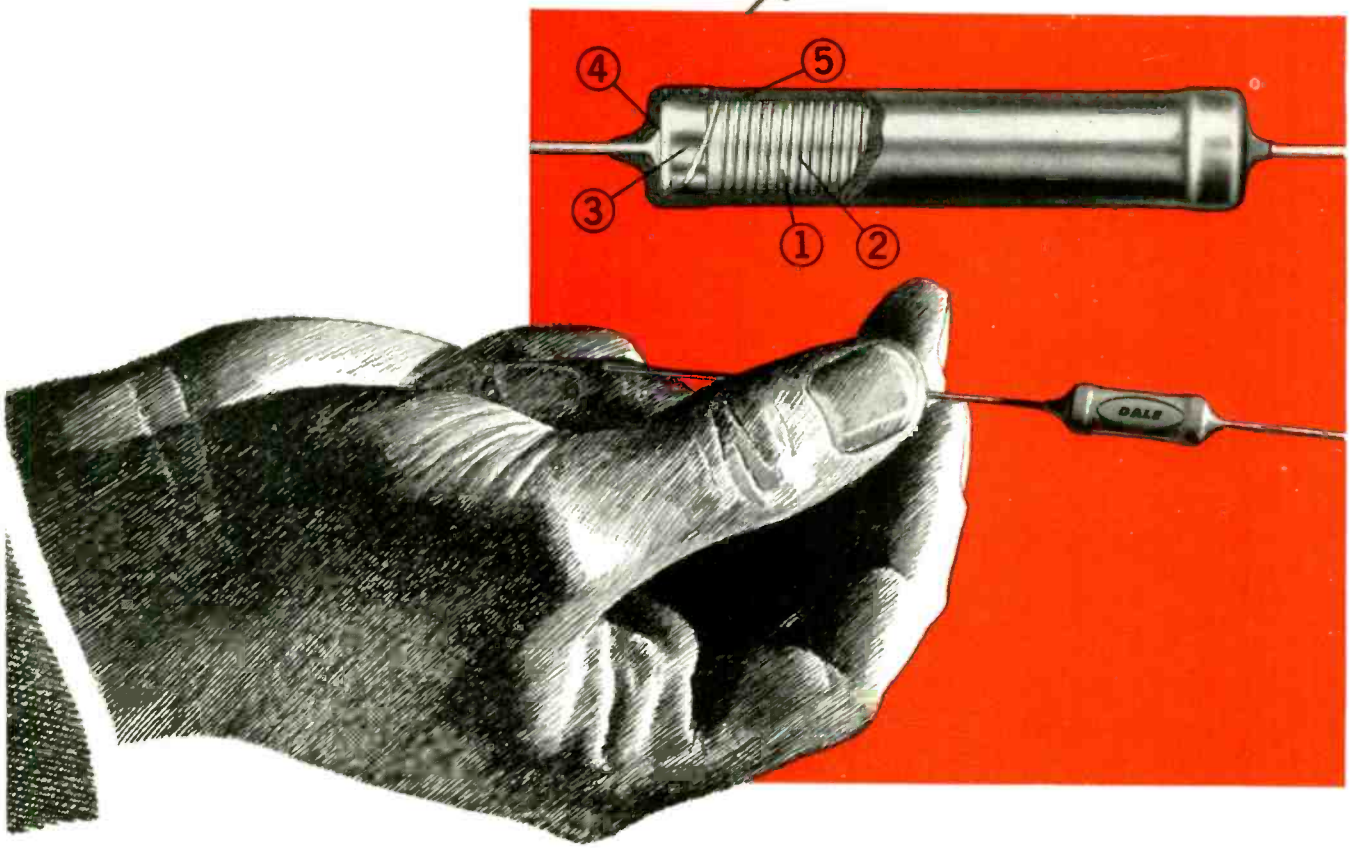
ENGINEERS:

Investigate the rewarding opportunities at AEL.

TYPICAL APPLICATIONS OF AEL ANTENNAS

- beacons
- communications
- direction finding
- gain calibration
- search
- surveillance
- telemetry

STABILITY IS INHERENT IN DALE High Temperature HS RESISTORS



These new silicone coated resistors give outstanding performance in both power and precision applications. Can be used in high temperature applications where formerly only vitreous enamel resistors could be used, yet are better in quality and performance. They feature low temperature coefficient, miniature size and long life stability.

SPECIFICATIONS

- Meet applicable paragraphs of MIL-R-26C, characteristic V.
- Maximum continuous operating temperature 350° C.
- Nine physical sizes rated at 1.25, 3, 3.25, 3.75, 4.25, 6.5, 9, 13 watts.
- Resistance range from 0.05 ohm to 175K ohms, depending on type and tolerance.
- Tolerances 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%.
- Temperature coefficient 20 PPM/ degree C.

Write for Dale Resistor Catalog A

HERE'S HOW DALE "BUILDS IN" RELIABILITY

1. CORES are centerless ground, high purity ceramic, untouched by hand or foreign materials. Wire lays firmly and uniformly, eliminating local hot spots.
2. RESISTANCE WIRE is procured to rigid specifications (analysis of each melt required). Untouched by hand or foreign materials. Tension accurately controlled; pitch limited to 200% minimum.
3. END CAPS are made from non-corrosive stainless steel for good weldability and ideal mechanical properties.
4. COMPLETE WELDED CONSTRUCTION from terminal to terminal. Welds tested on sample basis to destruction.
5. SILICONE COATING built up as a lamination of many thin coats, each cured separately at a temperature higher than the maximum operating temperature of the resistor, thus providing an automatic normalizing process. This exceedingly tough, uniform coating is free of pin holes, cracks or blisters; provides outstanding protection against thermal shock, moisture and mechanical damage.

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

DALE ELECTRONICS, INC.

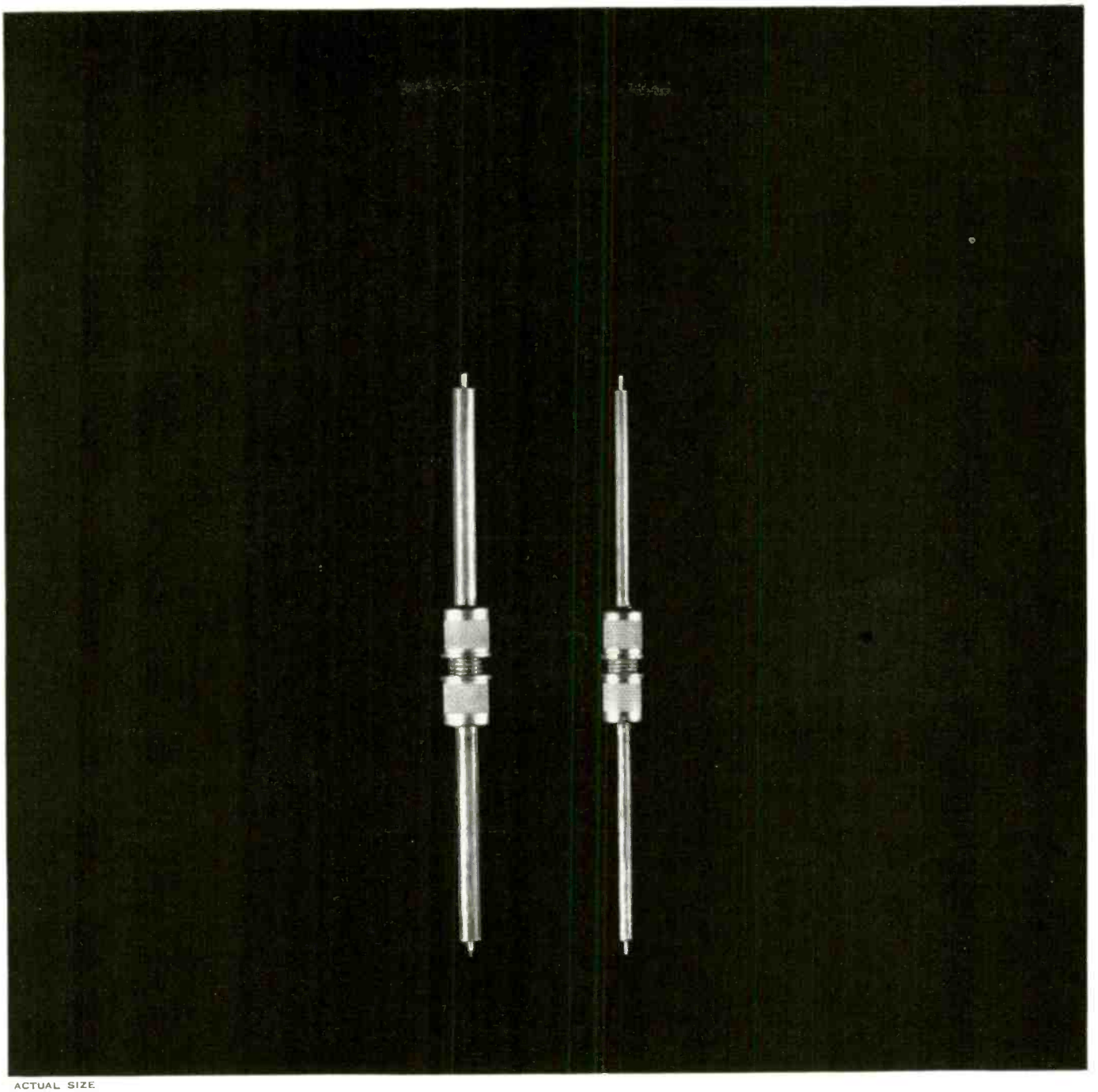
DALE

1304 28th Avenue, Columbus, Nebraska

A subsidiary of THE LIONEL CORPORATION

SEE OUR SPECIFICATIONS IN VSMF THE MICROFILM CATALOG FILE

Also Made and Sold by Dale Electronics Canada, Ltd., Toronto, Ontario, Canada



ACTUAL SIZE

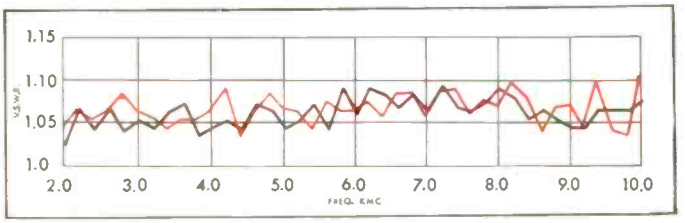
We have two new r-f connectors. They are wee ones.

They are designed to replace N series connectors in the 1 to 10 KMC frequency range where size, weight, and low VSWR ratings are critical factors.

The larger small one is the BRM. It terminates .140 semi-rigid cable either by threading or by threading and soldering. The smaller small one is the BRMM. It is for a .085 semi-rigid cable.

Talk about low VSWR ratings. Look at these curves. The black one is for the BRM; the red one is for the BRMM. The maximum VSWR is less than 1.1:1 over the frequency range of 1 to 10 KMC.

Now, about size and weight. The BRM connector is 1/28 the size of its N series counterpart. And it weighs 1/38 as much. The BRMM unit is 1/48 as large as the N series connector, 1/70 as heavy. You might call them miniatures. They are.



These precision r-f environmental resistant electrical connectors are machined from brass and heavily gold plated over silver underplate. The center dielectrics are electrical grade Teflon. They show high performance and excellent durability.

Developed at the Research Laboratories Division of Bendix, this new series of r-f connectors has been thoroughly production designed by Scintilla Division for maximum user satisfaction. Possibly you have an application in which the use of our new r-f connectors would be advantageous. Tell us about it. Or, write us in Sidney, New York, for technical data.

Scintilla Division

THE Bendix CORPORATION

Circle 42 on Inquiry Card

GOVERNMENT ELECTRONIC CONTRACT AWARDS

(Continued from page 23)

Transponders	562,704
Tubes, electran	2,433,803
Tubes, klystron	56,409
Tubes, magnetron	127,012
Tuners	158,439
TV equipment	88,757
Wave analyzer system	43,011
X-Ray equipment	86,449

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

Accelerometers	185,637
Amplifiers	861,164
Antennas	1,657,219
Automation printing system	27,940
Batteries	53,550
Cable, assys	62,912
Cable, shielded	74,900
Cable, telephone	158,850
Communications equipment	169,626
Comparators	30,249
Computers	82,681
Connectors	844,145
Control system	990,116
Detection instruments, radiation	1,576,480
Digital data acquisition system	85,955
Digital data communication control	1,738,954
Gyroscopes	677,441
Indicators	138,286
Jamming systems	56,507
Laudspeakers	47,061
Magnetic detecting set	785,517
Meters	452,197
Microphones	918,054
Oscillographs	29,486
Power supplies	118,037
Pulse ranging equipment	30,652
Radar	14,597,903
Radio equipment	2,189,762
Radio terminal assembly	36,420
Radiosonde equipment	210,467
Receivers	6,252,510
Recorder	27,570
Recorder/repraducer	179,650
Recording system	265,618
Relay	138,637
Relay armature	29,811
Resistor	557,618
Semiconductors	1,313,151
Shielded enclosures	58,383
Signal generators	592,572
Simulators	1,760,149
Sonar	402,147
Sonobuays	2,134,736
Spectrometer system	87,307
Switchboard	69,020
Switches	230,350
Synchronizing circuit	27,444
Synchro equipment	401,605
Tape, sound recording	290,371
Telemetering equipment	268,854
Telephone equipment	361,053
Teletypewriter equipment	5,546,281
Terminal digital equipment	349,303
Terminal, telegraph	27,617
Test equipment	509,562
Test sets	1,361,366
Transceivers	2,514,149
Transducers	29,815
Transmission assy	2,692,658
Transmitters	362,004
Tube, electron	1,976,374
Tube, klystran	164,500
Tube, magnetron	127,795
Tuning units	36,876
Ultrasonic cleaners	61,665
Vibrator	36,123
Video transmission equipment	267,530
Waveguide	81,527
X-ray equipment	204,354

An AID must have depth

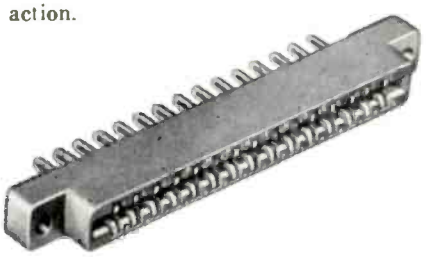
To be an Amphenol Industrial Distributor (AID), an organization must stock Amphenol-Borg electronic components in considerable depth and breadth.

R. F. Meinicke

You benefit because you can choose from this wide range of products (a few examples follow) which are available *locally*, in quantity, for immediate shipment—and at factory prices.

Printed Circuit Connectors

Probably the most outstanding feature of Amphenol Prin-Cir* connectors is the fact that they can't be overstressed, even after repeated insertions and withdrawals. This is due to their circle-lip contact design which assures a firm contact with the circuit, whether board thickness happens to fall at the high (.073") or low (.055") end of the tolerance range. What's more, Prin-Cir connectors accept warped and twisted boards with a firm and positive contact action.



Amphenol Industrial Distributors stock Prin-Cir connectors in 6, 10, 12, 15, 18 and 22 contact configurations, each of which is available in any one of five termination styles. If you ask him, your AID will also furnish polarized Prin-Cir connectors.

Micro Edge® Receptacles

Amphenol Micro Edge printed wiring receptacles are tiny (15 contacts on .075" centers) connectors with a unique "fold back" contact design. Fold back contacts provide two lines of interference per circuit as well as two termination points per contact for wiring convenience. Contact flexing range approaches that of a printed circuit board

so that warped or twisted boards can be easily inserted and positively retained.

Minni E® Connectors

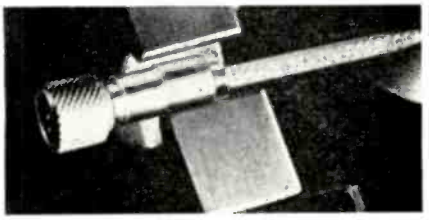
Some people call Amphenol's Minni E connector a "showoff." That's because it does more than just conform to MIL-C-5015 (in spite of its small size). On the really important points, like insulation and vibration resistance, the Minni E far exceeds requirements. Better-than-specification design is not just an engineering exercise. It *is* Amphenol's way of assuring you of the highest possible dependability in a MIL-C-5015 type connector.

Your AID stocks Minni E plugs, cable and panel receptacles and single hole mounting receptacles in four constructions, five shell sizes and seventeen insert arrangements.

New Subminax® Coaxial Connector

Many AID's now stock FXR's new Subminax quick-crimp micro-miniature coaxial connector. It's called the Series 5116 and it offers you at least three important benefits: 1. Fast assembly with new standard crimping tool, 2. more reliable assemblies and, 3. less costly assemblies.

Because the 5116 is interchangeable with competitive counterparts, you don't have to redesign your product to put it to work. (In fact, you can now specify a Subminax connector to mate with any



known sub-miniature coaxial connector on the market today.) Best of all, the Series 5116 is priced substantially below current prices for commercial "equivalents."

About the only thing we can add is—see your AID for more information on the Series 5116—soon.

Need more information?

Just check a box and drop me a line.

- ☐ IEC-4 Quick Reference AID Catalog
- ☐ Minni E Connectors
- ☐ Subminax Connectors
- ☐ List of Amphenol Industrial Distributors

R. F. Meinicke

Vice-President-Sales
Amphenol Distributor Division, Broadview, Illinois

*T.M. Amphenol-Borg Electronics Corporation

AMPHENOL ***Distributor Division*** / Amphenol-Borg Electronics Corporation

2875 South 25th Avenue, Broadview, Illinois, COlumbus 1-2020, Area Code 312, or TWX: Maywood 1069

Circle 44 on Inquiry Card

Circle 45 on Inquiry Card →

Hardware?

Maybe connectors were "hardware" twenty years ago.

That's when the P-38 was the hottest fighter plane we had. Pilots were proud when they could hit 300 MPH and go up to 50 or 60 thousand feet. With this kind of performance requirement, most connectors worked without a hitch. You just connected them and forgot about them, like nuts and bolts.

HOW TIMES HAVE CHANGED

Now we're up around Mach 5 and altitude has been pushed into outer space. Nose cones light up like giant soldering irons and components have to operate in a near vacuum.

Fortunately, Amphenol engineers saw that the old "hardware" concept was headed out the window. Programs coming up were going to need connectors that could put up with terrific environmental conditions of heat and altitude cycling. For example, at high temperatures most of the elastomers used as insert materials or connector seals either melt into a puddle, turn into a cinder, or set-up and lose compression.

What's more, connectors now have to keep on functioning *all* the time, with no allowance for failure. So—Amphenol designers went to work developing a connector to meet the new space-age standards.

DISSECTING MOLECULES

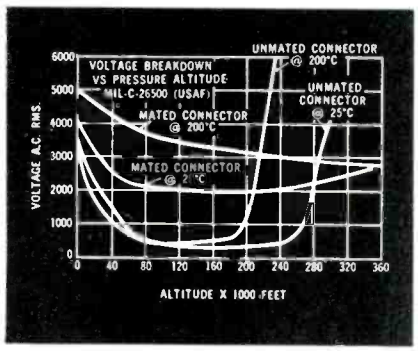
The Amphenol Materials Lab, with the help of a shiny new infra-red photospectrometer, began dissecting elastomer molecules. They were able to pinpoint the weak spots in molecular structure where breakdowns begin. Then they were able to plan and build new molecules, with built-in "armor" to protect against failure. Result: an exclusive silicone rubber compound that maintains its integrity and elasticity under severe temperature extremes and also withstands exposure to violent new propellants like hydrazine and nitrogen tetroxide.

At the same time, Amphenol design engineers were hard at work perfecting metal-to-metal shouldering of mating shells that allowed precision control over compression of the sealing ring. In addition, the metal-to-metal design damped vibrational stress nine times more effectively than resilient damping. Finally, they incorporated a semi-rigid anti-deflection disc to control insert expansion under thermal stress.

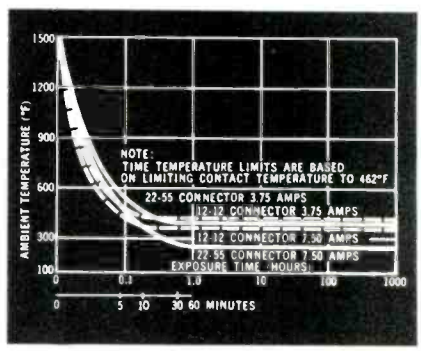
Having all the pieces, we put them together, called it the Amphenol 48 Series, and started testing. In the vacuum chamber, 48 Series connectors operate very nicely at a simulated altitude of 500,000 feet. They are quite comfortable in the hot box at 200°C ambient, *carrying full rated current.* They don't even mind going up to 600°C, if they don't have to stay too long. In short, Amphenol 48's can take almost anything you throw at them.

PROJECTS WANTED

Amphenol designers have established criteria for determining connector time-temperature-current capability. This information will be especially valuable to engineers presently engaged in "exotic" projects, perhaps the kind of project where previous connectors have failed to measure up to the new space-age standards. If this is the case, contact an Amphenol sales engineer. He's a "space-age hardware" expert. Or, write directly to Bob Dorrell, Vice President, Engineering, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.

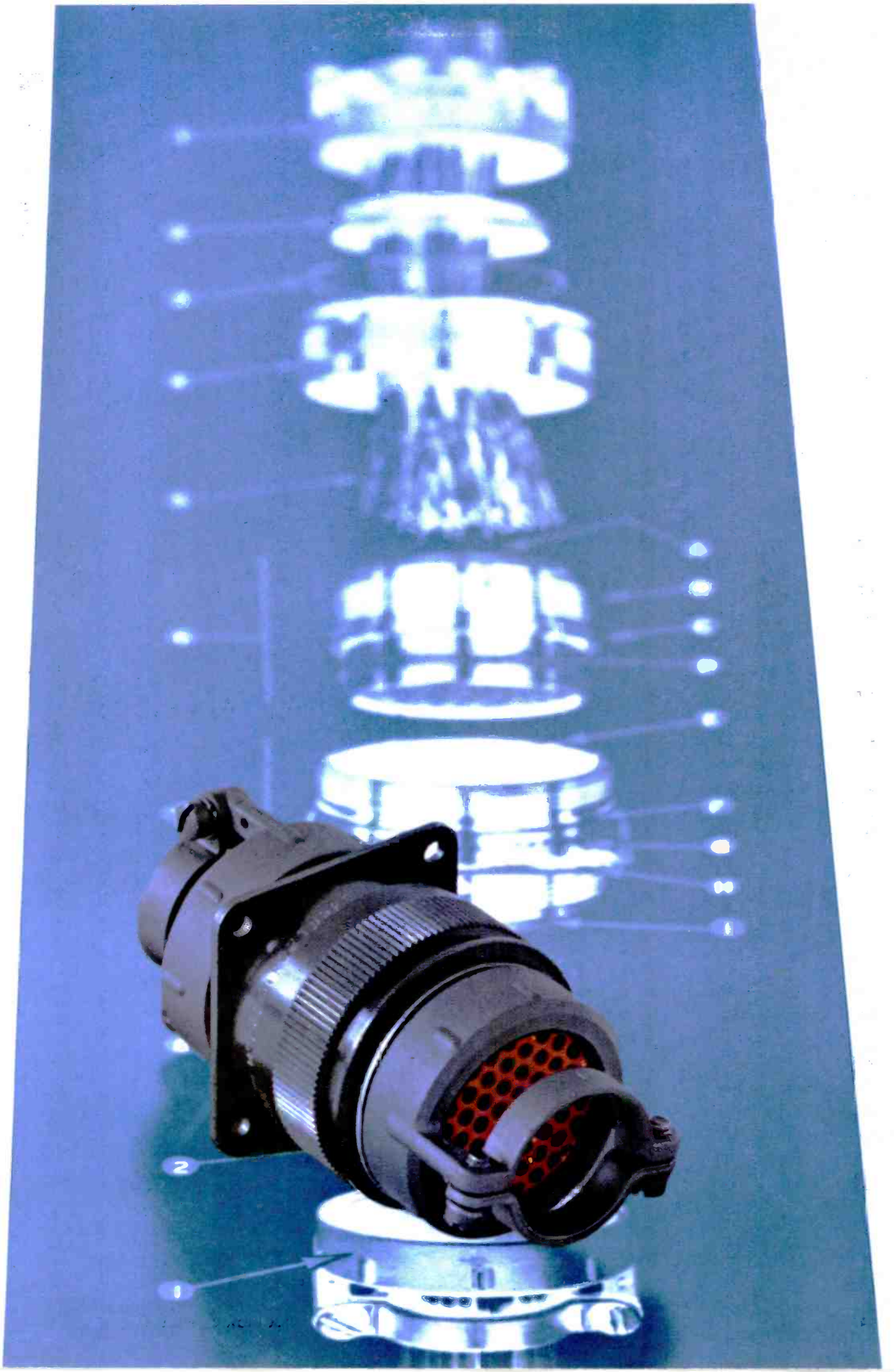


High altitude air has low dielectric strength. By maintaining an air-tight seal 48 Series Connectors enjoy extremely high voltage safety factors.



While Amphenol 48 Series Connectors are nominally rated at 200° C, they can also withstand considerably higher short-time temperature exposures.

Amphenol 48 Series Meets Mil C 26500 (USAF).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NEWS FROM
BELL LABORATORIES

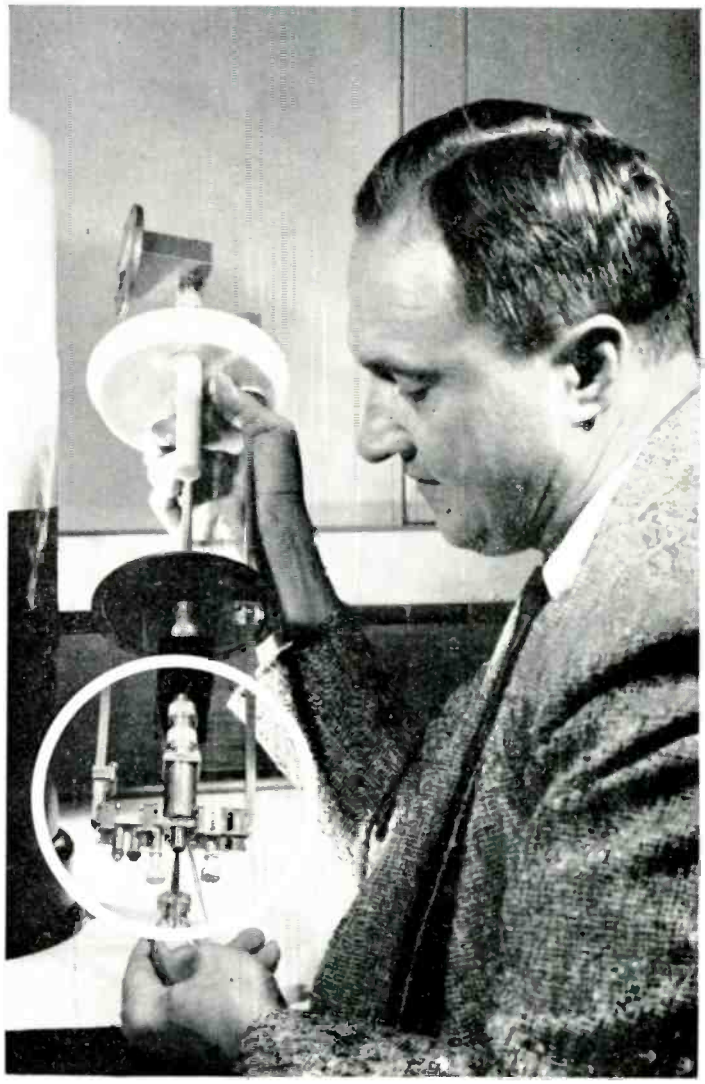
A simple, highly sensitive microwave amplifier

Bell Laboratories engineers have developed an extremely sensitive parametric amplifier which approaches the maser in sensitivity. Both will be used in experiments with Telstar, the Bell System's experimental communications satellite.

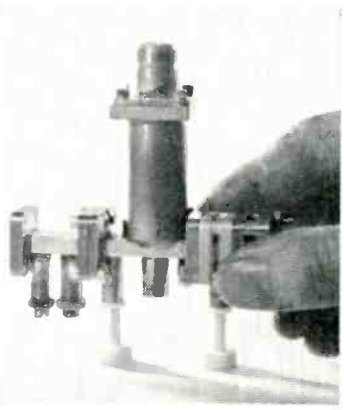
Heart of the parametric amplifier is a newly developed semiconductor diode with very low intrinsic noise. Previously, the sensitivity of such amplifiers at microwave frequencies was severely limited by the unwanted noise generated in their diodes. The new diode, no bigger than the eye-end of a needle, solved this problem.

Our engineers also devised new circuitry to stabilize precisely the output of the klystron (microwave generator) supplying power for the amplifier. To reduce further the intrinsic noise of the amplifier, they immersed the diode and its circuits in liquid nitrogen, utilizing a new cooling arrangement which economically maintains a low temperature for many days without attention.

The new amplifier fills a need in the communications field for a simple microwave amplifier of high sensitivity in applications for which the higher sensitivity of the maser does not justify its additional complication.



Bell Laboratories' Michael Chruney adjusts waveguide assembly (in circle) housing the diode. After adjustment the entire parametric amplifier will be immersed in liquid nitrogen in dewar at left. The new amplifier operates at 4170 megacycles (center of band) and provides an almost flat gain of 38 db over a 50-megacycle band with a noise figure of approximately 0.5 db.

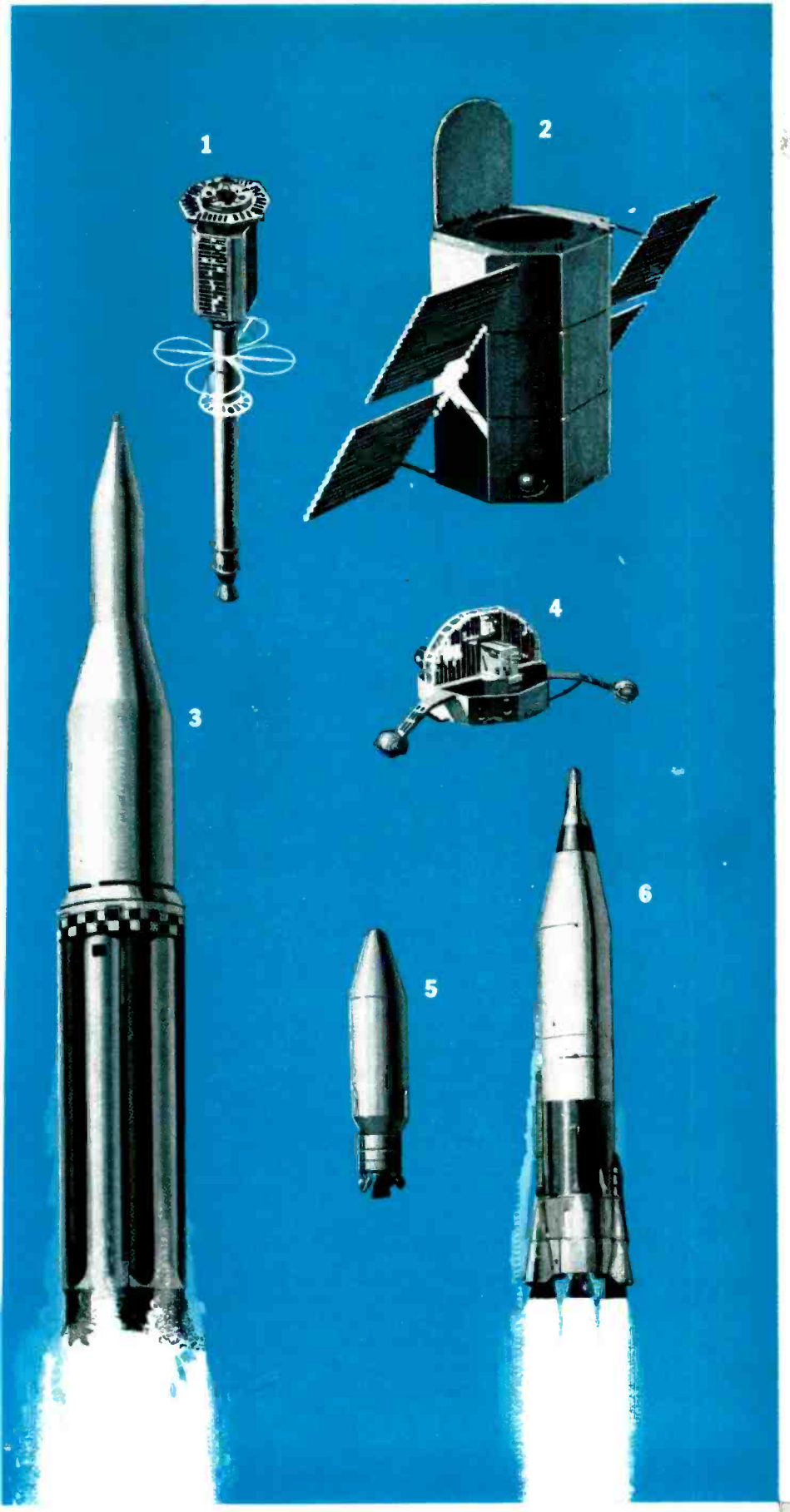


Close-up of the waveguide assembly, in which Bell Telephone Laboratories' newly developed diode is located.

Heart of amplifier—a hermetically sealed gallium arsenide diode—is compared with eye of average-sized sewing needle.

BELL TELEPHONE LABORATORIES

World center of communications research and development



"Keeping in touch": communications for space

Space communications gear by Avco's Electronics and Ordnance Division today meets a wide range of military and nonmilitary needs . . . on the ground, in missiles and launch vehicles, and in space vehicles. For example:

1. **Explorer XI.** Between April 27 and December 6, 1961, Avco's Satellite Receiver and Decoder functioned reliably more than 1,000 times before ordered to "turn off" satellite.
2. **Orbiting Astronomical Observatory.** The OAO, being built for NASA by Grumman, will carry four Avco Satellite Receivers and an Avco Video Detector.
3. **Saturn.** Avco's Solid State Decommutator, ground-based at Canaveral, can process simultaneously all data telemetered from the Saturn booster engines.
4. **Orbiting Solar Observatory.** The OSO, developed for NASA by Ball Bros., took into orbit a combination of Avco's Satellite Receivers and Decoders on March 7, 1962.
5. **Ionosphere Research.** Avco Phase Lock Receiving Systems, at six locations in the U. S., will measure phase differences between signals from a series of ionosphere satellites, one of which is up —four more to go.
6. **Range Safety.** Hundreds of Avco Missile Command-Destruct Receivers have served in space-launch vehicles, missiles, and drones since 1953 without a single failure.

For complete information on Avco's space communications capabilities, write: Director of Marketing, Electronics and Ordnance Division, Avco Corporation, Cincinnati 41, Ohio.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . REGARDLESS OF RACE, CREED, COLOR, OR NATIONAL ORIGIN . . . WRITE AVCO ELECTRONICS & ORDNANCE TODAY.

Avco // ELECTRONICS AND ORDNANCE DIVISION

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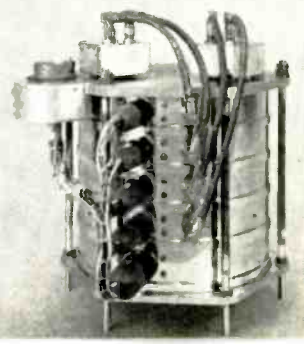
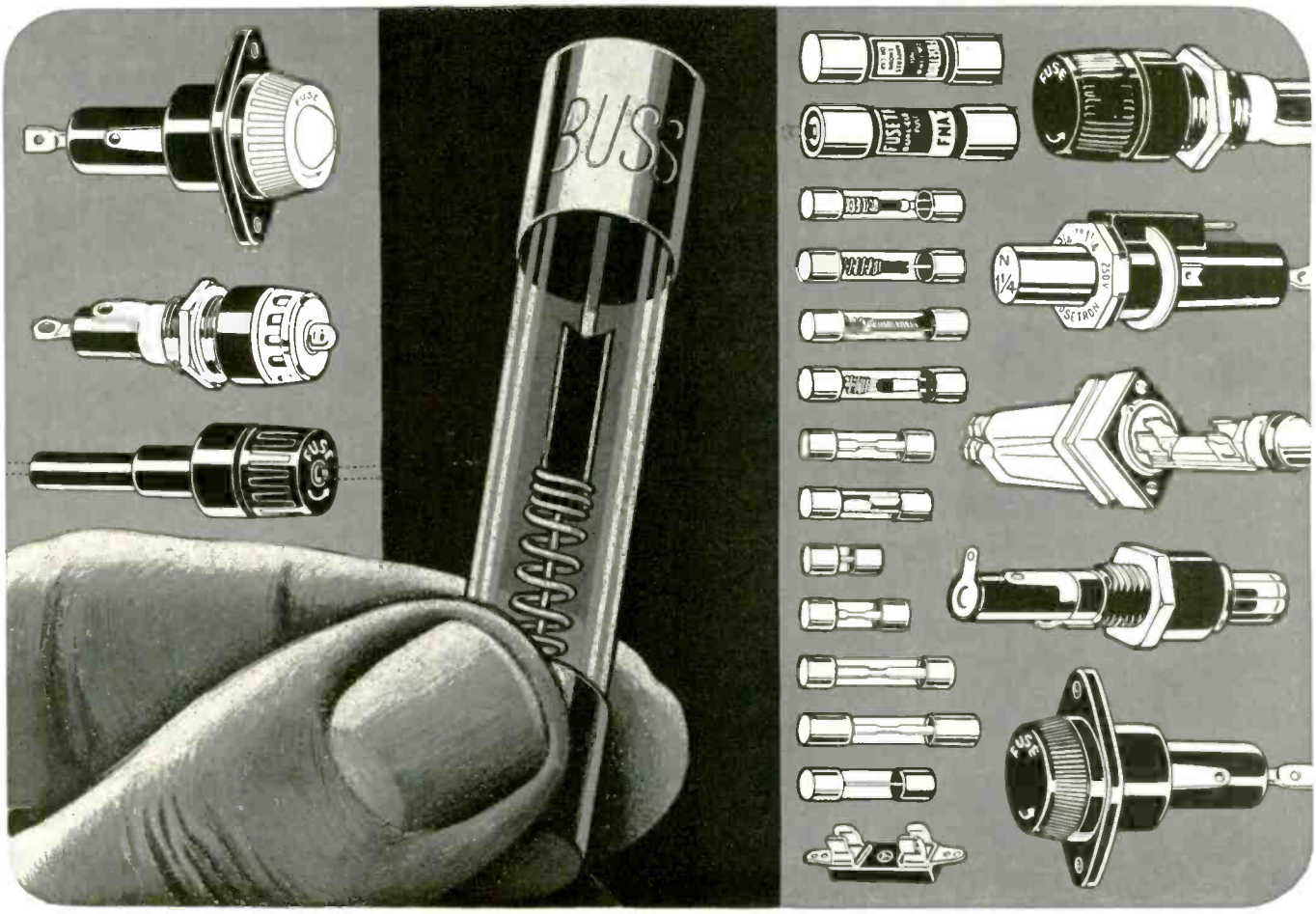
This Avco Satellite Command Receiver and Video Detector package will activate and control all equipment aboard NASA's Orbiting Astronomical Observatory.





For Every Electrical Protection Need

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:

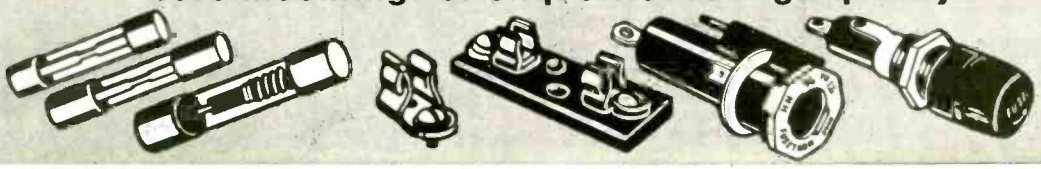
Single-element fuses for circuits where quick-blowing is needed;—or single-element fuses for normal circuit protection;—or dual-element, "slow-blowing" fuses for circuits where harmless current surges occur;—or indicating fuses for circuits where signals must be given when fuses open. Fuses range in 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.



FUSETRON BUSS McGRAW EDISON

BUSSMANN MFG. DIVISION
McGraw-Edison Co.
St. Louis 7, Mo.

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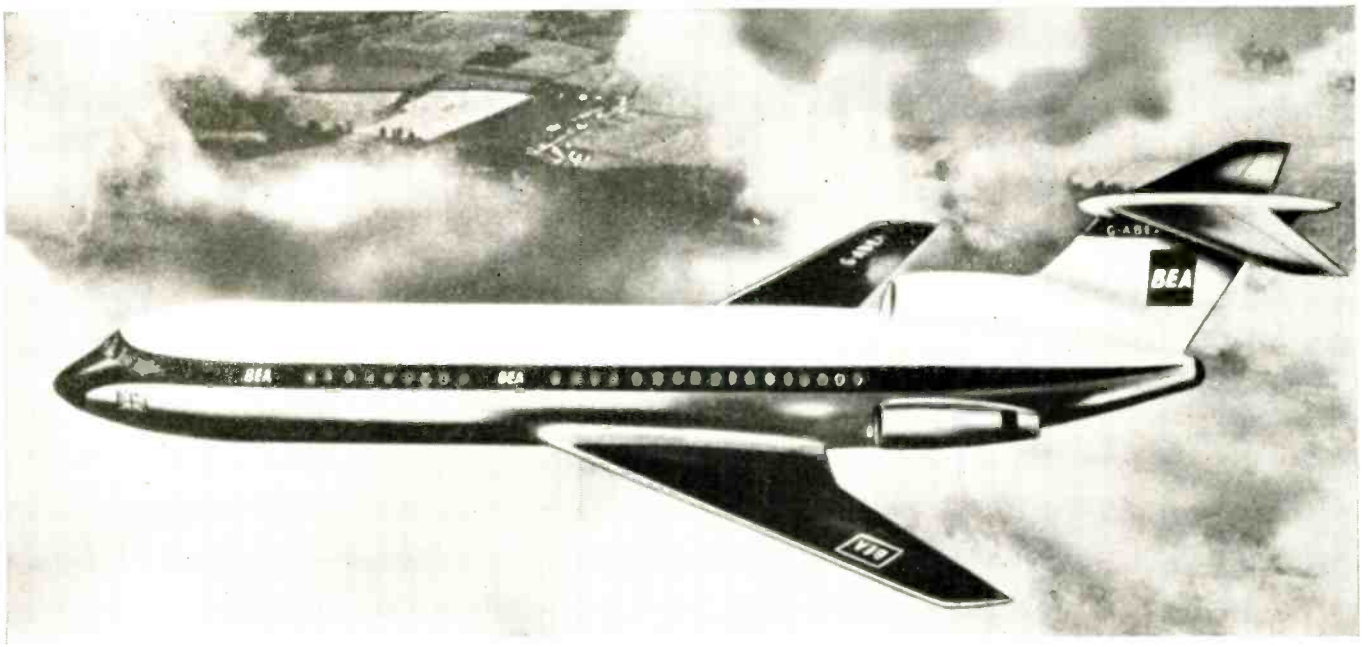


HOW HIGH IS A TRIDENT?

Actual Size

An STC radio altimeter, part of the automatic landing equipment, provides the answer to this question for the pilot of the BEA Trident and many other types of modern aircraft.

A highly stable microwave oscillator is at the heart of the radio altimeter. This oscillator employs a coaxial line resonator type of Klystron (Heil tube)—type V243A/2FS—yielding an output of nearly one watt at a frequency of approximately 4 300 Mc/s, and was developed by STC Valve Division especially for radio altimeter service. In this application frequency modulation is achieved by a rotating vane in the oscillator cavity.

Considerable experience with coaxial line oscillators in multi-channel microwave link systems—where the tubes are employed as local oscillators—lies behind the development of this tube design.

For stable operation at a given frequency, the coaxial line oscillator has three distinct advantages:

1 *Beam current can be controlled and automatically stabilized, independently of the resonator voltage, using an accelerator grid.*

2 *The collector electrode is separate from the resonator, thus minimising the flow of beam current to the resonator.*

3 *No forced-air cooling is required, even with outputs of the order of one watt.*

Write for STC Valve Data Sheets.

62/15MS

Standard Telephones and Cables Limited

COMPONENTS GROUP

VALVE DIVISION: BRIXHAM ROAD · PAIGNTON · DEVON · ENGLAND

USA enquiries for price and delivery to ITT Components Division, P.O. Box 412, Clifton, N. J.

ITT

Circle 48 on Inquiry Card

Letters to the Editor

"Cues for Broadcasters"

Editor, ELECTRONIC INDUSTRIES:

Although I am an avid reader of your monthly feature, "Cues for Broadcasters," I find that too many articles lack appeal to the average small broadcast station. It is my opinion that many of these articles invariably show how some specific piece of equipment should be modified to suit the operating requirements of perhaps a few stations.

I would like to see more articles showing how to minimize air loss time, for instance, from power line failures; by simple devices. Also, more generalized maintenance hints and remote control practices.

May I convey my appreciation to your staff in maintaining this feature; the only one I know of among so many electronic trade and service periodicals.

M. Schaefer

61 Cedar Lane
Closter, N. J.

Ed: By a happy coincidence of timing, an article on just this subject was in the works when this letter was written. It appeared on pages 199-200 of our May issue, and was titled, "Emergency Power Line Switch-Over."—We would welcome other ideas on this subject, too. As Mr. Schaefer points out, it is a topic of considerable interest to small stations.

"Southward Ho?"

Editor, ELECTRONIC INDUSTRIES:

We read with a great deal of interest and no little pride your recent editorial, "Southward, Ho?" in the April issue of ELECTRONIC INDUSTRIES. While we appreciate very much these kind words we would like to make a few additional points that may not have been called to your attention.

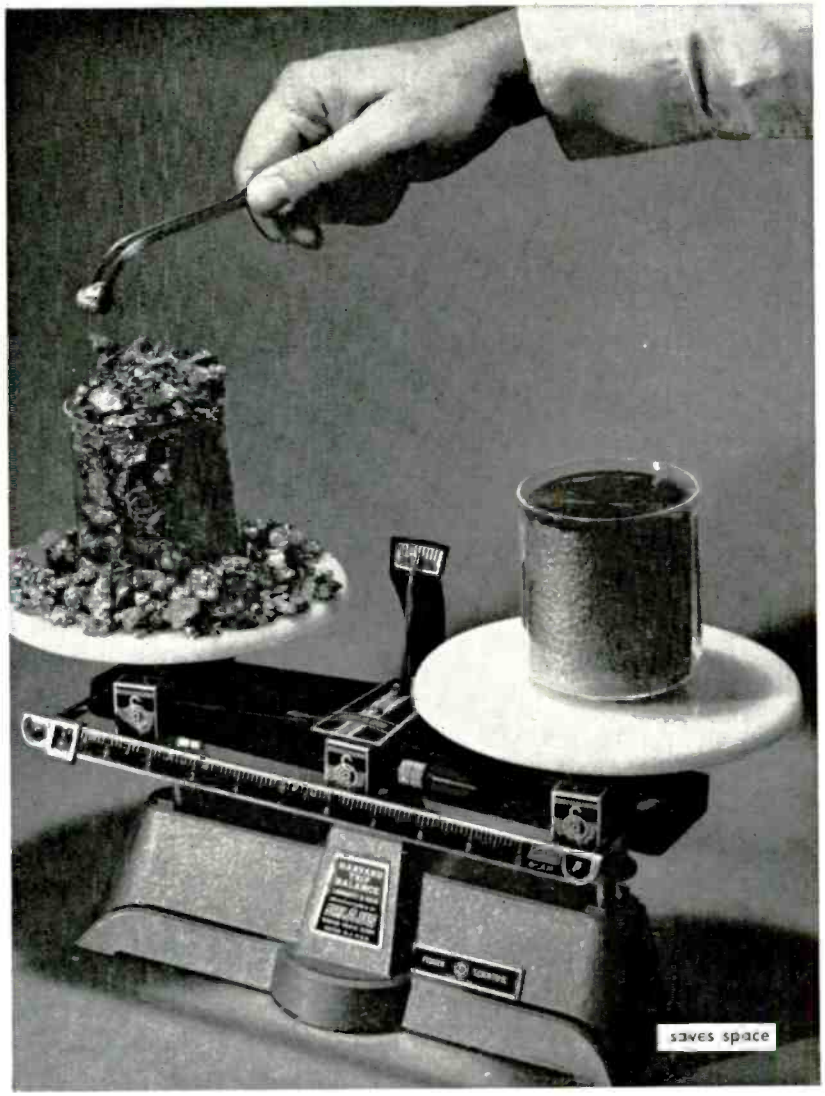
Industries in the State of Florida have available an Engineering and Industrial Experiment Station at the University of Florida in Gainsville with research facilities having annual expenditures currently exceeding 1½ million dollars. Created by an act of the Florida Legislature in 1941 at a time when there were no laboratories to provide research facilities for industry, the Industrial Experiment Station has nursed many of the state's industries from infancy. For example, Radiation Inc., the state's first electronic firm, was established by men who worked at the University of Florida in the development of the famous proximity fuze.

Another significant electronic contribution by the Industrial Experiment Station was the pioneering work in the field of weather radar which has become the basis of the U. S. Weather Bureau's hurricane warning system.

Other space-related projects are

(*Continued on page* 62)

For production economies



Single piece deposited crucible charges give many cost advantages

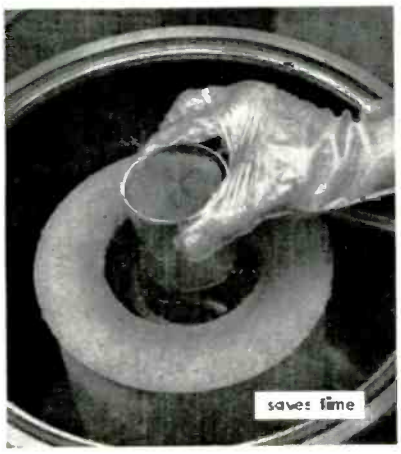
Dow Corning now provides single piece crucible charges for Czochralski crystal growers in diameters up to 65 mm (2.56 inches). You can now realize production economies by specifying these pre-packaged charges of hyper-pure deposited silicon. Here's how.

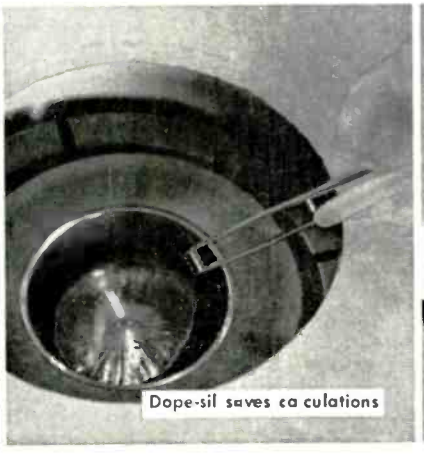
You order Dow Corning single piece polycrystalline crucible charges to the desired weight and diameter. You specify the weight to give optimum crucible fill. There are no voids in Dow Corning deposited crucible charges. You are assured of maximum volume from each crucible . . . up to 40 percent more single crystal silicon from each charge.

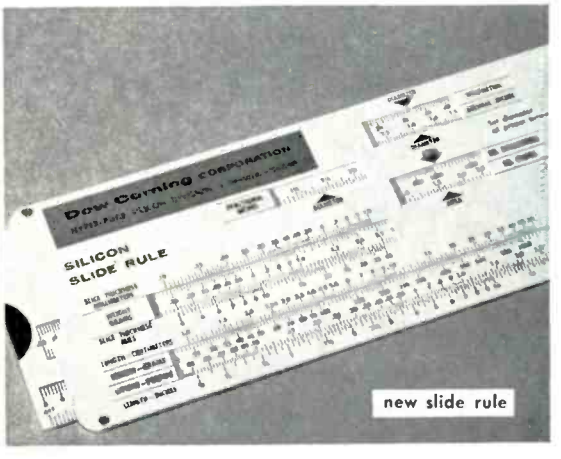
As a result, you get maximum production from your Czochralski grower; there is less surface area for accidental contamination; the crucible charge is easier to handle and permits quicker charging; and, you can use the exclusive Dow Corning Dope-sil* module doping technique to achieve maximum doping accuracy and even greater production time savings.

*Trademark for Dow Corning's doping modules.

Here's another useful new tool offered by Dow Corning—a Silicon Slide Rule. It enables you to make rapid calculations as to diameter and length of the crystal you can grow from a given charge weight and many other computations . . . simply and easily.







For your Silicon Slide Rule and technical product data, write on your letterhead to Dept. 3607.

Dow Corning CORPORATION

HYPER-PURE SILICON DIVISION • HEMLOCK, MICHIGAN

Circle 21 on Inquiry Card

Letters to the Editor

(*Continued from page* 60)

underway in the Induction Heating Laboratory where re-entry problems are being studied.

The industries, electronic and others, coming to Florida will find a College of Engineering at the University of Florida second to none in the Southeast. Last year, for instance, the College of Engineering awarded 15 PhD's in 7 major disciplines; showing the emphasis we are placing on our graduate program.

Through the recently created Institute of Continuing University Studies the College of Engineering is making available to industrial personnel an off-campus Master's degree program to meet the specific needs of the individual industry.

M. E. Forsman
Assistant Director
Univ. of Florida
College of Engineering
Gainsville, Fla.

All-Channel Legislation

Editor, ELECTRONIC INDUSTRIES:

A few observations after reading your editorial on all-channel TV legislation in the May issue of EI.

The writer has been in commercial broadcasting since 1925. He is in FM now as a station owner. He has no interest in any TV station, nor any intention of getting in to that "ulcer-ridden industry."

The pattern of UHF has been the same as FM. Dominant interests deliberately sacrificed these potential wide service media to the policy of "scarcity and monopoly" established with a technically limited number of VHF channels available for a truly national service.

Why was this done? The FCC either had the wrong advice from engineers, or took the line of least resistance to get VHF service started in some manner. Remember, the FM bands were started in the 44 mc. region, and then abruptly shifted when 500,000 sets were in the hands of the public. Therefore, when the new FCC has the courage to recognize the mistakes of its predecessors, and the stamina to take drastic action to change the picture of a stacked house against the growth of UHF, it is not right to invoke the idea of "free enterprise" to try and stop the legislation.

Where is the public interest of the manufacturers in voluntarily doing this job years ago, without the compulsion of legislation? Every year that UHF languished due to lack of receivers the gulf between the two services became wider. It is my belief, and I am appalled many times by the invasion of our personal rights by the Federal powers, that in this situation the cure was necessary now and not later.

Had sets been produced years ago with the start of TV for both regions, early UHF operations would have had a chance, or an encouragement to remain and hold on for the future. But to know that sets were not even being made to receive a medium is the killing blow to any development.

Think of what FM would have been today had the same thing been done for it. FM is an admittedly superior technical transmission over present AM. Manufacturers were remiss in not offering it as an improvement over their old AM only sets. Broadcasters would have swung into FM as the set sales mounted. The ghetto of present AM operations (over 4,000) would have been avoided, and the public would have had superior transmission.

To continue the VHF monopoly is to put power and vast wealth into the hands of less than 800 stations to serve this country. To bring UHF into comparable service is to provide those early fat cats with needed competition, and to break down television into smaller market coverage from within. A look at the present VHF ownership will show the monopoly is the creature of wealthy newspapers, corporations, individuals, and a very small and tight little closed corporation!

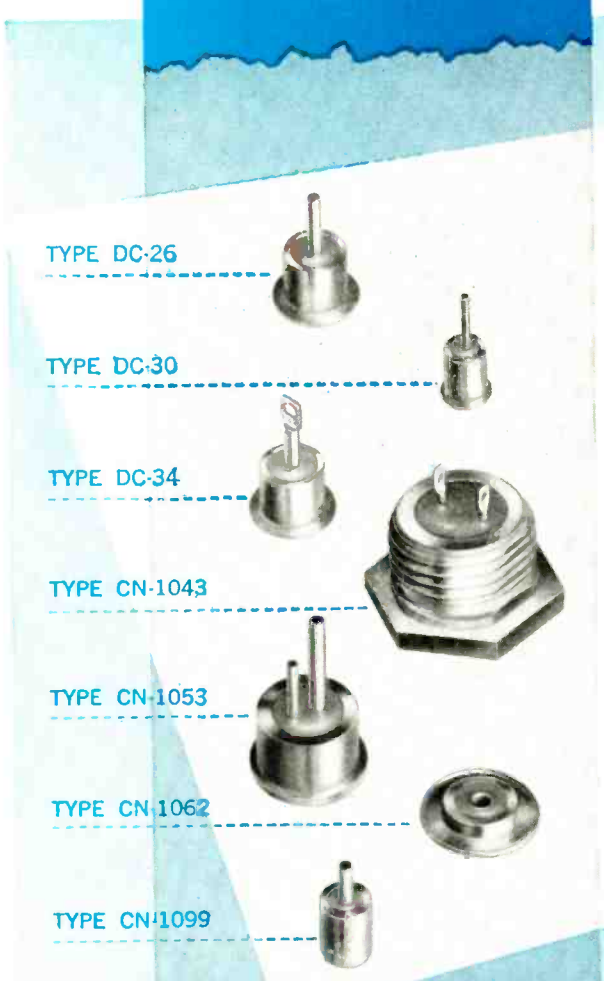
If RCA had put out a cheap TV receiver which would only receive the "low bands" of TV and ignore everything from Channel 7 down, what an uproar!

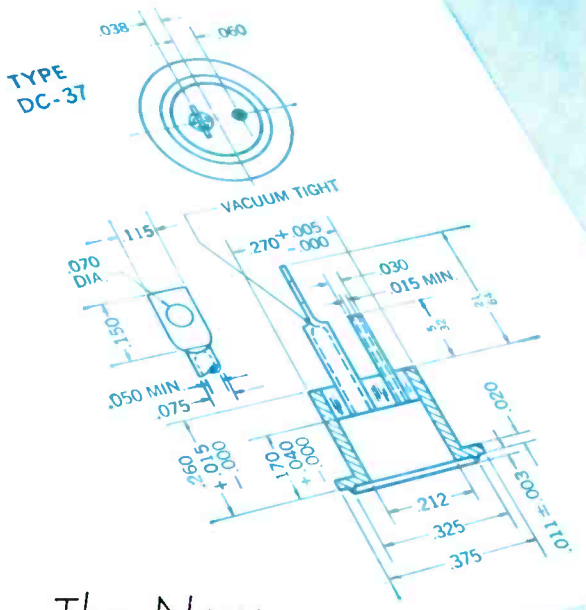
Your editorial is most complete up to its closing paragraphs. You have summarized the failings well. But where engineering counsel was not given well, nor followed to the public interest when initiated, it then becomes the duty of the FCC to "regulate in the public interest." That this takes the form of a legislative edict to UHF-VHF manufacturers is a blot on the name of American industry and engineers who should have stopped this VHF monopoly from ever beginning.

Next, legislation to require FM in every AM set. Of course, the Germans are already planning for the eventual supplanting of AM with FM as are other nations. Only this year have manufacturers finally started producing better and lower priced FM receivers. The only reason has been public demand to escape the flood of AM trivia, panic radio, rock and roll, and yak yak. What a shame our industry leaders cannot be ahead of the public, or do something beyond the immediate profits of a small and privileged group of their own interests.

S. A. Cisler
President
Fidelity Radio Inc.
Louisville, Kentucky

Diode News — from ELECTRICAL INDUSTRIES





The New

E-X-P-A-N-D-E-D

Line!

E-I Standard Diode Closures

SOLVE YOUR DESIGN PROBLEMS QUICKLY AND ECONOMICALLY!

Ruggedized Compression Sealing – E-I hermetically sealed diode closures are available in a wide range of standard types that meet practically any design requirement. Standard diode bases, or custom bases for special applications, can be supplied to your specifications. Rugged E-I compression construction – proven dependable in thousands of vital military and commercial projects – withstands the extremes of "space age" environments.

Standard Finishes Available – All diode closures can be supplied with finishes suited to your requirements. For recommendations on your particular sealing problems – just call or write E-I today!

GLASS-TO-METAL SEALS FOR ALL APPLICATIONS

- Individual Terminals
- Multi-lead Terminals
- Threaded Seals
- Miniature Closures
- Condenser End Seals
- Transistor Closures
- Color-Coded Terminals
- Clear Glass Windows
- Custom Sealing

A Division of Philips Electronics & Pharmaceutical Industries Corp.

ELECTRICAL INDUSTRIES

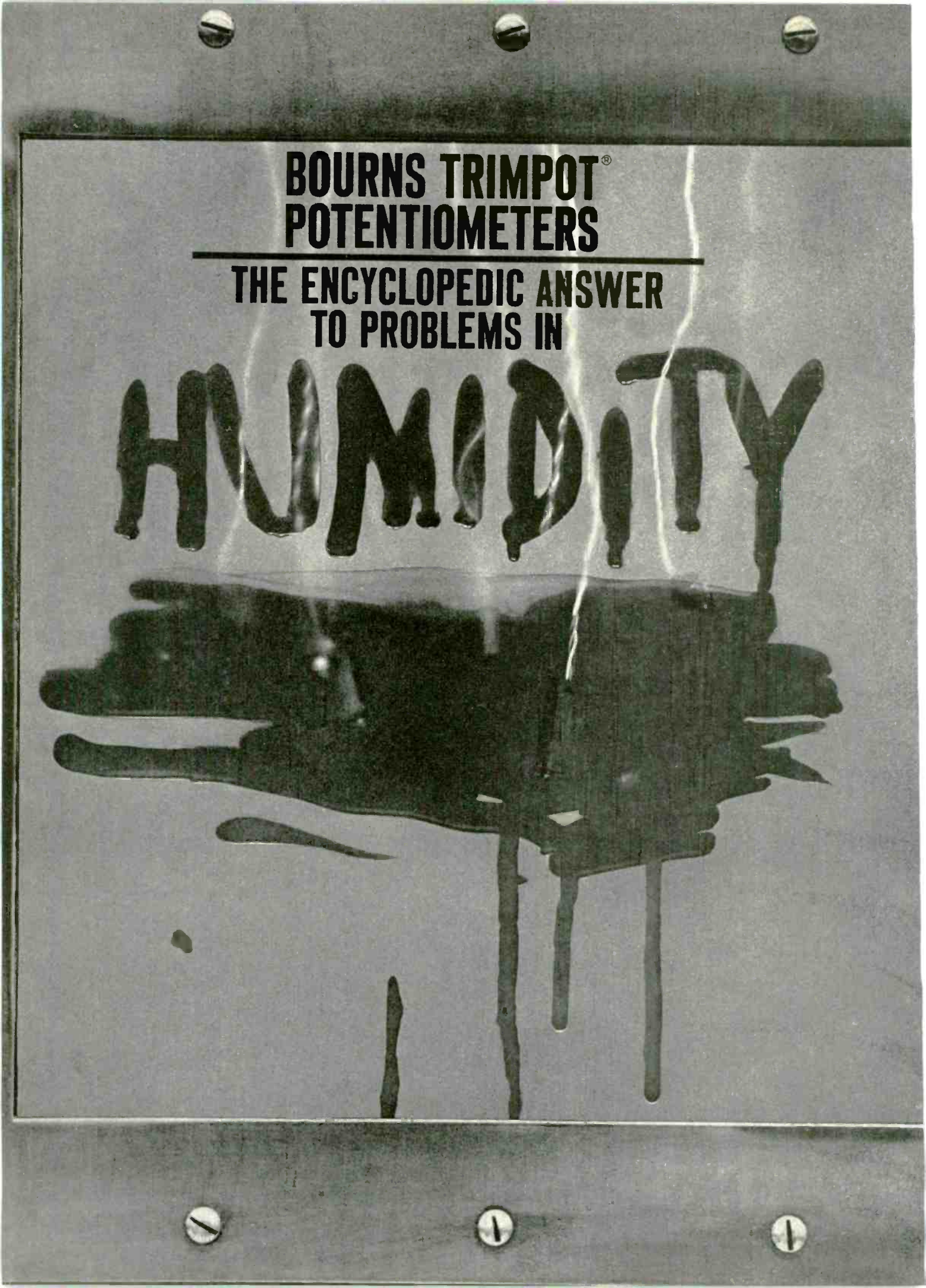
691 CENTRAL AVENUE, MURRAY HILL, NEW JERSEY

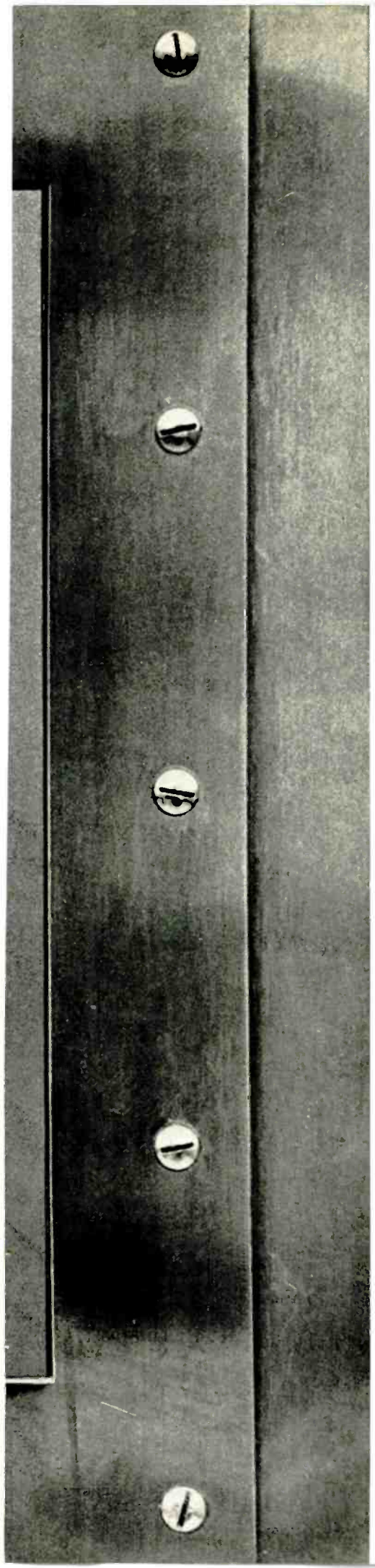
PATENTED IN CANADA, NO. 523,390; IN UNITED KINGDOM, NO. 734,583; LICENSED IN U.S. UNDER NOS. 2,561,520 AND 3,035,372

Circle 29 on Inquiry Card

BOURNS TRIMPOT® POTENTIOMETERS

THE ENCYCLOPEDIC ANSWER TO PROBLEMS IN





Bourns Trimpot potentiometers offer you 22 proven answers to both the environmental and the semantic problems of humidity. This is by far the nation's largest off-the-shelf assortment.

Trimpot humidity models are divided into two categories: units that meet military cycling humidity specs and units that meet military steady-state humidity specs. This method of classifying eliminates such equivocations as "moisture-resistant" and "humidity-defying." Our definitions—and specifications—are precise. And behind every specification is an important fact—a fact proven in virtually every U. S. space and defense program: even when it's wet, Trimpot potentiometers work.

CYCLING HUMIDITY MODELS

For your severest applications. Units meet or exceed MIL-STD-202A, Method 106, 10 days.

These units pass the most stringent humidity specs in the book without requiring additional preparations, such as coatings or potting. They are completely sealed against humidity, liquids, and potting materials. Even in your most demanding applications they will perform exactly according to their published specifications.

MODEL 3000 Micro-miniature, high-temperature, wirewound; 50Ω to 20K; 0.5W; Max. oper. temp. 175°C.

MODEL 3250 Square, high-temperature, wirewound; 100Ω to 50K; 1.0W; Max. oper. temp., 175°C.

MODEL 3001 High-temperature, Resiston® carbon; 20K to 1 Meg.; 0.20W; Max. oper. temp., 150°C.

MODEL 3251 Square, high-temperature, Resiston® carbon; 20K to 1 Meg.; 0.25W; Max. oper. temp., 150°C.

MODEL 3010 High-temperature, wirewound; 10Ω to 100K; 1.0W; Max. oper. temp., 175°C.

MODEL 3280 Square, micro-miniature, wirewound; 100Ω to 50K; 1.0W; Max. oper. temp., 175°C.

MODEL 3011 High-temperature, Resiston® carbon; 20K to 1 Meg.; 0.25W; Max. oper. temp. 150°C.

MODEL 220 Sub-miniature, high-temperature, wirewound; 100Ω to 30K; 1.0W; Max. oper. temp., 175°C.

MODEL 224 High-temperature, wirewound; 10Ω to 100K; 1.0W; Max. oper. temp., 175°C.

MODEL 3051 High-temperature, Resiston® carbon; 20K to 1 Meg.; 0.25W; Max. oper. temp., 150°C.

MODEL 3020 High-power, high-temperature, wirewound; 3.75W; Max. oper. temp., 200°C.

STEADY-STATE HUMIDITY MODELS

Humidity protection at a low price. Units meet or exceed MIL-STD-202A, Method 103A.

Most industrial and many military requirements are readily met by Trimpot steady-state humidity units, which conform to MIL-STD-202A, Method 103A. These potentiometers withstand tests of 96 hours at 95% to 100% relative humidity and display high insulation resistance (100 megohms min. after four hours of drying). Here is genuine humidity protection with outstanding economy.

MODEL 200 General-purpose, wirewound; 10Ω to 100K; 0.25W; Max. oper. temp., 105°C.

MODEL 3368 Single-turn, Resiston® carbon, sub-miniature; 20K to 1 Meg.; 0.25W; Max. oper. temp., 105°C.

MODEL 260 High-temperature, wirewound; 10Ω to 100K; 1.0W; Max. oper. temp., 175°C.

MODEL 3500 Precision wirewound, 10-turn, bushing mount; 500Ω to 125K; 2.0W; ⅜" dia.; Max. oper. temp., 125°C.

MODEL 215 General-purpose, Resiston® carbon; 20K to 1 Meg.; 0.25W; Max. oper. temp., 125°C.

MODEL 3510 Precision wirewound, 3-turn, bushing mount; 200Ω to 50K; 1.0W; ⅜" dia.; Max. oper. temp., 125°C.

MODEL 3067 Commercial, wirewound; 100Ω to 20K; 0.5W; Max. oper. temp. 85°C.

MODEL 3520 Precision wirewound, 5-turn, bushing mount; 200Ω to 75K; 1.5W; ⅜" dia.; Max. oper. temp., 125°C.

MODEL 3068 Commercial, Resiston® carbon; 20K to 1 Meg.; 0.2W; Max. oper. temp., 85°C.

NOTE: Models 3500, 3510 and 3520 can also be supplied to meet cycling humidity specs.

MODEL 3367 Single-turn, wirewound, sub-miniature; 100Ω to 20K; 0.5W; Max. oper. temp., 105°C.

MODEL 3600 Precision readout, wirewound (Knobpot®), 10-turn; 1K to 100K; 1.5W; ¾" dia.; Max. oper. temp., 85°C.

MOST UNITS AVAILABLE IMMEDIATELY FROM STOCKING DISTRIBUTORS ACROSS THE NATION

Write for complete information

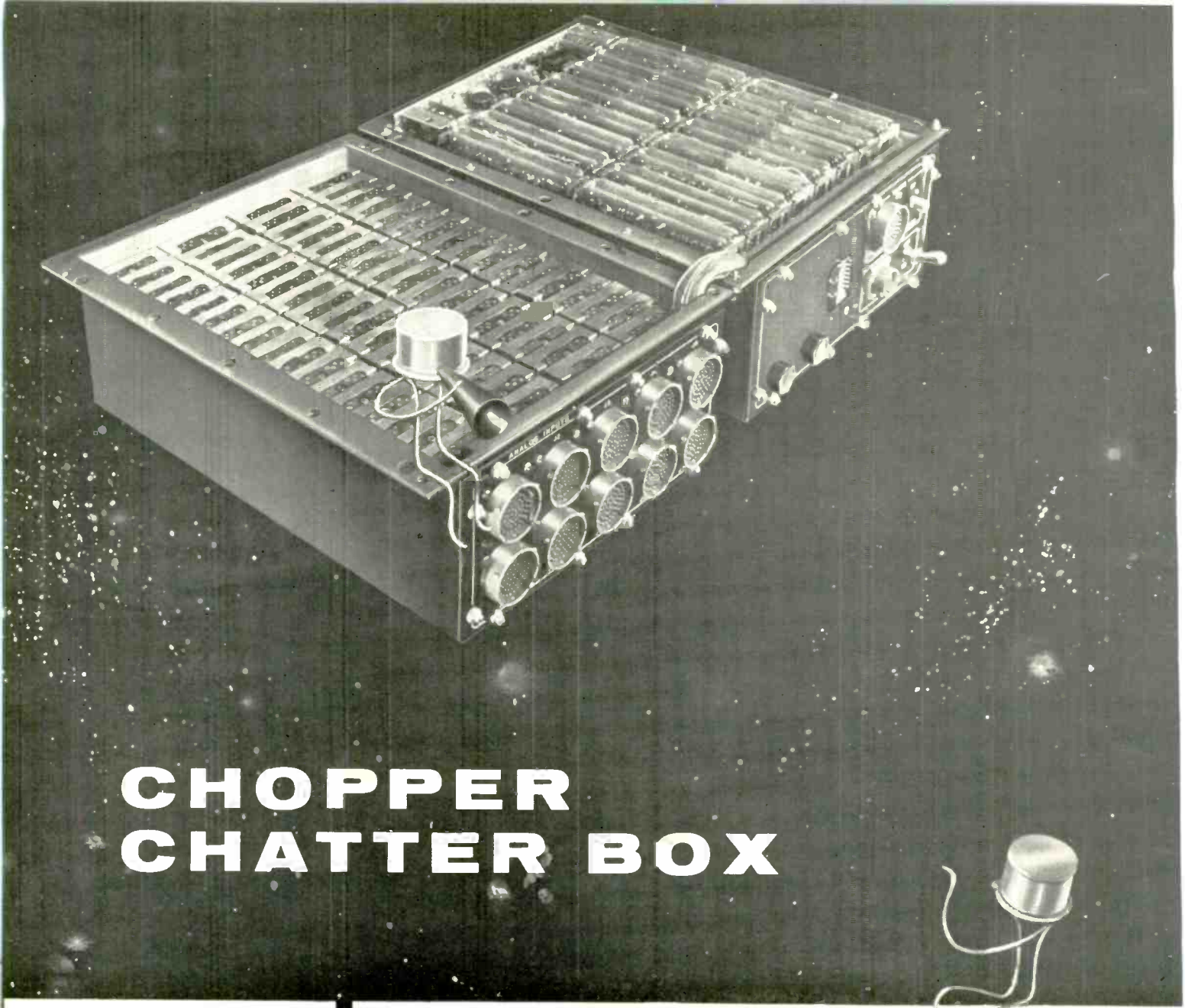
BOURNS

BOURNS, INC., TRIMPOT DIVISION
1200 COLUMBIA AVE., RIVERSIDE CALIF.
PHONE: 684-1700 · TWX: RZ9222
CABLE: BOURNSINC

Units shown ½ actual size unless otherwise indicated

PLANTS: RIVERSIDE, CALIFORNIA; AMES, IOWA; AND TORONTO, CANADA. MANUFACTURER: TRIMPOT® POTENTIOMETERS; TRANSDUCERS FOR POSITION, PRESSURE, ACCELERATION.

Circle 55 on Inquiry Card



CHOPPER CHATTER BOX

America's First Operational
LOW LEVEL PCM TELEMETRY SYSTEM DESIGNED BY EPSCO FOR TITAN II USES SPERRY MATCHED CHOPPERS

The Epsco Pulse Code Modulation system made telemetry history on the U.S. Air Force's Titan II 5,000 mile test. It is the center of the fact gathering complex and transmits 196 channels of vital information to ground stations.

A unique feature of the Epsco system is a technique which appreciably reduces the size and the number of components while actually increasing reliability — and it's only the size of a shoe box.

Almost all the semiconductors in this miniaturized system are Sperry Matched Chopper transistors. For detailed information on Sperry Choppers, write for Technical Application Bulletins 2107 and 2109. For Epsco PCM Specifications write for brochure PC 5196LL.

SPERRY

SEMICONDUCTOR

DIVISION OF
SPERRY RAND CORPORATION
NORWALK, CONNECTICUT

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SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS*).
ALLOY SILICON TRANSISTORS AND DIODES

SALES OFFICES: CHICAGO, ILLINOIS; LOS ANGELES, CALIFORNIA; OAKLAND, NEW JERSEY; MEDFORD, MASSACHUSETTS; SYKESVILLE, MARYLAND; BETHPAGE, L. I., NEW YORK

SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS

*Trade Mark, Sperry Rand Corporation

BTK

Much higher reliability ... slightly higher price

DD

In order to furnish parts with a confidence level acceptable to the user, manufacturers must design beyond nominal or "standard" usage requirements. At Deutsch, this concept is the guideline for all design criteria. We *exceed* the minimums in every applicable specification to assure our customers of continuous performance above and beyond documented requirements. For instance, our DD ball-lock and BTK bayonet-lock connectors exceed, by far, the latest revision to MIL-C-0026482. Here are just a few examples:

- Deutsch-developed silicone materials provide better wire and interfacial seals against altitude and moisture... assure temperature performance above 300°F... guarantee better dielectric characteristics and dimensional stability under exposure to oils and fuels.
- Contact retention of 25# exceeds the 15# specification by more than 60%.
- Fixed coupling rings make sure the connector remains a complete unit throughout assembly... provide grope free engagement... insure proper mating and lock of plug and receptacle.
- Positive visual lock indicators afford inspectability for correct connector assembly and engagement.
- Millivolt drop, measured by the latest specification techniques, is 50% below the minimums before and after corrosion testing. And insulation resistance is at least four to five times higher at 300°F. than the specification's minimum at room temperature.
- Insertable and removable contacts are crimp terminated to military standard geometry, and are held in place by mechanical devices that insure retention, contact alignment and are replaceable if damaged.
- MIL-C-0026482 electrical performance ratings, at altitude, are met and exceeded at 110,000 ft. instead of at the specified 80,000 ft.

These and the many additional advantages of DD and BTK connectors may cost a little more, but in terms of value analysis are priced lower due to assembly time savings, repairability and, perhaps most important, favorable MTTF ratios under actual use. If you are faced with criteria calling for a high confidence level rather than just meeting a specification, we suggest you get all the facts on DD and BTK performance from your local Deutschman, or write for Data File U-7.

DEUTSCH

Electronic Components Division · Municipal Airport · Banning, California

ADVANCED SPECIFICATION MINIATURE ELECTRICAL COMPONENTS

Books

Operations Research in Production and Inventory Control

By Fred Hanssmann. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 254 pages. Price $8.95.

Theory of scientific inventory management has seen its major growth during the past decade. This book presents a comprehensive, up-to-date exposition of all the major technical developments that have occurred during this important period. Book is balanced between mathematical theory and applications with about half of the chapters devoted to applications.

Physics in the Soviet Union

By A. S. Kompanayets. Published 1962 by Philosophical Library Inc., 15 E. 40th St., New York 16, N. Y. 592 pages. Price $7.50.

Book is intended for engineer-physicists, though it may be useful to specialists working in fields associated with physics-chemists, physical chemists, biophysicists, geophysicists, and astronomers.

Aim of the book is not only to give the reader an idea about what theoretical physics is, but also to furnish him with a working knowledge of the basic methods of theoretical physics.

Linear Signal-Flow Graphs and Applications

Yutze Chow & Etienne Cassignol. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 144 pages. Price $6.95.

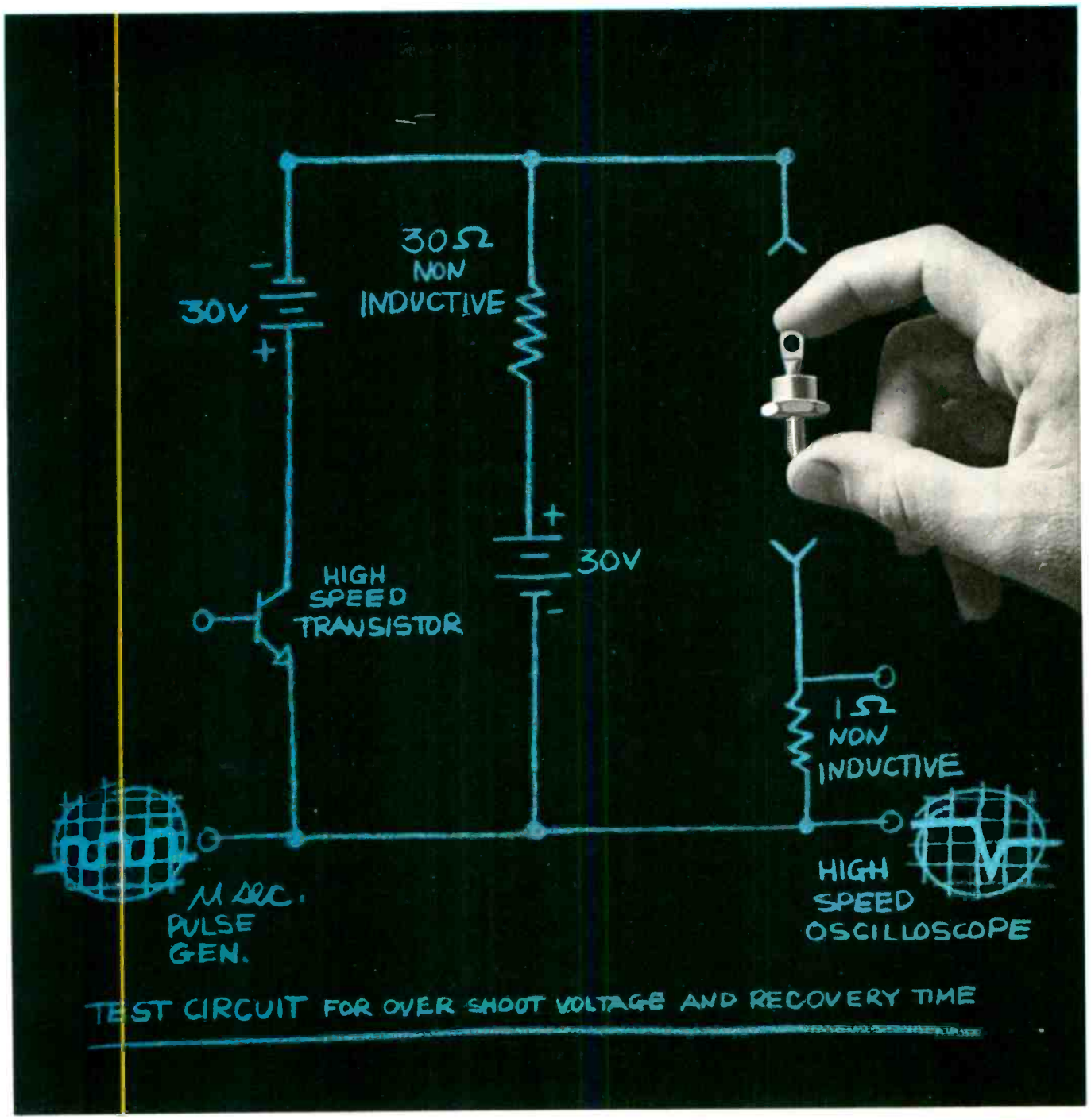
Simplicity and elegance of conventions used for signal-flow graphs permit an interesting and significant development of the theory to nourish the field of linear network analysis. The subject is treated with clarity and precision, with many examples to illustrate definitions, rules and applications.

Management Models & Industrial Applications of Linear Programming, Vol. II

By A. Charnes & W. W. Cooper. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 861 pages. Price $11.75.

Volume II includes a wealth of illustrations drawn from actual experience in managerial, engineering and economic applications. These applications are incorporated into a unifying theme identified as the idea of "model types." This has proven to be an invaluable strategy when dealing with applications in many diversified areas. Similarly, from the theoretical standpoint, a unified approach to a wide variety of mathematical theorems is supplied by the idea of "regularization." This is developed around the concept of linear programming itself.

(Continued on page 74)



In the time it takes you to read to here a Hughes fast-switching rectifier can recover 25,000,000 times

Hughes new "Golden Line" fast-switching silicon power rectifiers are a unique combination of power, speed and reliability.

Typical recovery time of 0.08 μsec. Typical room temperature reverse leakage currents at rated PIV of 1 to 35 μamps for 1 to 35 amp device types, respectively. Maximum forward voltage drop of less than 1.5 volts at rated current.

Hughes 1 thru 35 amp power rectifiers are available in quantity—today—in regular or insulated stud packages and as standard or fast-switching types.

NEW 6-PAGE RECTIFIER BROCHURE. To get your copy call your nearest Hughes representative or write Hughes Semiconductor Division, Marketing Department, Newport Beach, California.

WATCH FOR OUR NEW LINE OF STANDARD AND CUSTOM HIGH-VOLTAGE, HIGH-POWER STACKS!

RELIABILITY PLUS

Creating a new world with Electronics

HUGHES

HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DIVISION

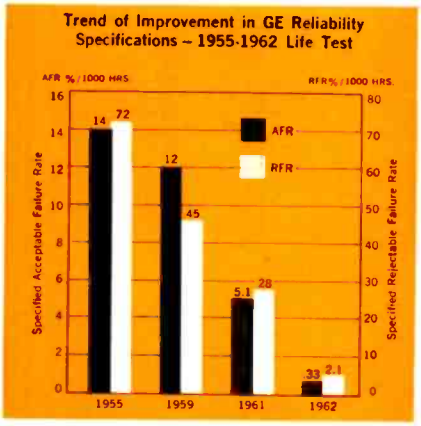
DIODES • TRANSISTORS • RECTIFIERS • PACKAGED ASSEMBLIES • CRYSTAL FILTERS

Circle 59 on Inquiry Card

TIPS *(Technical Information and Product Service)*

6 NEW DEVELOPMENTS FROM G-E

Circle 134 on Inquiry Card



General Electric... first with ASSURED LOW FAILURE RATE tubes

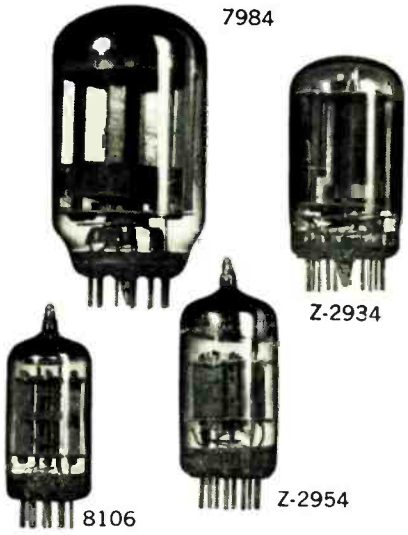
Many reliability improvements in General Electric 5-Star Tubes have been made over the past seven years (see graph, above). The latest achievement in a long line of firsts is to greatly reduce the *assured* failure rates of tubes offered to military specifications.

For example: Improvements made since 1955 in AFR and RFR are approximately 10 to 1 and 14 to 1, respectively, for G-E types 5751W1 and 5814WB. AFR, acceptable failure rate, is that value of failure rate in % per 1,000 hours at which the producer's risk of rejecting a lot that meets the specified acceptable failure rate is 5%. RFR, rejectable failure rate, is that value of failure rate in % per 1,000 hours at which the customer's risk of receiving tubes with a failure rate equal to the specified rejectable failure rate is 10%, providing a lot of such poor quality is even submitted for sampling inspection.

Thus, in the case of types 5751W1 and 5814WB, General Electric *assures* an acceptable failure rate (AFR) of 0.3% per 1,000 hours, and a maximum reject failure rate (RFR) of 2.1% per 1,000 hours with 90% confidence when used within the high reliability ratings. An AFR of 1.3% and RFR of 5.3% are assured with 90% confidence when used within normal ratings.

Write today for the complete information on low failure rate 5-Star Tubes.

Circle 135 on Inquiry Card



Four new tubes expand G-E communication line to 30 types

Two new compactrons and two 9-pin miniature tubes, designed for operation in the 175MC range, have been added to the G-E COMMUNICATION tube line. Brief specifications on the new types are outlined below:

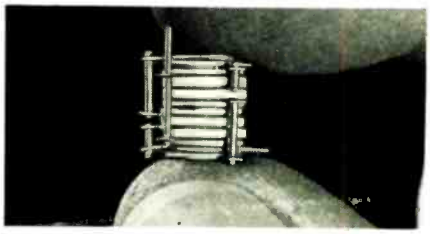
7984—High-power transmitting tube—Power output: 46 watts at 175 MC. Features: single-ended construction, low seated height, short internal leads, multiple cathode and screen connections, low output capacitance, and low driving-power requirements. Compactron, T-12 bulb.

Z-2934—Medium-power transmitting tube—Power output: 18 watts at 175 MC, low output capacitance: 4.8 pf, compactron T-12 bulb. $1\frac{15}{16}$ inches seated height, multiple cathode and screen leads.

8106—175-MC Driver and Multiplier—Miniature beam pentode. Features: low cathode- and screen-inductance, multiple leads, T-6½ bulb. Interelectrode output capacitance: (p to h +k +g2 +b.p.) 2.6 pf.

Z-2954—FM Modulator and Frequency Tripler—Miniature triode-pentode. Ideal signal source for (c) above, when (c) is used as a multiplier. Large cathode-cross-section assures long operating life. T-6½ bulb.

Circle 136 on Inquiry Card



TIMM circuit elements now available

TIMM (Thermionic Integrated Micro Module) circuits represent a unique *high-temperature* (580°C.), *radiation-resistant*, *microminiature system*. Ceramic and titanium components tolerate 10,000 times the steady-state radiation of circuits employing solid-state devices. TIMM component densities of as high as 250,000 parts per cubic foot are possible.

Individual components are now available for breadboard experimentation, characteristics evaluation, and overall familiarization with TIMM microminiaturization techniques.

Resistors—1,000 ohms to 100,000 ohms rated at ¼ watt (at 580°C.)

Capacitors—20 pf to 200 pf units to 300 vdc (at 580°C.)

Diodes
50 volts max. P. I. V.
2 mA DC plate current (at 580°C.)
2.3v self-bias

Triodes—As a switch (at 580°C.)
off—E_b=10v, E_g=0v, I_b=100 ua max.
on—E_b=7.5v, E_g=+2.5v, I_b=2.0 mA, I_g=200 ua

To help you value analyze TIMM circuit elements at high temperatures, General Electric has prepared a TIMM accessory kit consisting of:

One mounted 1½" diam. x 8" long oven, two circuit mounting boards, quartz insulating sleeves, four circuit spacers, connecting wire and ribbon, asbestos tape, thermocouple (Cr-Al), end-plugs, thermal insulating sheet.

Write for price and availability information today.

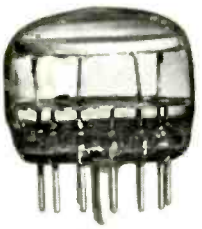
RECEIVING TUBE RESEARCH

Circle 137 on Inquiry Card

7427

B425, B46,

A35, A33



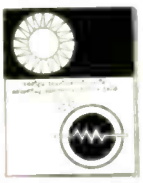
B935

New line of hermetically sealed G-E photoconductive cells

Now immediately available from G.E.—hermetically sealed, cadmium sulfide photoconductive cells in four basic sizes, three power ratings, and multiple resistance ranges. G.E.'s time-proven type 7427, and three new, end-illuminated cells enable the designer to select a maximum power dissipation of either 50, 250, or 400 mw. Spectral response peaks are in the visible light range.

The hermetically sealed package and the extremely dry atmosphere in these cells are significant factors in assuring reliable operation for many thousands of hours of operation.

Free Value Analysis Booklet: "Design Considerations in Selecting Photoconductive Cells" summarizes principles of operation, photocell design techniques, sample schematics, and discusses typical applications which utilize optical sensing systems.



Circle 138 on Inquiry Card

New ceramic Lighthouse Tubes "Custom-Built" to last 3 Years

General Electric is custom building a number of ceramic planar triodes with an expected life of at least 25,000 hours of continuous operation. Based on a tube's performance during 1,000 hours of test operation, G-E *value analysis* can predict, with a high degree of certainty, whether or not it will last the required 3 years.

The tubes, intended for use in "Project Advent" Communications Satellites, have a number of unique construction features:

(1) A ring-type heat sink made of oxygen-free high-conductivity copper for thermal cooling, in place of the conventional fin radiators.

(2) Each tube's cathode is made of high-purity 499 nickel for increased life.

(3) A higher seal-off vacuum is maintained, 5×10^{-9} mm hg, as compared to 5×10^{-6}, the commercial standard.

Circle 139 on Inquiry Card

GM-IP=800

New Z-2901 high-reliability tetrode for wide-band, high frequency applications

Newest of G.E.'s 5-Star, high-reliability tubes, the Z-2901 high-gain tetrode is intended for use in critical industrial and military applications in which operational dependability is of primary importance.

Designed to replace the 6CY5, its entertainment prototype, and as a functional replacement for the 5-Star 5654, the Z-2901 is ideal for wide-band high frequency amplifiers.

In addition to improvements in material and construction, the Z-2901 features higher gain (GM to IP ratio of 800), and higher I_p/I_{g_2} ratio (6.7 to 1) than the 5654.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Please send me more value-analysis information about:

- ☐ Low Failure Rate 5-Star Tubes
- ☐ New COMMUNICATION Tubes
- ☐ Hermetically Sealed Photoconductive Cells
- ☐ TIMM Circuit Elements
- ☐ "Project Advent" Ceramic Tubes
- ☐ Z-2901 5-Star Tetrode

G-E Receiving Tube Department
Technical Information and Product Service (TIPS)
Box 1733B, Owensboro, Kentucky

Name .....

Title .....

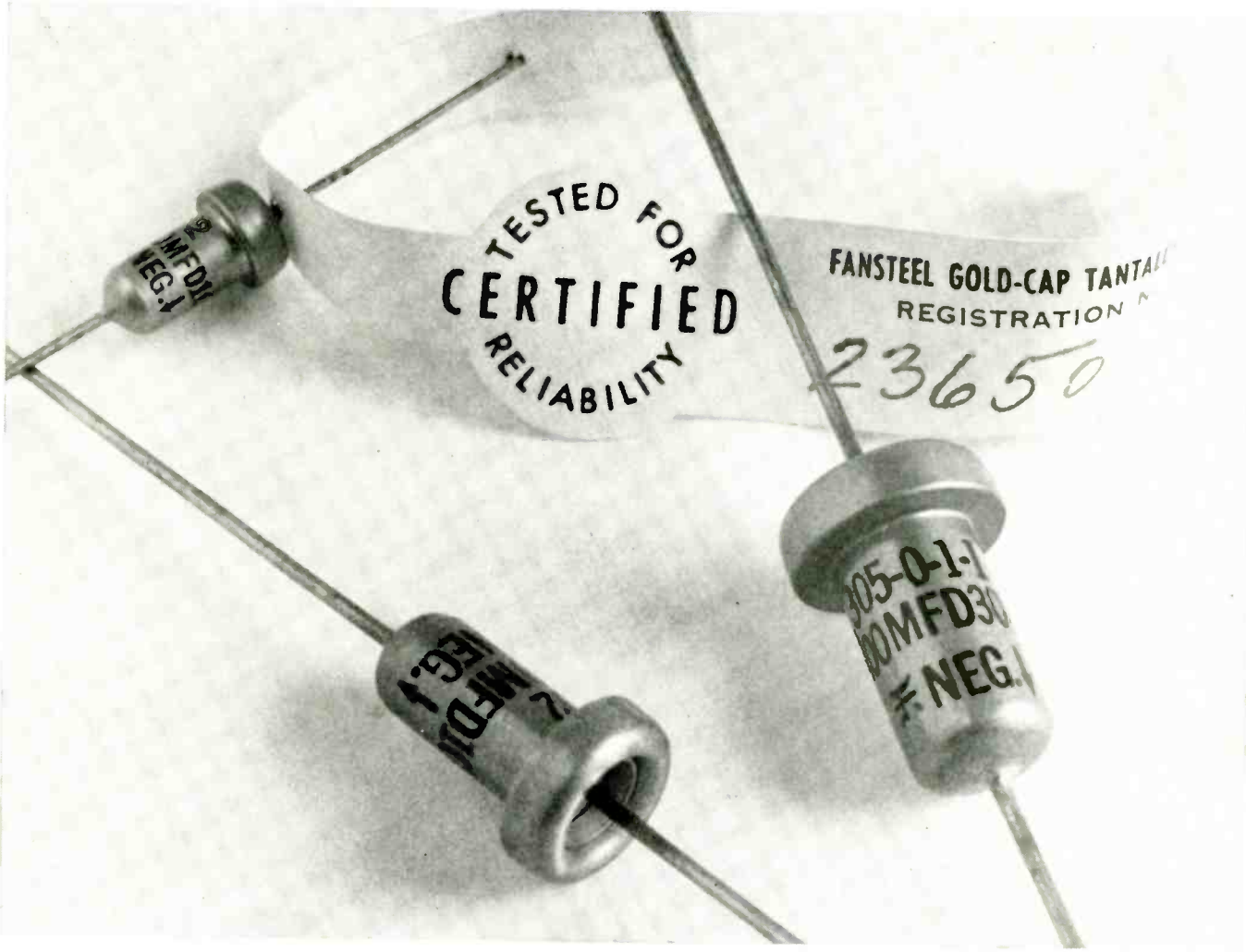
Company .....

Address .....

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

FANSTEEL RC
METALLURGICAL CORPORATION
RECTIFIER-CAPACITOR DIVISION

You may not need capacitors as good as these



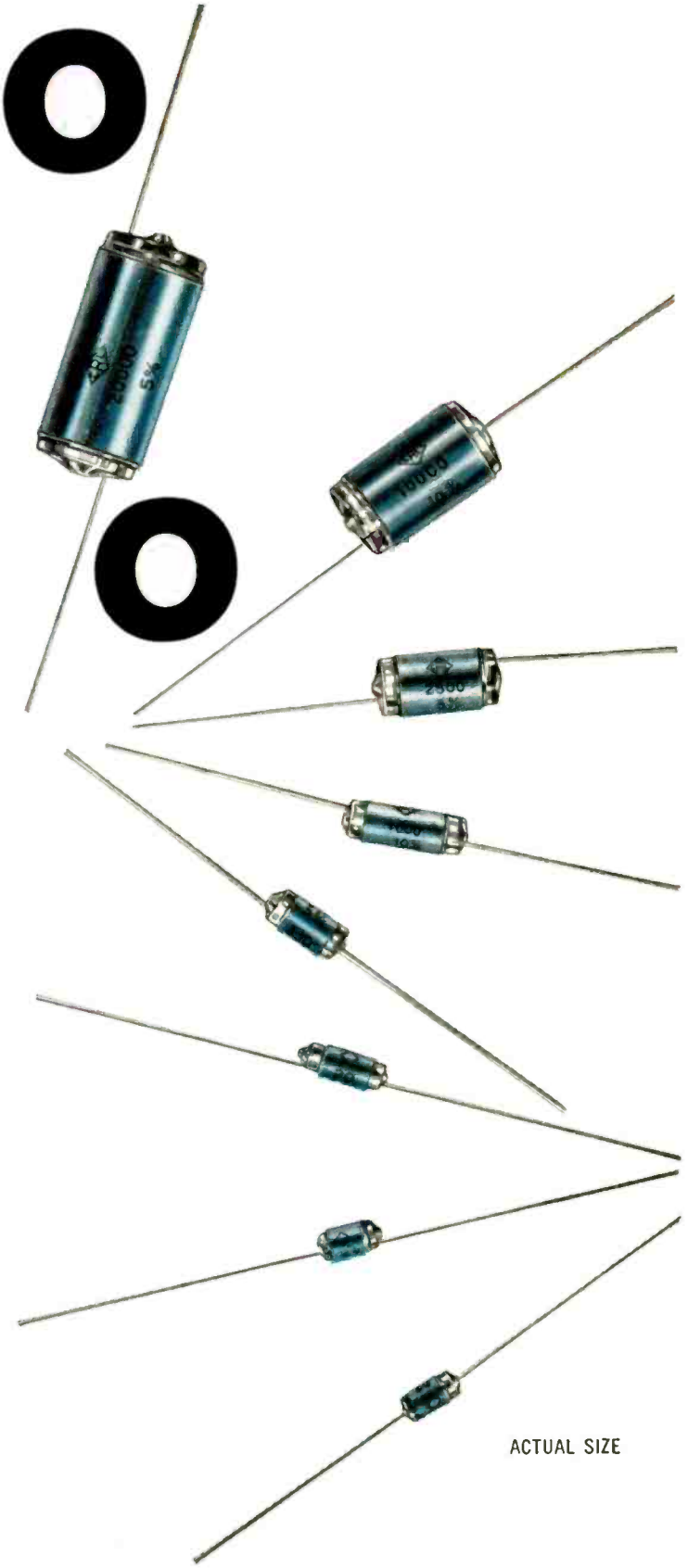
Fansteel GOLD-CAP® tantalum capacitors satisfy a very particular need for extremely high reliability. Your design may not justify their extra cost. If so, Fansteel makes and stocks twelve other types of tantalum capacitors that will surely fill the bill. Gold-Caps are produced under Fansteel Spec. No. 6CA-101 which exceeds the requirements of any Mil. Spec. The stability of each and every unit is tested at temperature extremes for Capacitance, D-C Leakage, E S R, and Impedance. Altogether, 7,891 readings, calculations, examinations, and comparisons are made for every 100 units by Fansteel's tough Reliability Center with the aid of modern computers. When a capacitor is given a GOLD-CAP tag, individually serialized, and provided with certified test results, it has *earned* it. No, we can't be positive that these are the best tantalum capacitors in the world, but we have no reason to think that they aren't. Send for GOLD-CAP Spec. No. 6CA-101 and see what we mean. Rectifier-Capacitor Division, Fansteel Metallurgical Corporation, North Chicago, Ill.

This is what you get—certified test data, such as illustrated, is furnished with each and every GOLD-CAP capacitor. Further inspecting or testing is unnecessary.

CAPACITOR NO.	TEST NO.	TEMP. °C	C	DF %	DC LKG.	% INITIAL C
23650-0012	1	+25	54.0	4.8	.80	
23650-0012	2	-55	47.0	18.6	.20	87.0
23650-0012	3	+25	54.0	4.8	.80	100.0
23650-0012	4	+125	56.0	4.6	2.40	108.7
23650-0012	5	+25	53.3	4.8	.80	98.7

REDUCE CAPACITOR COSTS 80%

WITH CENTRALAB Q-KAPS* POLYSTYRENE CAPACITORS



ACTUAL SIZE

EXCEPTIONALLY LONG LIFE AND PROVEN RELIABILITY

The polystyrene film dielectric of these new Centralab capacitors permits their use as direct replacements for micas and Mylars... in any application within their capacity limits and operating temperature range . . . yet their price is fantastically low. Fast delivery is available on all standard EIA (RETMA) values from 20 pf to .01 mf, 500 VDCW, 1500 VDCT, ±5% or ±10% tolerance. Other capacity values, tolerances (±2.5%, ±20%), and voltages (125 VDCW, 375 VDCT) can be supplied on special order.

CAPACITANCE DRIFT: 0.3% or less after temperature cycling of +25, −10, +85, +25°C.

INSULATION RESISTANCE: 5000 Meg/mf or 500,000 Meg, whichever is greater, at 100 VDC, +25°C, 80% R.H.

"Q" FACTOR: Over 2000 at 1 mc, 25°C.

OPERATING TEMPERATURE RANGE: — 10°C to +85°C.

For detailed information and complete specifications on these new Centralab "Q"-Kaps, write for Bulletin EP1034R3.

Immediate delivery, from stock, of all EIA values, 5% tolerance, is available through Centralab Industrial Distributors.

Centralab®

*Trademark

D-6223

THE ELECTRONICS DIVISION OF GLOBE-UNION INC. • 938G EAST KEEFE AVENUE • MILWAUKEE 1, WISCONSIN

Circle 103 on Inquiry Card

Books

(*Continued from page 68*)

Method of Least Squares and Principles of the Theory of Observation

By Yu. V. Linnik. Published 1961 by Pergamon Press Inc., 122 East 55th St., New York 22, N. Y. 360 pages. Price $12.50.

The author has provided an account of the method of least squares in sufficient detail to cover most practical requirements, combined with a thorough treatment of those fundamental statistical techniques which are useful in interpreting the results.

Numerical examples are provided to make clear the most convenient ways of carrying out the calculations needed to apply the methods developed in the book.

The Birth of Broadcasting, Vol. I

By Asa Briggs. Published 1961 by Oxford University Press, 417 Fifth Ave., New York 16, N. Y. 425 pages. Price $10.00.

This is the first part of a projected three or four volume history of broadcasting in the United Kingdom. The whole work is designed as an authoritative account of the rise of broadcasting in England up to the passing of the Independent Television Act in 1955 and the end of the BBC monopoly. Though naturally largely concerned with the BBC, it will be a general history of broadcasting, not simply an institutional history of the BBC, and will briefly sketch the background of wireless developments in other parts of the world.

Introduction to Transients

By D. K. McCleery. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 232 pages. Price $7.50.

The study of transient phenomena has generally been regarded by teachers of electrical engineering as too difficult for elementary students.

For some years now, the standard method applied to these problems has been that of the Laplace transform, which is rightly claimed to give a completely rigorous and satisfying mathematical treatment. The author believes that a simpler approach is possible, and this book offers a new look at an old method: the operational calculus of the late Mr. Oliver Heaviside.

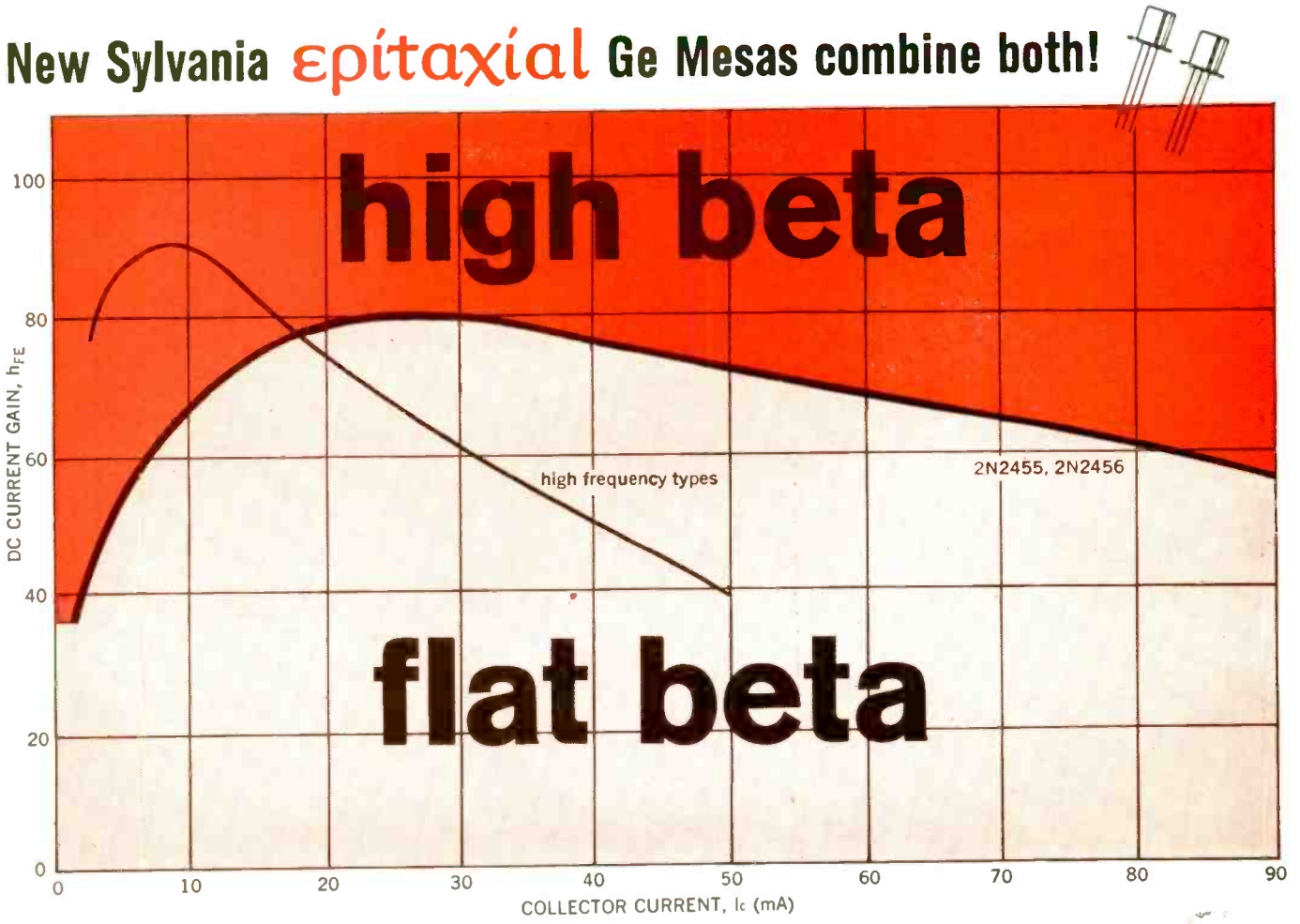
Computer Applications in the Behavioral Sciences

Edited by Harold Borko. Published 1962 by Prentice-Hall, Inc., Publishers, Englewood Cliffs, N. J. 633 pages. Price $11.65.

Written expressly for the social scientist who is not a specialist in computers the book provides a general introduction to computers plus specific information on how computers are currently being used to expand and facilitate research. It explains the essentials of programming and the

(*Continued on page 78*)

New Sylvania epitaxial Ge Mesas combine both!



...offer superior GBW (2N2456 typically 1200MC)

New 2N2455, 2N2456 provide high beta at low current and exhibit virtually linear beta over a *wide current range*. In this respect, as well as in current gain characteristics and GBW product, they far surpass performance of popular high-frequency types.

Packaged in TO-18, the 2N2455 and 2N2456 offer optimum performance in both PNP switching and amplifier applications. Both combine the well-known reliability and dissipation capabilities of the mesa structure with the reduced storage time, low saturation voltage and extraordinary uniformity inherent in Sylvania epitaxial process.

The full range coverage of Sylvania high beta types—at low current (2N2455, 2N2456)—at medium current (2N960 series)—and at high current (2N705, 2N781) offers wide design flexibility at optimum current levels. Your Sylvania Sales Engineer or Sylvania Franchised Semiconductor Distributor can give you full details. Ask him. Or, write for tech data to Semiconductor Division, Sylvania Electric Products Inc., Woburn, Massachusetts.

ABSOLUTE MAXIMUM RATINGS AT 25°C

Collector To Base Voltage, V_{CB}	−15 volts
Collector To Emitter Voltage, V_{CES}	−15 volts
Collector Current, I_C	200 ma
Storage Temperature, T_{stg}	−65°C to +100°C
Junction Temperature, T_J	−65°C to +100°C
Power Dissipation, P_J	150 mw

ELECTRICAL CHARACTERISTICS AT 25°C		Min.	Typ.	Max.	Unit
Current Gain, h_{FE} I_C = 2.0 ma, V_{CE} = −.20 V		20	52	100	—
Current Gain, h_{FE} I_C = 30 ma, V_{CE} = −.40 V		40	76	—	—
Gain Bandwidth Product, f_T I_C = 10 ma, V_{CE} = −6.0 V	2N2455	600	820	—	mc
	2N2456	1000	1200	—	mc
Output Capacitance, C_{ob} I_E = 0, V_{CB} = −6 V, f = 1 mc	2N2455	—	—	3.5	pf
	2N2456	—	—	3.0	pf
Input Capacitance, C_{te} I_C = 0, V_{EB} = −1.0 V, f = 1.0 mc		—	—	4.0	pf
Rise Time, t_r	2N2455	—	11	30	nsec
	2N2456	—	8.0	15	nsec
Off Time, t_{off}	2N2455	—	45	65	nsec
	2N2456	—	37	65	nsec
Storage Charge Factor, K_s		—	30	60	nsec

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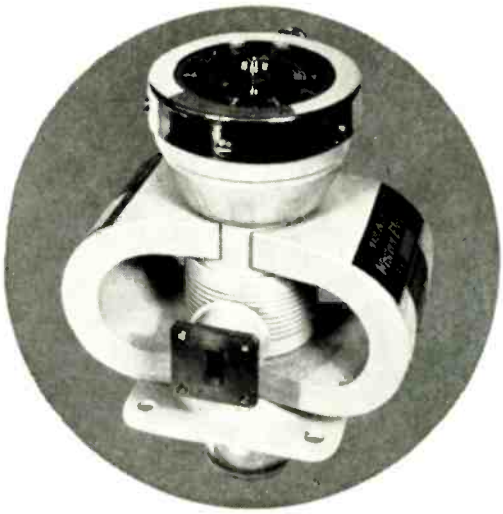
Circle 63 on Inquiry Card

To Contractors and Subcontractors on U. S. Government Projects

Announcing the newest member of Western Electric—Laureldale's Family of Coaxial Magnetrons:

8123 Ku-BAND COAXIAL MAGNETRON

Tunable
16 to 17 Gc



Weight
8¼ Pounds

HIGHLY STABLE FOR AIR-BORNE MTI APPLICATIONS

The 8123 magnetron is the latest addition to the coaxial family of magnetrons produced by the Laureldale Plant of Western Electric. Designed by Bell Telephone Laboratories, this tube is ruggedized to minimize vibration-induced frequency modulation and frequency shifts due to atmospheric pressure changes. The power output variation across the band is typically ± 0.25 db with an average operating efficiency of 40 per cent.

TYPICAL 8123 COAXIAL MAGNETRON CHARACTERISTICS

Peak Power Output	Pushing Factor	Pulling Factor	r.m.s. Jitter			Missing Pulses
			Fj	Vj	tj	
kw	Mc/A	Mc	kc	db	nsec	%
70	0.06	6	13	0.02	1.5	< 0.001

Another ruggedized coaxial magnetron, the 7208B, is also available. This tube tunes the frequency range of 15.5 to 17.5 Gc with a peak power output of 130 kw.

Coaxial magnetrons may be purchased from Western Electric's Laureldale Plant. For technical information, price and delivery, address your request to Sales Department, Room 105, Western Electric Company, Incorporated, Laureldale, Pa. Telephone—Area Code 215—929-5811.

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MAKER OF ELECTRON PRODUCTS

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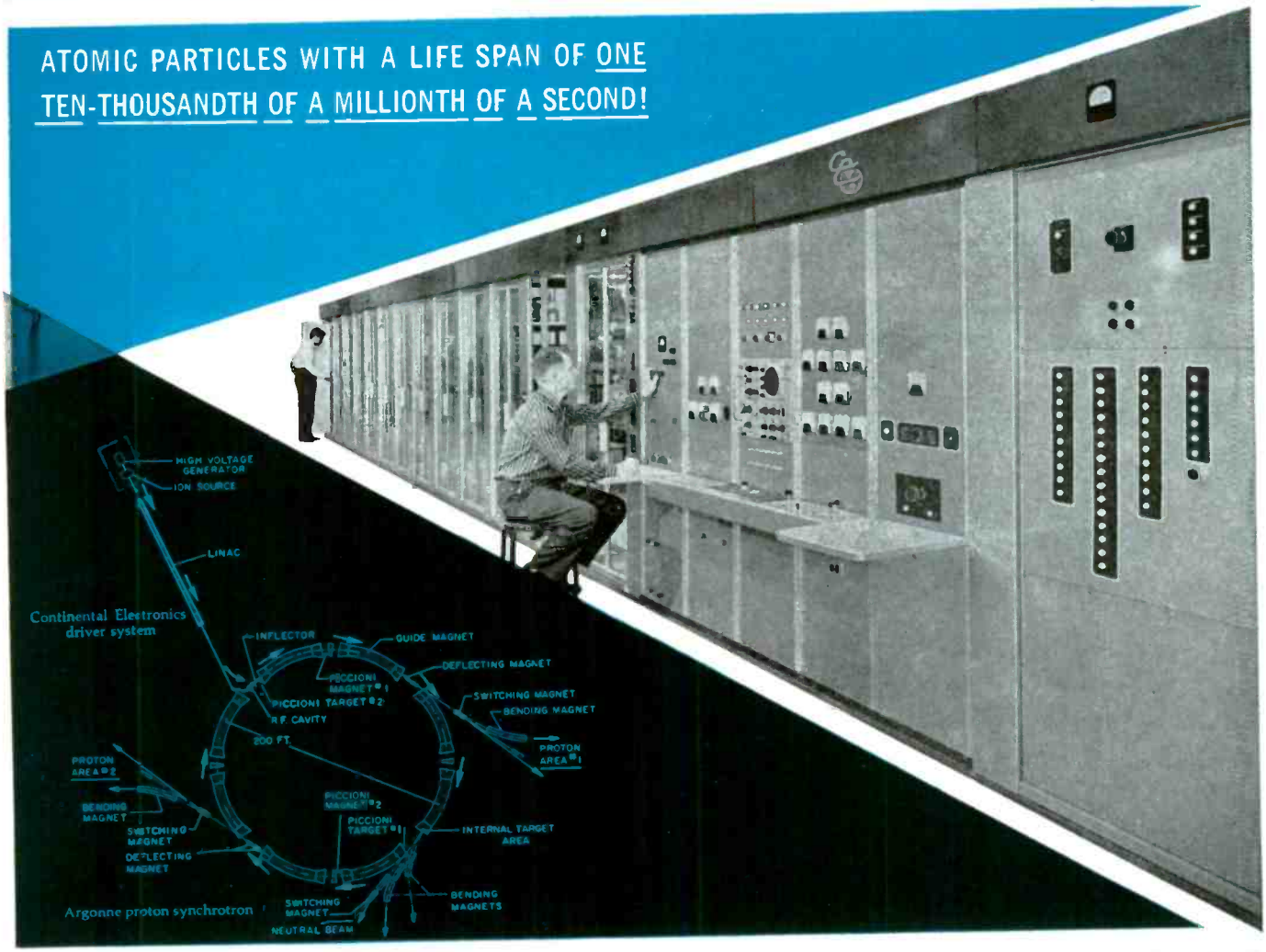
space age research



Continental Electronics, specialist in super power electronics equipment, is building the radio frequency driver system for the linear accelerator injector for the proton synchrotron now under construction for the Argonne National Laboratory. This driver system will have a peak power of 5 megawatts, with an average power of 25 kilowatts, operating at a frequency of 200 megacycles with a 500 micro-second pulse.

When completed, the Argonne proton synchrotron will accelerate protons to an energy of 12.5 billion electron volts, enabling scientists conducting atomic research to experiment with known phenomena and discover new phenomena that occur when protons of high energy collide with other protons at rest. This collision usually results in the production of rare, short-lived particles; some with a life span of one ten-thousandth of a millionth of a second!

To achieve the high energy required to produce these rare atomic phenomena, protons from a conventional ion source are first accelerated to 750,000 electron volts with a conventional high voltage supply. They are then increased to 50 million electron volts by passing through the linear accelerator, reaching final energy of 12.5 billion electron volts in the synchrotron.

Continental Electronics is proud to be a contributor to the Argonne National Laboratory's atomic research program which is dedicated to increasing scientific understanding of atomic energy.

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DESIGNERS AND BUILDERS OF THE WORLD'S MOST POWERFUL RADIO TRANSMITTERS

Books

(*Continued from page 74*)

technical aspects of computers in a manner easily grasped. Special emphasis is placed on non-computational usages.

Thermodynamics of Solids

By Richard A. Swalin. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 343 pages. Price $12.50.

Written for the reader who has had exposure to a formal course in thermodynamics, this book is a general treatment of the various properties pertaining to solids. The author covers all important classes of crystals and solids including metals, semiconductors—both elemental and compound—and insulators.

Theory and Application of Topological and Matrix Methods

By Keats A. Pullen, Jr. Published 1962 by John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y. 96 pages. Price $2.50.

Dependence of electrical circuit theory on topology (the theory of line graphs), first noted by Kirchhoff, is of growing importance because line graphs for networks represent their flow patterns. Application of topological methods had lagged behind the use of matrix methods only because of a few of the minor applicational problems. This book resolves these problems in a logical and understandable manner.

BOOKS RECEIVED

Management and the Computer of the Future

Martin Greenberger, Editor. Published 1962 by The M.I.T. Press, Cambridge 39, Mass. and John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N.Y. 340 pages. Price $6.00.

Essential Characteristics, 9th Ed.

G. E. handbook on receiving tubes, television picture tubes and replacement capacitors. Published 1961 by the General Electric Co. 300 pages. Price $1.50. May be obtained either from authorized receiving tube distributors or by ordering direct from G.E. warehouse, 3800 North Milwaukee Ave., Chicago, Ill.

Basic TV Course

By George Kravitz. Published 1962 by Gernsback Library, 154 West 14th St., New York 11, N.Y. 224 pages. Price $4.10.

Design & Operation of Regulated Power Supplies

By I. M. Gottlieb. Published 1962 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 112 pages, paperbound. Price $2.95.

Proceedings of the 1961 Institute in Technical and Industrial Communications

Edited by H. M. Weisman. Available from the Institute in Technical and Industrial Communications, Colorado State University, Fort Collins, Colo. 133 pages. Price $5.00.

(*Continued on page 83*)

This Counter . . .

Type 1130-A Digital Time and Frequency Meter, $2585 to $2950 *Depending on Time-Base Oscillator Selected.*

. . . Measures frequency, period, and time interval to 10 Mc without need for auxiliary plug-in units.

. . . Is designed and built like a computer . . . uses a decade code and counting circuits that are inherently reliable.

. . . Has a built-in "Memory" . . . readout is continuous or intermittent as desired.

. . . Has input trigger level, slope, and attenuator controls that permit triggering at any point on the signal waveform . . . useful for reducing the effects of noise.

. . . Permits simplified graphic recording. Data held by internal storage circuits is ready made for conversion to dc for all electronic-analog recording at low cost. G-R 1134-A Digital to Analog Converter is available (Accessory 1132-A Data Printer prints out rows of numerals at adjustable rate).

. . . Gives you choice of time-base stability; three plug-in oscillators are available. Best oscillator is standard frequency quality, provides short-term stability of 1 part in 10^9 per min, long term stability of 5 parts in 10^8 per week.

. . . Is individually tested during a rigorous 300-hour evaluation period before shipment.

. . . Operates for thousands of hours without downtime — for example, one of these counters recently ran 6000 hours before the first malfunction.

. . . Is easy to maintain. Circuits are on plug-in etched circuit boards that can be quickly removed and replaced. Spare pre-tested boards or decades can be stocked for maximum speed in repair.

. . . Has a companion converter, now under development, for measurements to 500 Mc.

Also Available from GR — New Solid-State, 220-kc Digital Frequency Meter at $915

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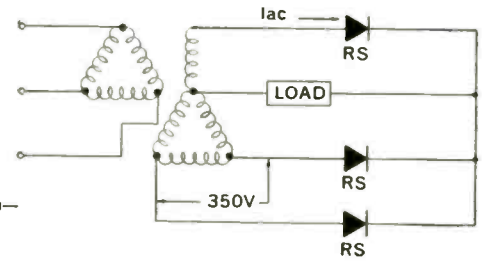
TARZIAN DESIGN IDEAS

RS = Economical Power Conversion

Sarkes Tarzian hermetically sealed medium and heavy current rectifiers combine efficient operation with low cost. A wide choice of ratings and circuitry fit power supply applications from air space to electrochemistry. Tarzian literature is available to show you the products—Tarzian engineering assistance is ready to apply them to economical solutions to your power conversion problems—at no cost. Write or call us now.

FOR HEAVY CURRENT APPLICATIONS...

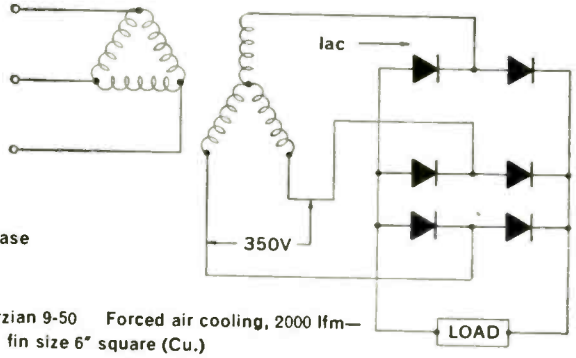
Three Phase Half Wave



RS—Sarkes Tarzian 9-50
Forced air cooling, 2000 lfm—
fin size 6" square (Cu.)

Output—230 VDC @ 625 amps Ripple—20% (unfiltered)
Iac—370 amp RMS

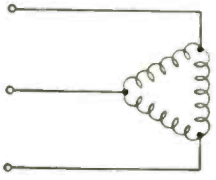
Three Phase Bridge



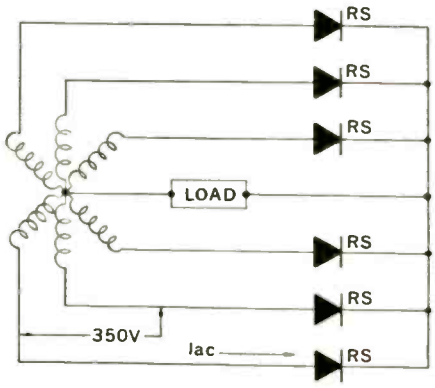
RS—Sarkes Tarzian 9-50 Forced air cooling, 2000 lfm—
fin size 6" square (Cu.)

Output—465 VDC @ 625 amps Ripple—4.5% (unfiltered)
Iac—510 amps RMS

FOR VERY HEAVY CURRENT APPLICATIONS...



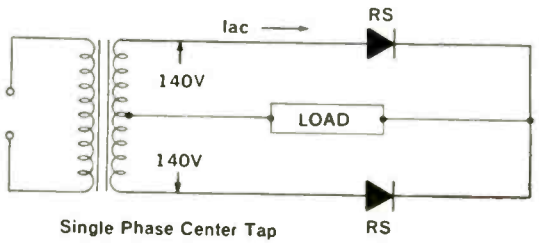
Six Phase Star



RS—Sarkes Tarzian 9-50
Forced air cooling, 2000 lfm—
fin size 6" square (Cu.)

Output 230 VDC @ 1250 amps DC
Ripple —4.5% (unfiltered)
Iac—500 amps RMS

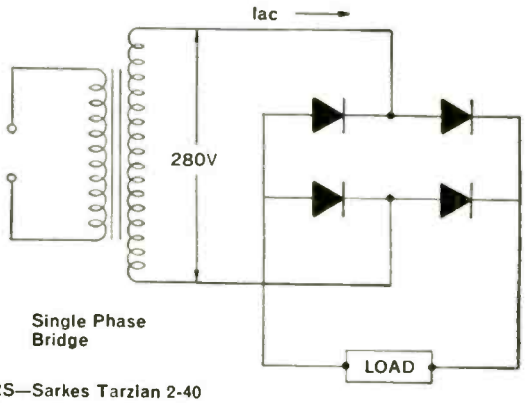
FOR MEDIUM CURRENT APPLICATIONS...



Single Phase Center Tap

RS—Sarkes Tarzian 40H3
Convection cooling—fin size 3" square (Al.)

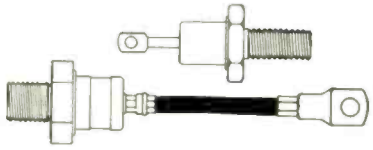
Output—125 VDC @ 12 amp DC
Ripple—52% (unfiltered)
Iac—9.5 amp RMS



Single Phase Bridge

RS—Sarkes Tarzian 2-40
Convection cooling—fin size 4" square (Al. or Cu.)

Output—250 VDC @ 25 amp DC
Ripple—52% (unfiltered)
Iac—28 amp RMS



Some Typical Sarkes Tarzian Hermetically Sealed Rectifiers

Type	Max. Peak Volts	Max. DC Amps*
Type H3 - 6 Amp Series		
20H3	200	6
40H3	400	6
60H3	600	6
Type 2 - 12 Amp Series		
2 - 20	200	12
2 - 40	400	12
2 - 60	600	12
Type 9 - 250 Amp Series		
9 - 20	200	250
9 - 40	400	250
9 - 60	600	250

Positive or negative base polarity available in all types
*with adequate cooling fins

SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

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FOR YOUR MICROWAVE APPLICATIONS SPECIFY ARNOLD C-TYPE MAGNETS

Arnold C-type Alnico Magnets are available in a wide selection of gap densities ranging from 1,000 to over 7,500 gausses. There are six different basic configurations with a wide range of stock sizes in each group.

The over-all size and gap density requirements of many prototype designs can be met with stock sizes of Arnold C Magnets on an immediate-shipment basis, or readily supplied in production quantities to meet your requirements.

When used in transverse field isolators, Arnold C Magnets supply the magnetizing field to bias the ferrite into the region of resonance, thus preventing interaction between microwave networks and isolating the receiver from the transmitter. These magnets are also used in differential phase shifters and duplexers, and Arnold is ready to design and supply tubular magnets to provide axial fields in circular wave guides.

A feature of all Arnold C Magnets is the excellent field uniformity along the length of the magnet. Versatility in design may be realized by using multiple lengths of the same size magnet stacked to accomplish the needs of your magnetic structure.

Let us work with you on any requirement for permanent magnets, including high coercive force Alnico VIII for TWT focusing applications. ● For information on Arnold C Magnets, write for Bulletin PM-115. For data on Alnico VIII, ask for Bulletin PM-119. Address *The Arnold Engineering Company, Marengo, Illinois.*

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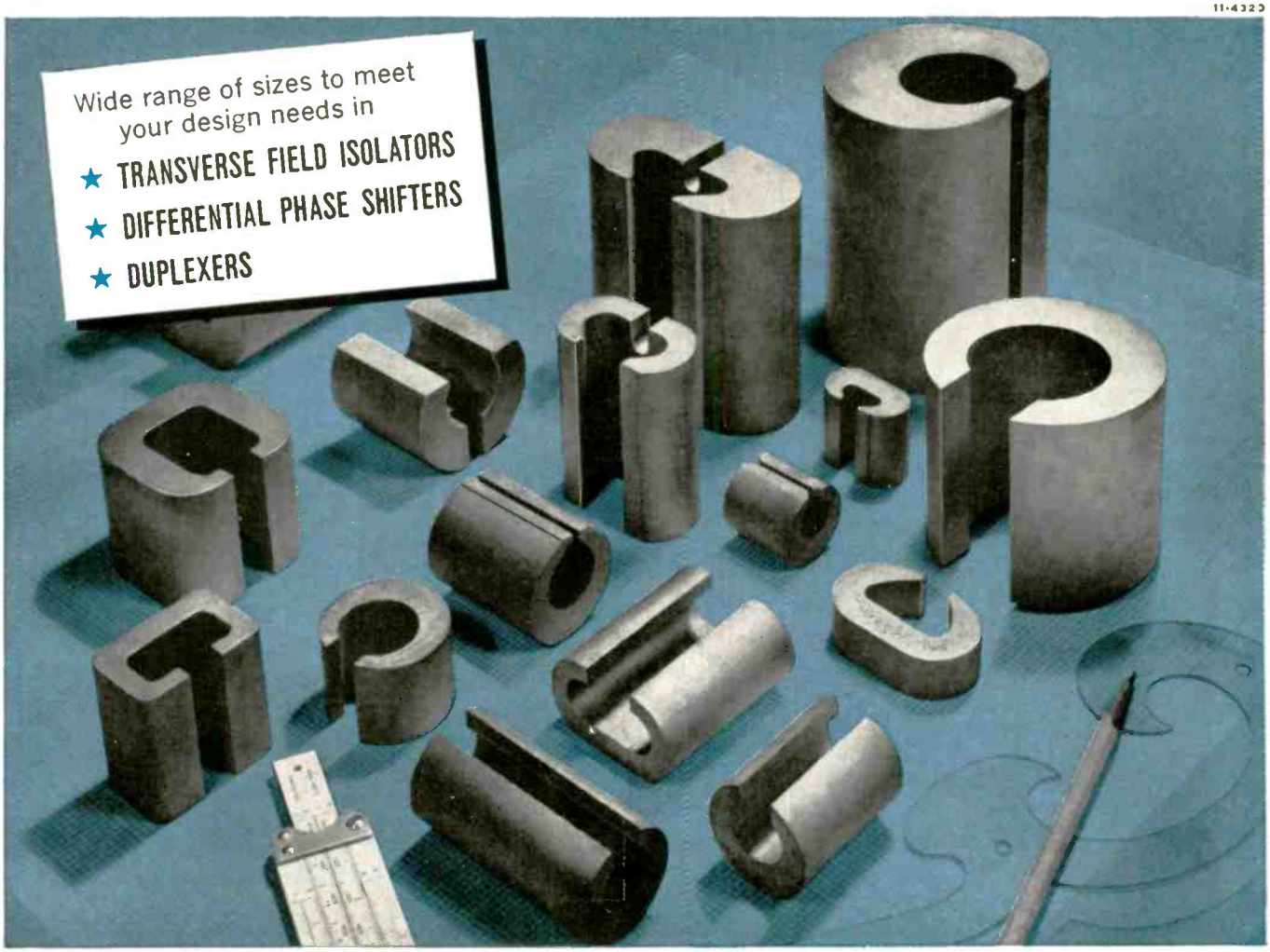
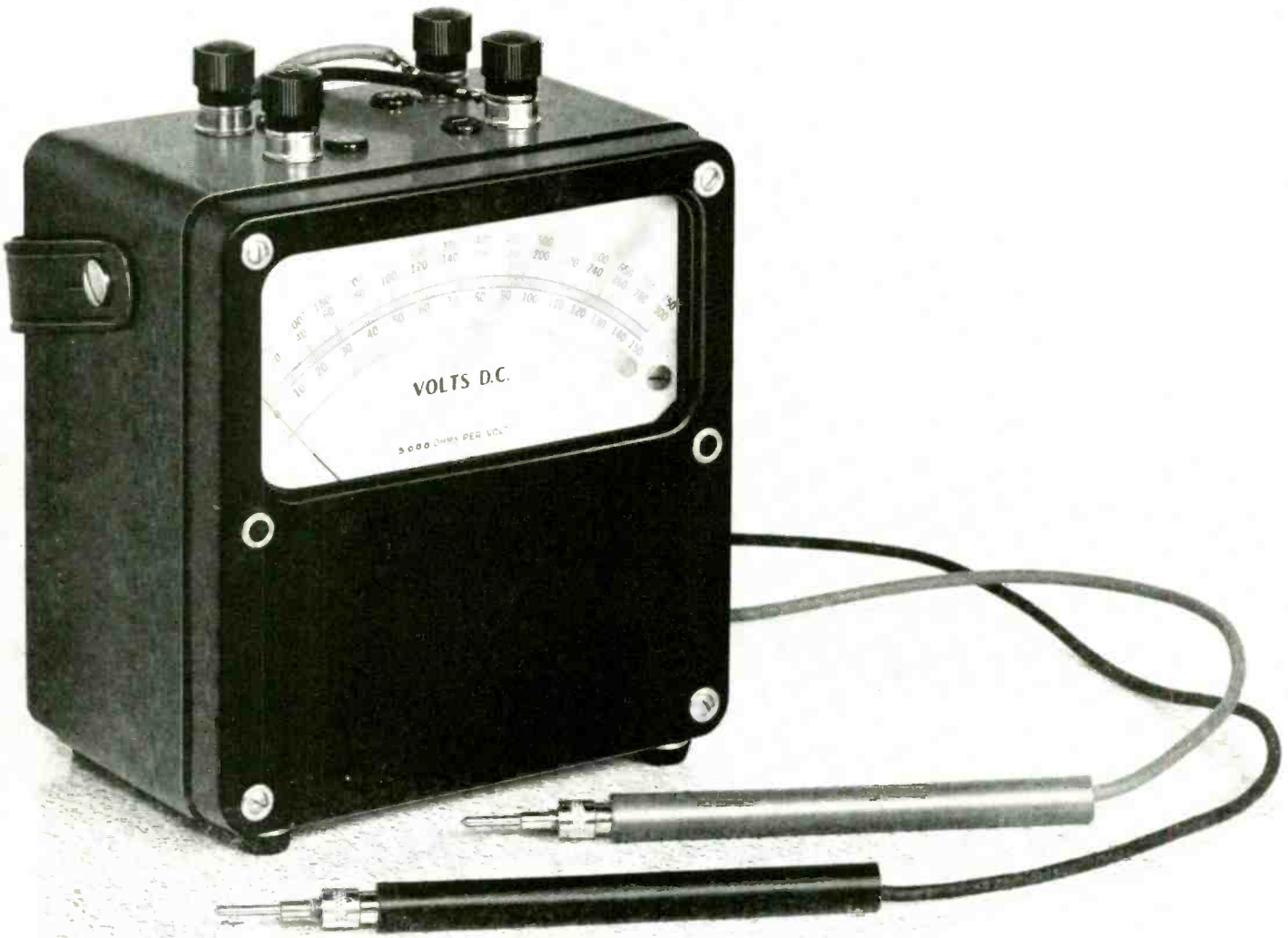


RELIABILITY BY DESIGN



RELIABILITY

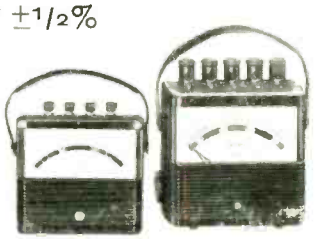
PROVED IN USE, INSTRUMENT OFFERS DEPENDABLE ACCURACY OF ±1/2%

When you measure with a Weston portable, you can depend on the reading. Weston superior design offers a long history of reliability under rugged industrial use.

Weston Portables are also engineered to give you maximum flexibility for specialized or general-purpose applications.

- Model 931 DC Portables are available from 30 μa to 50 amp, and up to 750 volts full scale. Accuracy: ±½%
- Model 433 AC Portables are available from 30 ma to 50 amp, and up to 750 volts full scale. Accuracy: ±¾%
- Compact construction — only 5 x 5¼ x 3¼"
- Scale length — 4.04"
- Matching DC and single phase AC Wattmeters
- Immediately available through a network of distributors
- In case of damage, authorized repair centers throughout the country assure fast, dependable service

Write Weston — first name in portables — for a detailed catalog on these popular instruments. Department 57.



MODERN STYLING, high accuracy and long 5½" scales make Model 901 DC ±¼% and 904 AC ±½% Portables favorites of many engineers. Matching Wattmeters round out the broad line. Write for details.

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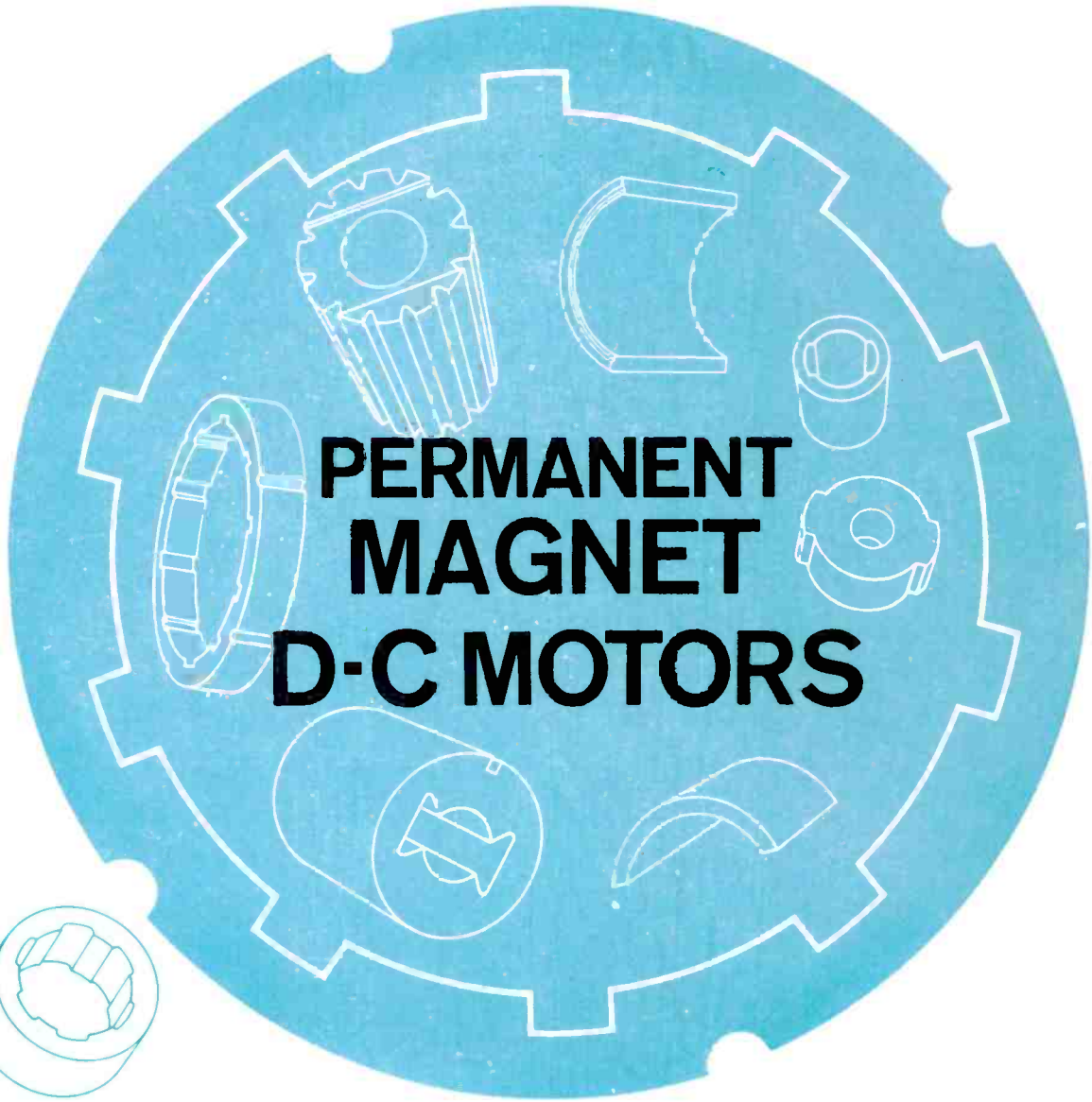
Aerospace Instrumentation • Bimetal Thermometers • Calibration & Test Equipment • Panel & Switchboard Meters • Photosensitive Devices • Precision Metal Film Resistors • Relays & Tachometers • Systems Design & Development



PERMANENT MAGNET D-C MOTORS

. . . up to 20% efficiency increase

Continental Electric Co., in producing Permanent Magnet D-C motors to replace wound field types, used Crucible magnets specifically designed for their applications. Some of the advantages proved by Continental's tests are:

1. Increased efficiency.
2. Smaller size and lighter weight for given power rating.
3. Reduced inrush starting current—because of starting with full magnetic field flux.
4. Lower temperature rise or greater output for given sizes.
5. Fewer parts.
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7. Lower manufacturing costs.

COMPARISON DATA

TYPICAL CONTINENTAL P-M MOTORS VS. COMPARABLE WOUND FIELD TYPES

			% REDUCTION FROM EQUIVALENT WOUND FIELD MOTOR		
BODY DIAM.	H.P.	R.P.M.	LENGTH	WEIGHT	% EFF. INCREASE FOR P-M TYPES
2¼"	1/30	6,000	12	15	8
2¾"	1/10	8,000	15	16	15
3"	¼	7,200	16	20	20

Use the services of Crucible's experienced magnet engineers for your own design and development projects. For more information write to Dept. EI3, Box 88, Pittsburgh 30, Pa.

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MAGNET DIVISION, P.O. BOX 32, HARRISON, N.J.

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Circle 77 on Inquiry Card

Personals

Eugene J. Martin—named Production Engineering Manager, Silicon Transistor Corp., Carle Place, N.Y.

Lockheed Missiles & Space Co., Sunnyvale, Calif., announces the following appointments: **R. G. Gibson**—named Product Assurance Director, Missiles Systems Div.; **Dr. L. S. Gephart**—appointed Product Assurance Director, Space Systems Div.; **R. P. Buschmann** — appointed Director, Planning Staff, Space Systems Div.; **Dr. J. P. Nash**—named Director, Research and Engineering Laboratories; **Dr. Wayland C. Griffith**—named Research Director, Research and Engineering Laboratories; and **Frank J. Bednarz**—named Director of Engineering, Research and Engineering Laboratories.

Dr. Carl E. Faflick—named Director, Advanced Systems Planning, Sylvania Electronic Systems Div., Sylvania Electric Products Inc., Waltham, Mass.

Dr. C. E. Faflick

J. W. Auer

Joseph W. Auer—appointed Applications Engineer, Vitramon, Inc., Bridgeport, Conn.

Dr. Richard C. Becker—appointed Senior Research Scientist, Corporate Research and Engineering, Amphenol-Borg Electronics Corp., Broadview, Ill.

Dr. Allen Nussbaum—named Head of new Solid State Div., American Electronic Laboratories, Inc., Colmar, Pa.

A. W. McEwan—appointed Director, Electron Tube Laboratories, ITT Components Div., International Telephone & Telegraph Corp., Clifton, N.J.

Abraham Osborn—appointed Quality Control Manager, St. Petersburg, Fla., Div., International Resistance Co.

Fairchild Semiconductor, Mountain View, Calif., announces the following appointments to the technical staff of the Research & Development Laboratory: **Dr. Edward Duffek** and **Arthur E. Lewis** on the Chemistry Staff and **Everett Guthrie** on the Microwave Physics Staff.

Bruce Chancellor—appointed Applications Engineer, Western Div., Computer Control Co., Inc., Los Angeles, Calif.

Potter Instrument Co., Inc., Plainview, N.Y., announces the following appointments: **Melvin Tudor**—named Chief Production Engineer; **Heinrich Wagemann**—appointed Senior Development Engineer; and **Donald C. Raby**—named Applications Engineer.

Weston Instruments Div., Daystrom, Inc., Newark, N. J., announces the following appointments: **Peter M. Gross**—named Assistant Chief Engineer for Metallurgy and Chemistry; and **T. K. Lakshamanan**—named Assistant Chief Engineer for Solid State Research and Application.

Joseph M. Chirnitch—named Product Line Manager, Spectrum Analyzers, Spectran Electronics Corp., Maynard, Mass.

Henry J. Noebels—appointed Director of International Research, Beckman Instruments, Inc., Fullerton, Calif.

H. J. Noebels

Dr. J. E. McNamara

Dr. John E. McNamara—appointed Staff Scientist for Materials, Motorola Semiconductor Products Div., Phoenix, Ariz.

Edward J. Butcher—appointed Manager of Manufacturing Engineering, Analytical & Control Div., Consolidated Electrodynamics Corp., Pasadena, Calif.

James H. Black—appointed Director of Quality Control, Wapakoneta, Ohio, plant of Superior Tube Co., Norristown, Pa.

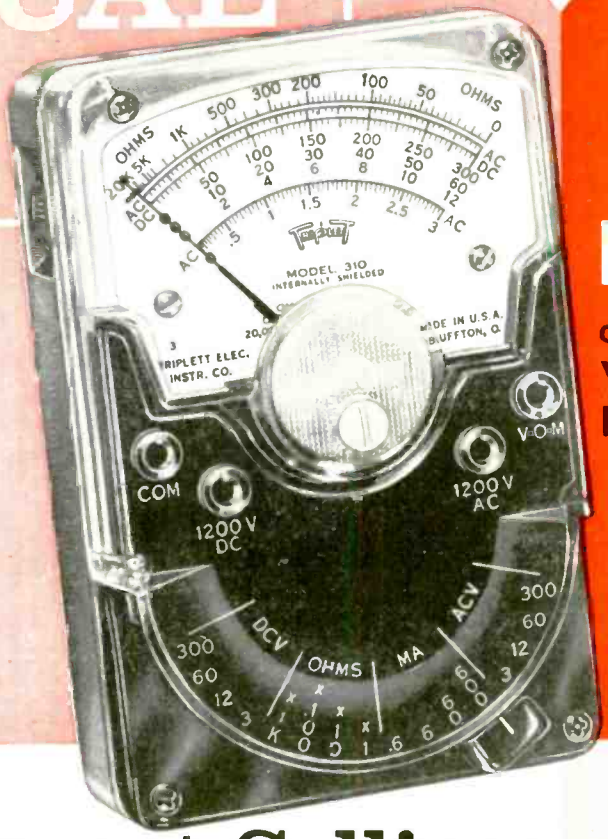
Christopher Karabats — named to the newly-created position of Manager of Production Control and Parts Fabrication, Tube Div., Varian Associates, Palo Alto, Calif.

Dr. Bernard Rabinovitch—named to the newly-created position of Manager of Research and Development in Magnetic Tape and other recording media, Ampex Laboratories, Ampex Corp., Redwood City, Calif.

Morris Brenner—appointed Chief Engineer, Industrial Div., Ungar Electric Tools, Hawthorne, Calif.

TRIPLETT

ACTUAL SIZE



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- Field Engineers
- Application Engineers
- Electrical, Radio, TV, and Appliance Servicemen
- Electrical Contractors
- Factory Maintenance Men
- Electronic Technicians
- Home Owners, Hobbyists

MODEL 310

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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.
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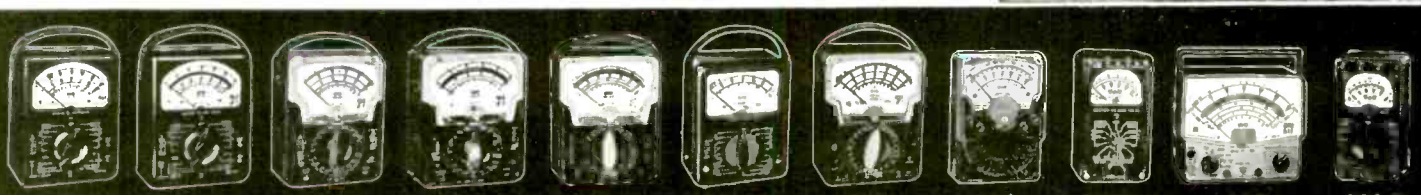

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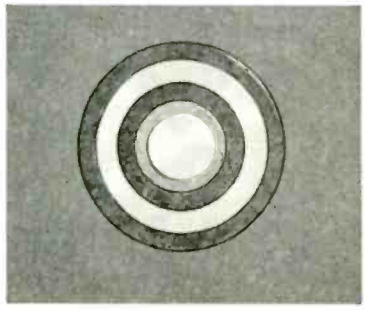

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Type No.	Description	Notable Advantage
2N2192	Similar to 2N1711 (see chart below)	V_{CE} (sat) = 0.35V max. V_{CEO} = 40 V min.
2N2192A	Similar to 2N1711 (see chart below)	V_{CE} (sat) = 0.16V Typ.; 0.25V max. V_{CEO} = 40 V min.
2N2193	Similar to 2N1613 (see chart below)	V_{CE} (sat) = 0.35V max. V_{CEO} = 50 V min.
2N2193A	Similar to 2N1613 (see chart below)	V_{CE} (sat) = 0.16V Typ.; 0.25V max. V_{CEO} = 50 V min.
2N2194	Similar to 2N696 (see chart below)	V_{CE} (sat) = 0.35V max. V_{CEO} = 40 V min.
2N2194A	Similar to 2N696 (see chart below)	V_{CE} (sat) = 0.16V Typ.; 0.25V max. V_{CEO} = 40 V min.
2N2195	General Purpose Industrial Type	V_{CE} (sat) = 0.35V max. V_{CEO} = 25 V min.
2N2195A	General Purpose Industrial Type	V_{CE} (sat) = 0.16V Typ.; 0.25V max. V_{CEO} = 25 V min.

(V_{CE} (sat) ratings @ I_C = 150 ma, I_B = 15 ma)

PLANAR PASSIVATED TRANSISTORS

Type Nos.					
TO — 18 Package	TO — 5 Package	h_{FE} @ I_C = 150 ma V_{CE} = 10 V	V_{CE} (sat) (max.) @ I_C = 150 ma I_B = 15 ma	V_{CER} (min.) @ I_C = 100 ma R_{BE} = 10	I_{CBO} (max.)
2N1717	2N696	20-60	1.5V	40V	1 μa @ 30 V
2N1718	2N697	40-120	1.5V	40V	1 μa @ 30 V
2N1719* 2N1719A**	2N698	20-60	5V	80V	5 mμa @ 75 V
2N720	2N699	40-120	5V	80V	2 μa @ 60 V
2N1718A	2N1613	40-120†	1.5V	50V	10 mμa @ 60 V
———	2N1711	100-300†	1.5V	40V	10 mμa @ 60 V
2N720A	2N1893	40-120†	5V	100V	10 mμa @ 90 V

† plus guaranteed minimum h_{FE}'s at several other currents
* same as 2N698 electrically except I_{CBO} = 1 μamp.
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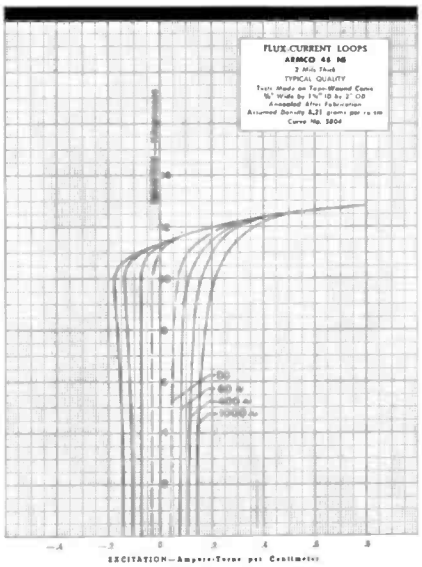

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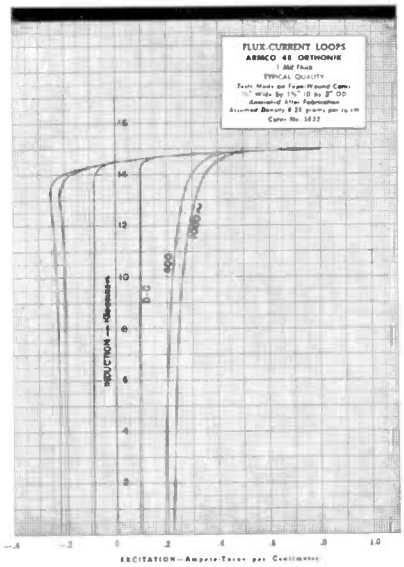

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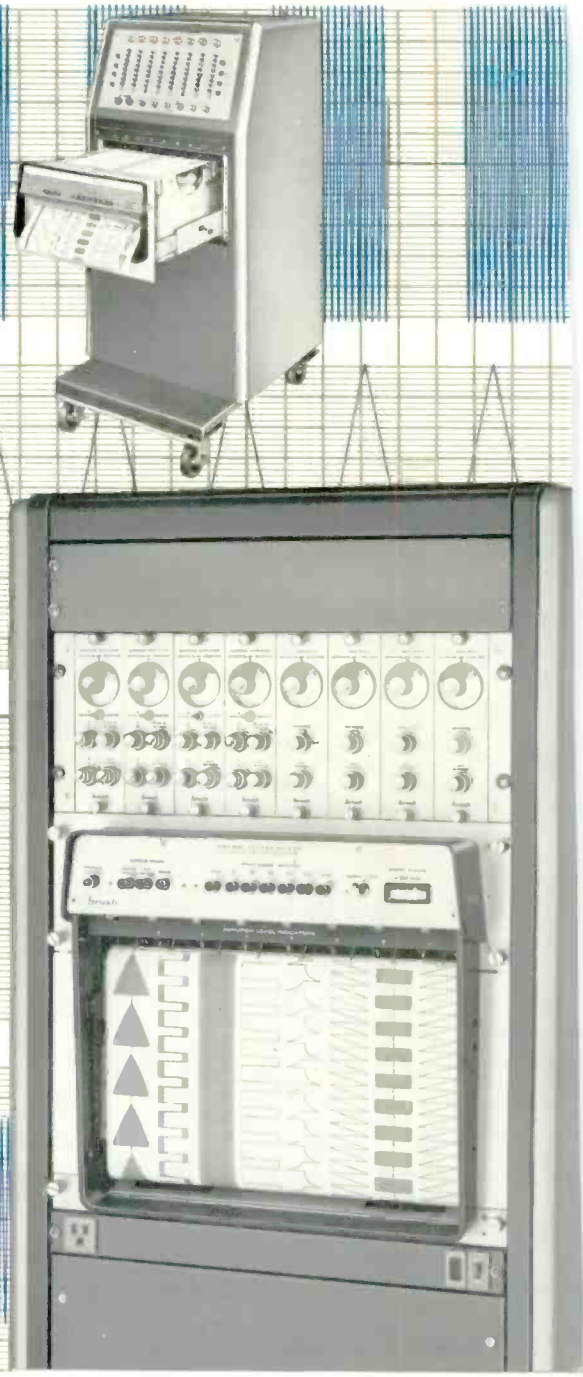

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Next month

ELECTRONIC INDUSTRIES 11th ANNUAL WESCON ISSUE

● GETTING THE MOST FROM A HEAT SINK

Careful thought to location, fin spacing, and shroud placement will increase the heat transfer efficiency of a power transistor heat sink. The findings described in this article should improve any heat sink installation.

● DESIGN AND PERFORMANCE DATA FOR X-BAND ANTENNAS

Various X-band antennas, suitable for airborne use, are described and their performance data presented. The simplicity of their design permits the use of low cost aluminum casting processes for the fabrication of production quantities.

● DIRECTED ENERGY WEAPONS

This type of weapon is often loosely referred to as a "death ray." The main idea behind the article is to provide a "primer" in the field, something that has not been done before, outside of classified literature.

● A TESTER FOR NUCLEAR BLAST ALARM SYSTEMS

Until recently we have not been able to test nuclear bomb alarm systems under actual conditions due to the moratorium. We cannot continue to test indefinitely. This article decribes a simulation device for nuclear yields extending into the megaton range.

● 1962 WESTERN ELECTRONIC SHOW & CONVENTION (WESCON)

Previewing the West Coast's biggest electronic engineering show, meeting this year in the Los Angeles Memorial Sports Arena, on August 21-24. Editorial coverage will include details on the technical papers, programs, field trips and other highlights of the show. Also included will be information on new products being released for the first time at the show. A round-up of currently available technical bulletins and catalogs from Western manufacturers will also be presented.

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COVER STORY

By JOHN S. HICKEY

Project Engineer
Superpower Microwave Tube Laboratory
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Schenectady, New York

The Multiple-beam Klystron . . .

Generating Microwave Superpower

With the emphasis on space communications and satellite control, the need for extremely high powers at X-band is becoming urgent. Here are the details of a major advance in achieving this power.

RADAR and communication system design and development have progressed rapidly during the past decade. To keep pace, there has been a steady demand for more and more r-f power; and, improved quality of the r-f energy generated.

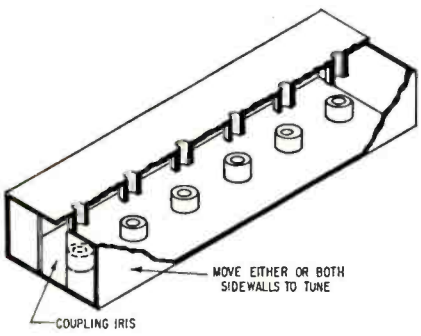
Until recently, the only stable energy source to meet these needs has been the single-beam klystron; and, its development has been carried to a high degree of refinement. However, to increase their power output, designers face various fundamental design limitations. For example, power cannot be increased simply by increasing the tube size; because, engineering requirements on the resonator limit the critical dimensions to a fraction of the operating wavelength.

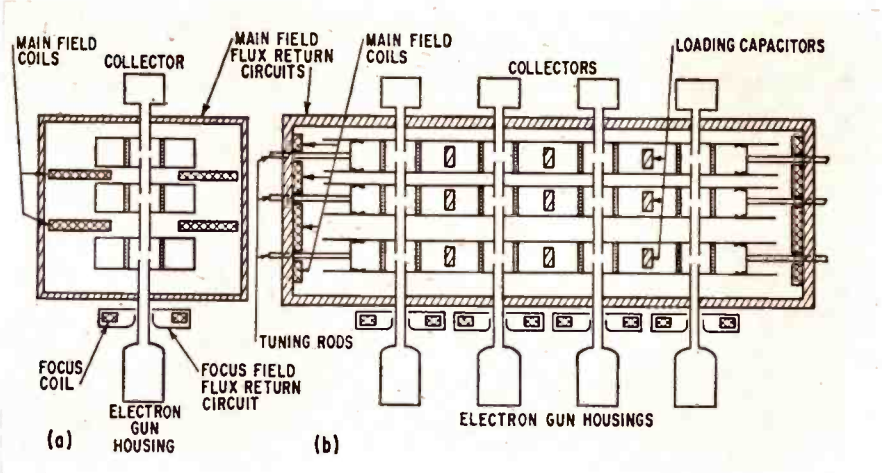
Increasing the beam voltage for more power is also limited; this is due to such problems as heat flux density, cavity impedance, and x-radiation.

The only solution providing the "order of magnitude" increases required is to extend the generating

Fig. 1 (below): Distributed Beam resonator.

Fig. 2 (right): Cross-sections of (a) single, or standard, tube and (b) a four-beam klystron. View (a) could be end view of (b).





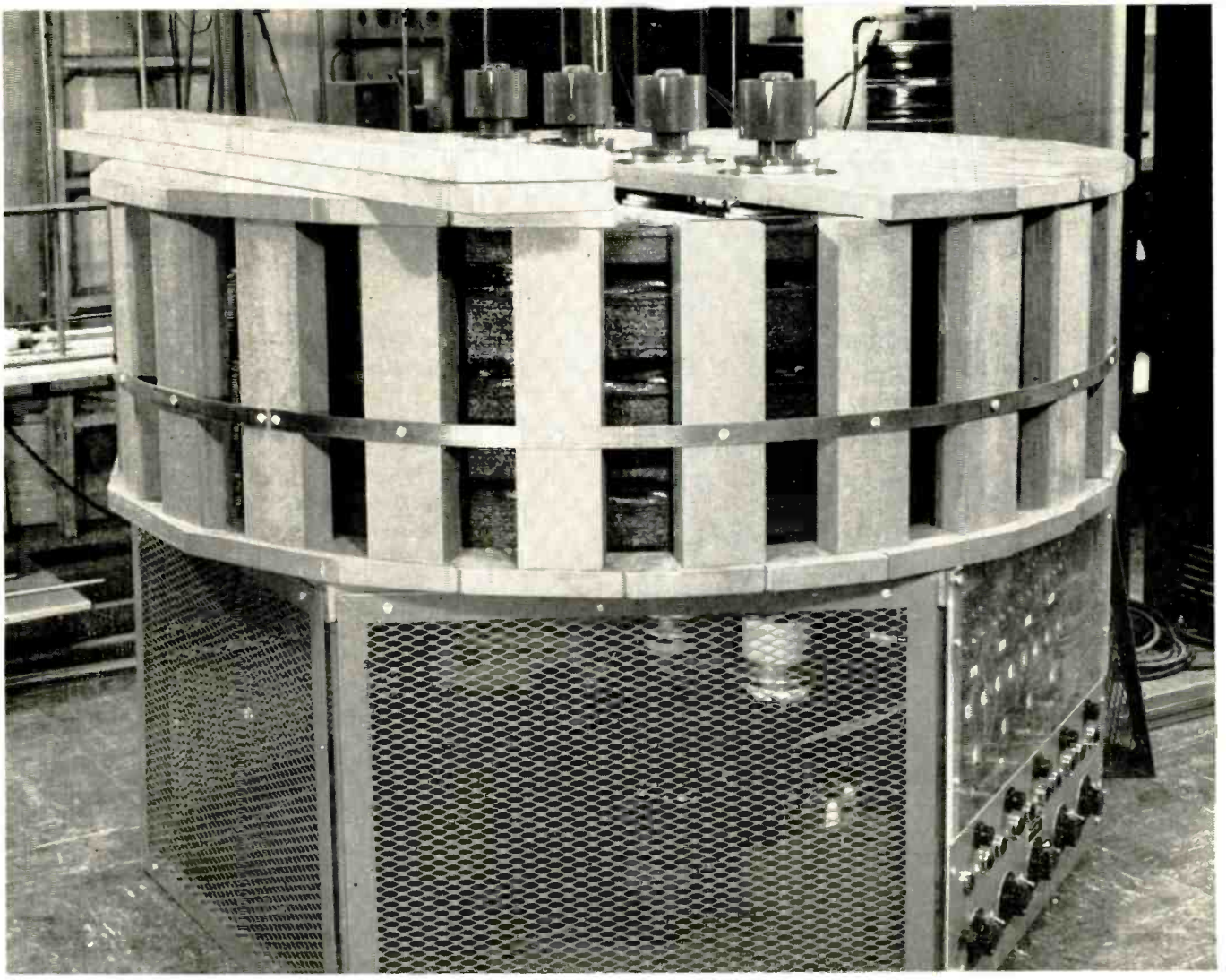


Fig. 3: Experimental four-beam klystron has the four separate tubes arranged in a straight line; a single coil provided the magnetic field necessary for beam focusing. Top and bottom of the magnetic circuit were formed by two large diameter plates; iron bars retain flux.

tube in one or more dimensions. Our recently developed multiple-beam klystron (MBK) is an example of a logical method of increasing the power levels by extending the interaction area.

Because the MBK's basic beam is a conventional klystron beam, its use requires no advance over the present state of the art. By paralleling several beams in one vacuum envelope—adding a dimension—it is possible to extend a single-beam klystron power level by one to two orders of magnitude; the effect of the multiple-beam interaction is to multiply power in proportion to the number of beams used. Furthermore, any advances in klystron technology can be incorporated in MBK designs. By using a moderate power prototype beam, the resultant MBK is a low voltage, high current approach to superpower. Also, there is no further stress on the thermal or electrical characteristics of the tube material. Such problems as high voltage power supplies and x-ray shielding are greatly simplified.

At first, it appears that the MBK does nothing more than parallel the capabilities of several electron beams; therefore, the results could be obtained by paralleling individual klystrons externally. From a system standpoint, the differences and advantages of an MBK design are more apparent.

At 8.5 GC, a 10-beam 100 kw MBK would be almost the same size and weight as a 25 kw single-beam klystron; and, each has the same number of tuning controls and electrical connections. However, to obtain the 100 kw output of the 10-beam MBK, four 25 kw klystrons would have to be paralleled. The system operator would have 12 more tuning knobs, three low level hybrids, three high level hybrids and three high power dummy loads.

Reducing circuit complexity by paralleling the beams inside the generator cavity is obviously great. A 10-beam MBK was compared with four conventional klystrons because it operates close to the state of the art limits required to obtain 25 kw at 8.5 GC.

Resonator

By properly choosing the multiple beam resonator shape, the r-f design of an MBK can be made without difficulty; because the basic resonator elements are the interaction gaps. These gaps must be small compared to a wavelength—electrically, they can be considered capacitors. The capacitor magnitude is largely determined by the power level per gap and the operating frequency. By arranging these gaps in a long rectangular box, Fig. 1, a cavity can be fashioned that looks like a waveguide shorted at the ends and periodically loaded by shunt capacitors.

Loaded waveguides are well understood and treated with great precision in traveling-wave tube design. This knowledge has been applied to the MBK. A significant difference: in the MBK, the electron beams are not aware of the cavity's traveling wave nature;

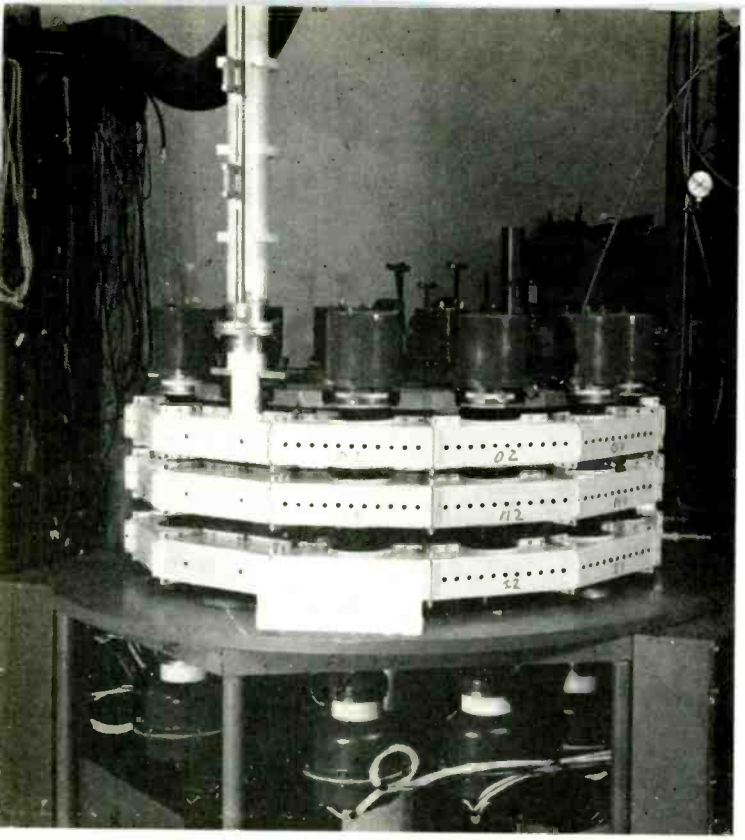


Fig. 4: The ten-beam model was arranged and tuned in the same manner as the four-beam tube, except the circuit was horseshoe-shaped. The ten-beam amplifier is shown here without the magnetic field.

Microwave Superpower *(Continued)*

because they each pass through the cavity perpendicular to the flow of r-f energy only once. When this loaded waveguide theory is applied, the only other requirement is that all beam gaps have the same r-f voltage. This is necessary so the MBK may have the same efficiency and gain as its prototype.

Mode Pattern

A loaded waveguide such as Fig. 1 has a great many possible resonances. Each has a different frequency and different voltage distribution. The waveguide with the highest possible resonant frequency is called π mode. It also has a uniform voltage distribution—the electric fields in the resonator are all concentrated on the tunnel tips. This mode can be derived from the prototype klystron cavity by laying many cavities side by side. A rectangular parallelopiped is formed with a common wall between adjacent cavities. When the cavities are excited 180° out of phase, the currents on opposite sides of the common wall are of equal magnitude and opposite direction. When the common wall is removed, the electromagnetic fields are not affected and the resultant long box is exactly Fig. 1. The name, π mode, is derived from the 180° phase shift between sections.

The π mode resonance in a multiple beam cavity has only one drawback. Because it is the last possible resonance in a loaded waveguide passband, it has no group velocity—energy is not propagated along the structure. Measurements on a π mode structure with as few as four beams show that loading one end with a loop, or iris, does not load the two beams at the other end.

However, there is a mode pattern that does have a finite group velocity and equal voltage on all beam gaps. Exactly half way in a loaded waveguide passband, a mode exists where the phase shift is 90°, or $\pi/2$ radians, between capacitors. When this resonance is excited in a shorted length of loaded guide, voltage appears only on the odd numbered gaps. By using only the odd numbered gaps to contain beams, no electrons are wasted. The MBK uses this cavity design mode.

Physically, a $\pi/2$ mode cavity can be derived from Fig. 1 by adding a dummy capacitor between each of the beam gaps. It is an apparent paradox that adding these dummy capacitors at a point where no r-f voltage appears across them completely alters the operations of the structure. In truth, there is no voltage on these capacitors, provided they are infinitesimally small in length and then, only for the single frequency at the response of the unloaded resonant cavity. A finite loading puts a very small voltage on each of these capacitors.

Testing 4 Beams

For flexibility and convenience, the basic MBK principles were not tested by designing a single-vacuum envelope encompassing a multiple of beams; but rather, by using conventional, commercially-available, external circuit klystrons inserted into multiwavelength waveguides. This setup proved to be very useful; because, modifications could be made in the r-f circuitry without disturbing the dynamics of the individual electron beams. The tubes chosen were three-gap klystrons which operated from 610 to 985 MC. Although rated at 2 kw r-f output, these tubes were operated conservatively at the reduced beam voltage of 7 kv and a power output of 1.0 kw. The goal was to show that ten such tubes, properly interconnected, could operate as an MBK and deliver 10 kw of r-f power to a single load; and thus, represent an order of magnitude increase in power capability.

A four-beam MBK so designed was made first. Fig. 2 is a cross-sectional view. Fig. 2(a) shows the arrangement used to operate each klystron as a standard single beam amplifier. It could also serve as the end view of Fig. 2(b), except for a slight difference in the location of the magnetic field coils. Fig. 2(b) shows the cross-section of a complete four-beam MBK. (Not pertinent to the basic MBK are the separate electron gun housings, magnetic field coils and yoke, and separate collectors.) Inside the magnetic field are the three MBK cavities, which, for all four beams, serve as input cavity, penultimate or center cavity, and output cavity. These three cavities are mechani-

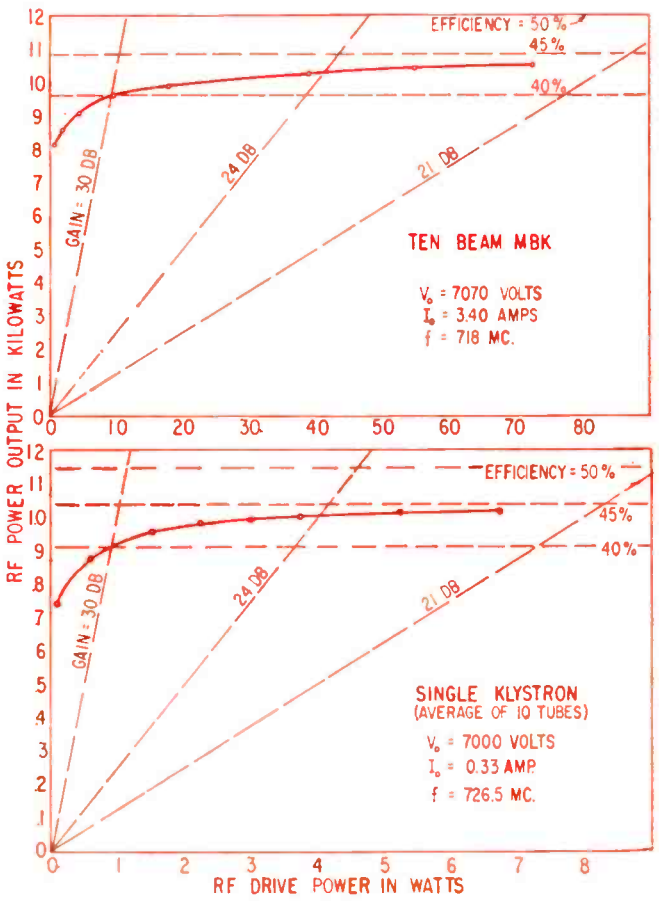
cally identical to cavities used in many single-beam klystrons. The dummy capacitors are shown between each tube as a slug in the guide center. Both a symmetric centered slug and a post attached to one side were used. Mechanical considerations favored the asymmetric post although both worked equally well. Tuning was accomplished by movable shorts located at each end of the cavities. The input and output cavities were coupled by loops opposite one of the tubes.

Tubes were arranged in a straight line and a single diameter coil provided the magnetic field necessary for beam focusing, Fig. 3. Two large diameter plates formed the top and bottom of the magnetic circuit, and the flux was retained by a series of 24 vertical iron bars spanning the distance between the plates.

Testing 10 Beams

After the four-beam model performed successfully, a ten-beam model was constructed. It was arranged and tuned in the same manner as the four-beam model, except the circuits were horseshoe-shaped rather than linear. A photograph of an assembled ten-beam MBK is shown in Fig. 4. The circular waveguides consisted of units, each occuping 30° of arc. The electron beams travel vertically upward through the three waveguide circuits into water-cooled collectors insulated from the tube bodies, to permit monitoring of individual body current on each tube. The output cavity used probe-coupling which was located directly below a double-slug tuner (shown in the upper part of the photograph). Input coupling was

Fig. 5 Multiple-beam and single-beam klystron output performance.



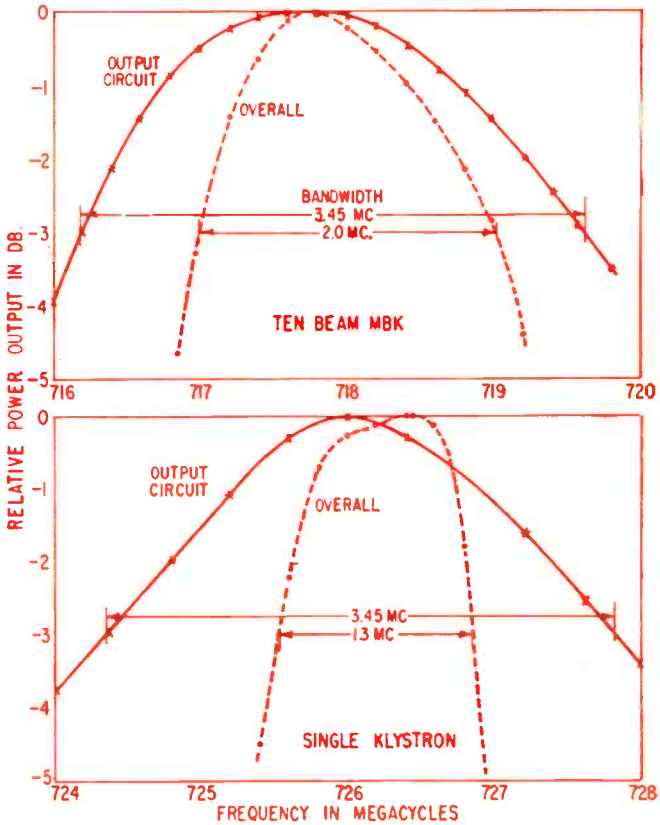


Fig. 6: Ten-beam MBK bandwidth compared with that of a single beam.

obtained by a loop in the corresponding cavity of the input deck. The corresponding cavity of the center deck was not used for coupling but loaded by a capacitor equal to the average tube gap capacity to preserve $\pi/2$ mode. Tuning was done by double tuning pistons with gear mechanisms placed in the cavities, diametrically opposite the coupling cavities. In all, the 12-unit circuit was composed of ten units enclosing the tubes, one coupling unit, and one tuning mechanism unit. The same magnetic circuit arrangement was used as the four-beam configuration except the tubes were threaded through a series of holes near the periphery of the structure rather than being placed along a diameter.

The performance of this initial ten-beam MBK is most readily evaluated by comparing it with single-tube performance. This comparison, Fig. 5 shows r-f power output plotted as a function of r-f power input. The upper curve is the ten-beam MBK. The lower curve was obtained by taking data on a single-beam klystron. Subsequently the efficiency was scaled at a drive level of six watts to average the individual efficiencies of the ten tubes as determined by manufacturer supplied data. In taking these curves, the middle or penultimate circuits were optimized at each drive level. Although the two curve shapes are very similar, the MBK gives ten times more power output at a drive level ten times that of the corresponding prototype point. Significantly, this was not done by raising beam voltage but by increasing current, or, in effect, perveance by a factor of ten.

The ten-beam MBK bandwidth is compared with single-tube bandwidth in Fig. 6. Two measurements

Microwave Superpower

(Continued)

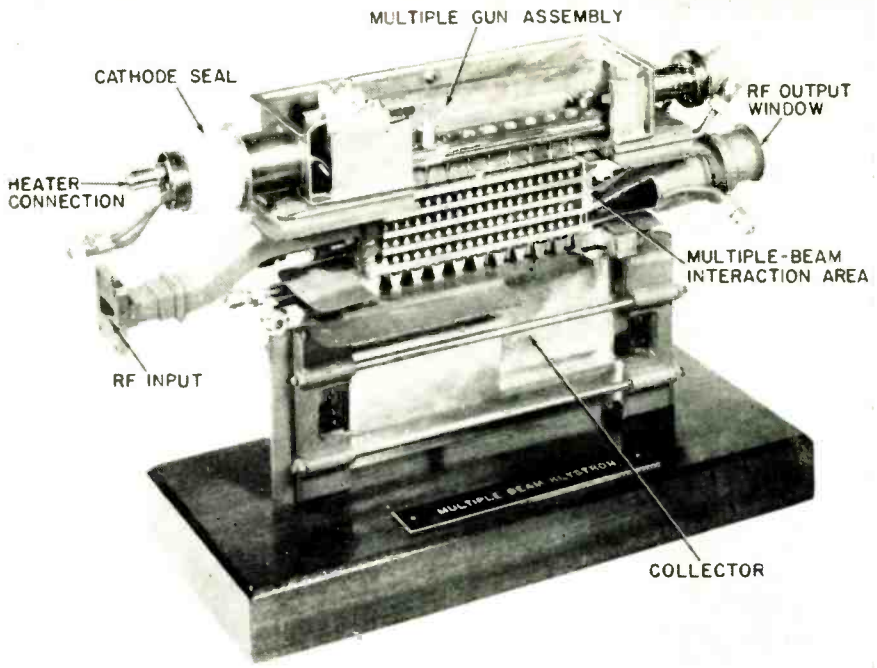


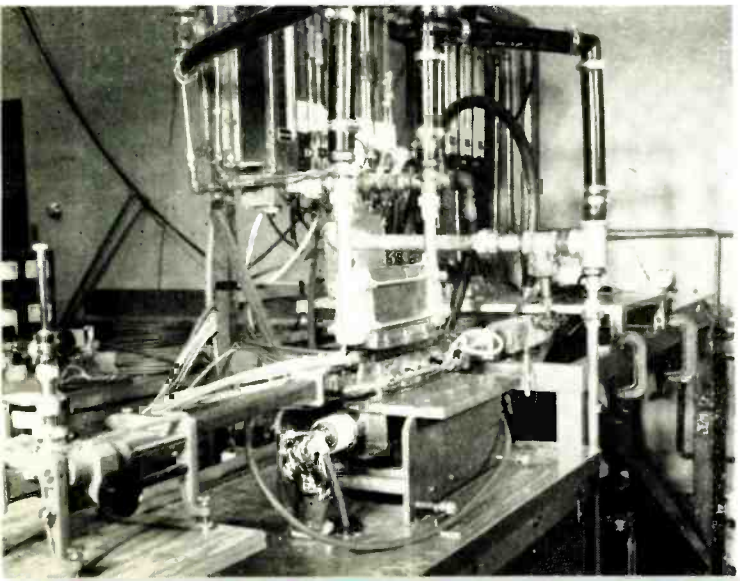
Fig. 7: Modular concept is apparent in this cut-away view of a typical ten-beam multiple-beam klystron which operates at 8.35 GC.

of bandwidth were made. First, all circuits were optimized at midband and a power output *versus* frequency curve was taken with no retuning. These curves are the dashed-lines marked "overall." Second, the solid lines were made by keeping drive level constant and retuning both input and middle circuits. In this test, the output circuit remained fixed; hence, the curve is indicative of output circuit bandwidth. If additional stagger-tuned bunching cavities were available, presumably the dashed curves could be made to approach the solid curves as in conventional broadband klystrons.

Bandwidth Comparison

Comparing bandwidths, the MBK output circuit performed as well as the single-tube, both bandwidths being about 3.5 MC out of 720 MC. This represents a bandwidth of 0.5% which is proper for a beam whose dc beam resistance is about 20,000 ohms working into an output circuit with an R/Q of about 100. The reason for the apparent improvement in the overall MBK bandwidth is probably the different relative placement of the resonant frequencies of the input, middle, and output circuits. Because of lower cavity losses resulting from the removal of some copper from each prototype cavity, the penultimate cavity had a higher Q than its prototype. This allows the penultimate cavity resonance to be placed further away from the operating frequency than is possible in its prototype.

Fig. 8: A complete MBK in a test socket. The input is in the foreground; the output, connected to a water load, at the rear.



Tests confirmed that the MBK is relatively insensitive to beam failures. If a beam is lost, the power output drops by an amount roughly equal to the power the lost beam was contributing. There is some effect on the performance of the other beams, but it is not major. For instance, dropping out one beam reduces dc input power by 10%, hence output power would be expected to drop off by a similar factor. When the initial ten-beam MBK test was made, output power dropped by 14%. The additional drop-off over that expected is due to a combination of factors, such as reduced effective R/Q, lower circuit efficiency, and improper output impedance. This last factor can be eliminated by reoptimizing the output impedance after a tube is dropped out. A subsequent test was made in which three beams of the ten-beam MBK were biased nearly off, resulting in a 28% reduction of dc input power. Under these circumstances, output power dropped 40%. By reoptimizing the output load impedance, drop-off was reduced to 35%, which compares favorably with the expected drop-off of approximately 28%.

With the experience gained on the 720 MC array, a ten-beam X-band MBK which paralleled beams in one vacuum envelope was designed. A goal of 50 kw at 8.35 GC was set. These limits were chosen for a variety of reasons. The driver tube available operated at 8.35 GC, and 5 kw was a respectable amount of power for a single-beam klystron.

As with any klystron, the design of this typical MBK can be separated into several distinct sections. However, taken step by step, each section has a significant difference from the prototype single-beam tube.

Beam Design

Before any klystron is built, an r-f cavity must be designed and a beam developed to fit it. Lacking a

beam from a previous tube, or having to scale one from a different tube, a conventional beam tester was built using one beam in a circularly symmetric envelope. A beam was considered satisfactory when it worked in a symmetric magnet or in any beam position in the MBK magnet—the total interception up to the output gap was required to be less than ¼%, and the beam free of scalloping.

Using this method of beam design has resulted in six successive developmental tubes with an average interception of the ten beams in any one tube always less than 0.3%. Also, ten beam transmission at half power of 99.9% and full power transmission of 99.8% have been achieved; and a CW MBK operated at a moderate r-f output with less than 1 db variation, from 15 kw min. to 17.5 kw max. over a two to one range of magnetic field. Better performance has been achieved by pulsing the MBK, at 70 kw of r-f output which demonstrates the practicability of operating ten beams with a single magnetic field coil.

Using standard klystron theory, the r-f cavity was designed around active gaps typical of klystrons operating at this power and frequency. The cavity has ten active gaps and nine passive capacitors. For machining ease, all gaps are made identical, although only the ten gaps have active beams.

A sectioned model of a complete ten-beam, 8.35 GC MBK is shown in Fig. 7. It is built in modules, assembled separately, and welded together to make the complete tube. The welds are made in thin stainless steel sections so that developmental tubes may be cut apart and reworked easily. This modular approach permits smaller brazed assemblies and simpler construction methods.

Modular Concept

The upper module is the electron gun assembly which consists of ten Pierce gun capsules held over ten conical anode apertures. The capsules, only one is shown, are mounted on a water cooled bar to eliminate thermal expansion problems. At the extreme left are the heater connection and water cooling tubes at cathode potential. One tube is also used as a cathode lead. The two steel bars, forming a trough, ensure that there is no stray field in the cathode area. The bottom plate, containing the conical anode apertures, is also the entrance pole piece for the magnetic field.

The electron gun housing is welded to the r-f body assemby which consists mainly of four identical cavities. The input waveguide is iris coupled to the first cavity, and the output guide iris coupled to the fourth or output cavity. Because this particular r-f body was used in development and was not designed to generate over 10 kw of r-f power total, provisions for water cooling were not incorporated into the tube. The tube is tuned by moving a side wall of each cavity. Normally two tuners are located on each side of the tube.

Below the r-f body is the exit pole piece and collector. The latter is a V-shaped trough, cooled by straight grooves which run parallel to the through bolts holding the water manifolds on each end. Their size is proportioned to give adequate heat transfer with the proper flow and pressure drop. Unlike single-beam tubes, the MBK collector cannot normally have the unlimited radical expansion of the beam after it leaves the magnetic field. However, this limitation does not apply at X-band because the beam spacing is approximately equal to the inner radius of collectors on typical high power single-beam tubes.

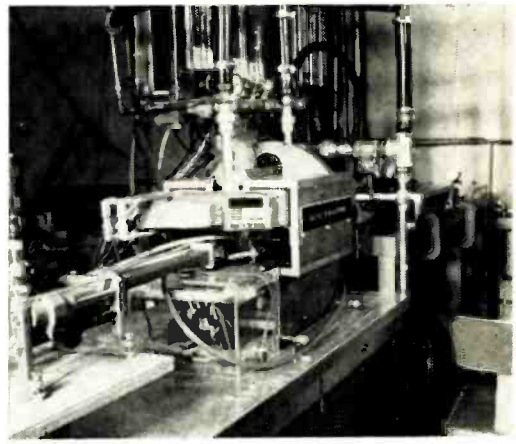


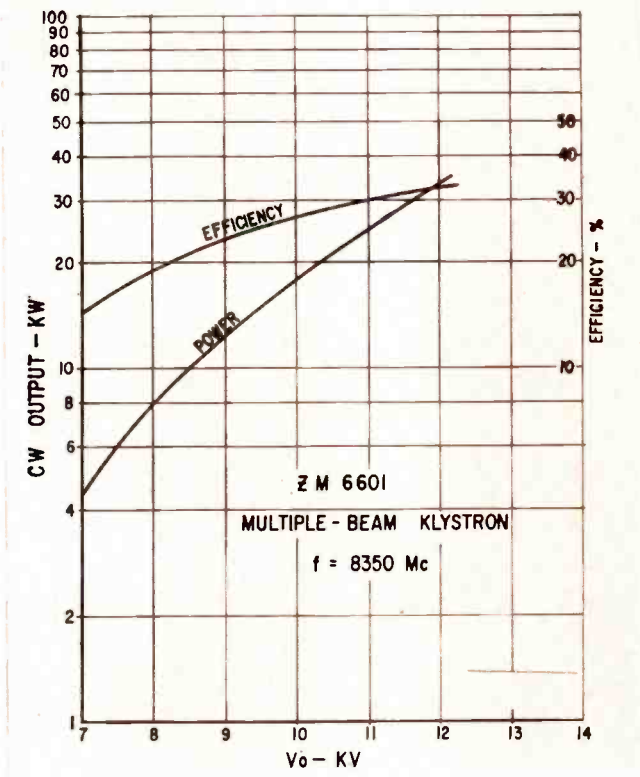
Fig. 9: This view is similar to Fig. 8; the difference is that the magnet coil and yoke have been installed.

Fig. 8 is a complete MBK in a test socket. The input is in the foreground; the output, connected to a water load, at the rear. Since this was a developmental tube, all ten heater leads were brought out. They can be seen below the input guide. In the background is a row of thermometers and flow meters for calorimetry of the various tube elements. Fig. 9 shows the magnet coil and yoke installed around the tube with a safety cover over the cathode seal.

Test Data

Test data taken on the first tube built with a capa-

Fig. 10: Test data taken on a tube built with a 50 kw capability.



Microwave Superpower *(Concluded)*

bility of 50 kw is shown in Fig. 10. A power output of 32 kw and 32% efficiency was achieved before the output window failed at 35 kw. Using an improved output window, the tube has recently produced 44 kw at 36.5% efficiency before a minor tuner failure occurred. The important point is that on the first trial of a new tube design, the performance is understandable. Subsequently, tests have demonstrated better performance. For example, pulse tests show that the efficiency will peak in the middle forties at 70 kw on this r-f body; tests with slightly higher perveance guns show that the efficiency peak will be near 50 kw.

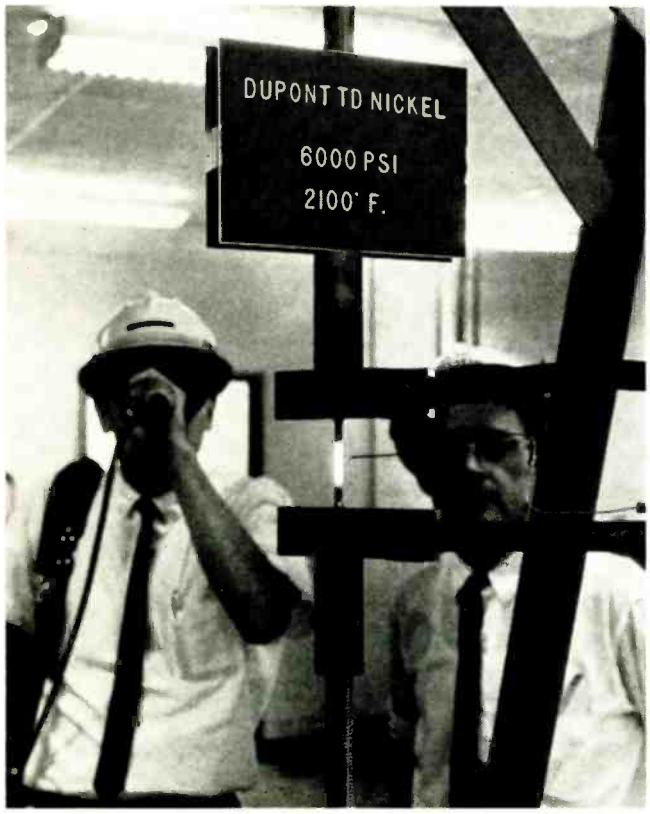
The second and third harmonic output of this ten-beam X-band MBK relative to its fundamental was measured and compared with harmonic content in a single klystron operating in the conventional manner. Second harmonic content of the single-beam tube was 40 db below the fundamental, the MBK second harmonic was 54 db below its fundamental. Third harmonic content of the single klystron was 45 db below the fundamental; in the ten-beam MBK, it was at least 51 db below. This represented the lower limit of the measuring equipment sensitivity. While no attempt was made to design circuits for minimum harmonic interaction, this limited test tends to confirm the conclusion that the harmonic content of an MBK can be lower than that of a single-beam klystron.

Limitations

The MBK ultimate power capability limits are not precisely known. The first limit will probably be due to adjacent mode interference. This will depend upon circuit design, individual beam impedance, and the ability to control mode excitation in the input circuit by selective loading or strapping. The present estimate for typical existing klystrons is that the limitation will occur somewhere between 40 and 100 beams.

A more fundamental limitation will be at power levels where the circuit losses are comparable to the unit power being developed. At present, the latter is now a practical limit. Also, the present single window power limitation can be avoided by using multiple windows. More than two windows in a single beam klystron present difficulties; in an MBK, two windows per beam is not impossible. And, as long as any one window does not exceed the "state of the art," the power per window can be varied to suit the system for which the tube is designed.

New Material for High Temperature Cathodes



A NEW material known as TD Nickel was unveiled recently by the Metal Products Section, Pigments Dept., E. I. Du Pont de Nemours and Co., Inc. of Wilmington, Del. The new alloy features an operating temperature range of from 1800° to 2400°F.

By means of a patented chemical process, of a colloidal nature, particles of thorium oxide (one-millionth of an inch in diameter) are uniformly dispersed within the grain structure of the nickel. For this reason it is called a dispersion-modified metal.

This process produces a metal with 98% thermal conductivity of pure nickel, stability at high temperatures, ease of fabrication at room temperatures, good oxidation resistance and excellent stress rupture strength from 1800° to 2400°F.

Composed of 98% nickel and 2% thorium oxide, TD Nickel is believed to give greater stability and longer life, or permit higher operating temperatures for equal life, to such components as vacuum tube cathodes. Other areas of use include high temperature probes and thermocouples.

Graphic demonstration of the high temperature strength of TD Nickel. The bar, heated by electrical conduction, reaches red heat, but does not fail at 2100°F., under a load of 6,000 lbs./sq. in.

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Simplified Filter Design

While filter design is generally conceded to be for specialists, there are times when it also becomes the responsibility of working design development engineers. Here is a simple step-by-step approach to designing an economical electric-wave bandpass filter.

THE ability to design an electric-wave band-pass filter in a simple, low cost manner is desirable to most engineers. Many engineers are somewhat familiar with the filter principles developed by Zobel, but are not always able to apply them. Unequal impedances in and out, narrow band-widths or very high or low values for the filter impedance often call for components which are either too large and bulky, have a high dissipation factor, or both.

This article is intended as an aid for engineers who are not filter specialists. We will show how the above difficulties can often be overcome in a simple, direct manner. The primary method is to use two pairs of equivalent circuits developed by E. L. Norton (see U. S. Patent 1,681,554), apply these equivalencies to filter configurations, and then illustrate with some examples.

While Norton's approach (often referred to as a pure reactance type of transformation) will be the main method employed throughout, mention will be made of a transformer-type of transformation which may have application where the former does not. The equivalencies developed by Norton can be used to obtain either a step-up or step-down impedance transforming filter section, which will behave like an ordinary band-pass filter plus an ideal transformer. There will be no change in the attenuation or phase characteristics of the filter, provided the circuit Q is not changed.

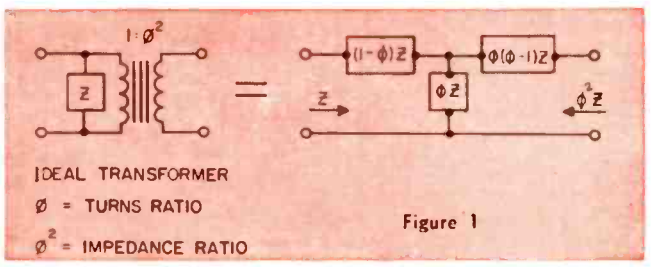


Figure 1

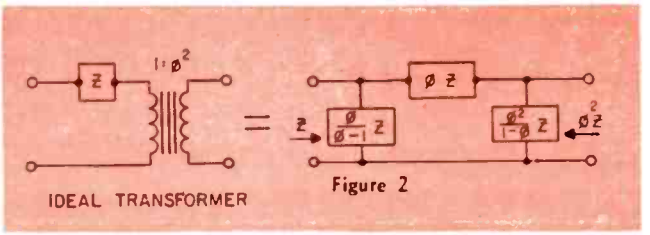


Figure 2

The validity of the equivalences in Figs. 1 and 2 can be demonstrated by showing that the open- and short-circuit impedances are the same for each network of a given pair.

In demonstrating the applications to different filter configurations, use will be made principally of constant-K type filters, since Norton's method of transformation is limited, mainly, to this type. Also, this method is restricted solely to the band-pass filter. Proof of the above can be seen by trying to apply these transformations to all types of filters.

Step-up Transformations

(using constant-K T sections)

The equivalence of Fig. 2 can be applied to either element of Fig. 3, $L_{1k}/2$ or $2C_{1k}$. The impedance of all elements to the right of the chosen element is then multiplied by θ^2.

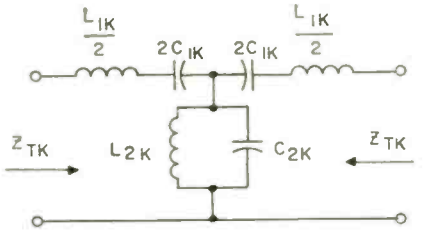
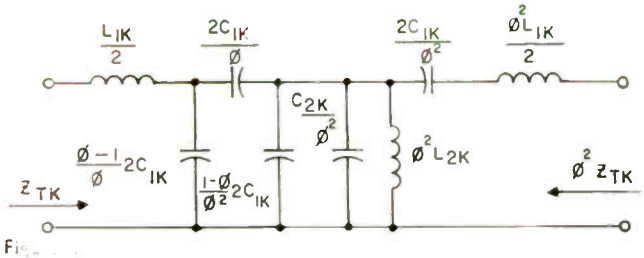


Figure 3

If $2C_{1k}$ is chosen as the element to be operated on, the transformation is as shown in Figs. 4 and 5.

Filter Designing *(Continued)*



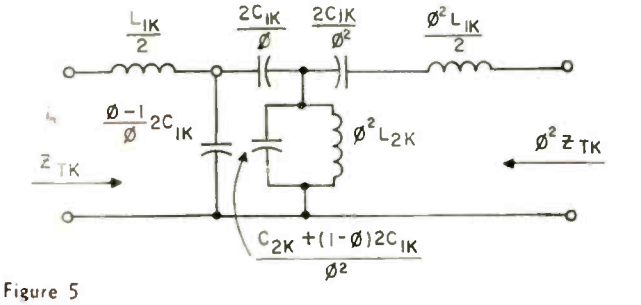


Figure 5

At this point the transformation shows an asymmetrical single-section constant-K band-pass filter whose input impedance has been stepped-up by θ^2 at the output terminals. Note that θ has to be greater than 1 (a real step-up) in order for $\frac{\theta - 1}{\theta} 2C_{1k}$ to be a positive capacitance.

If a symmetrical filter (same Z_{in} and Z_{out}) is desired, but the transformation is still needed to give better values for the circuit elements, the filter can be considered as 2 half-sections with the same operations applied to each half (Figs. 6 and 7).

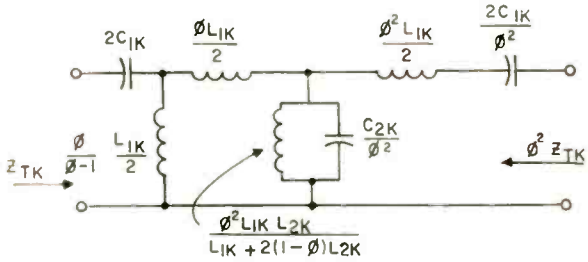


Figure 9

When $L_{1k}/2$ is the element chosen in Fig. 3 to be operated on, the transformation of Fig. 2 proceeds as in Figs. 8 and 9.

The symmetrical form of this filter is achieved by treating it as in Fig. 6 and results in Fig. 10.

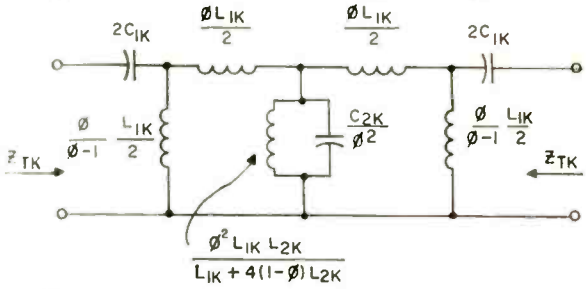


Figure 10

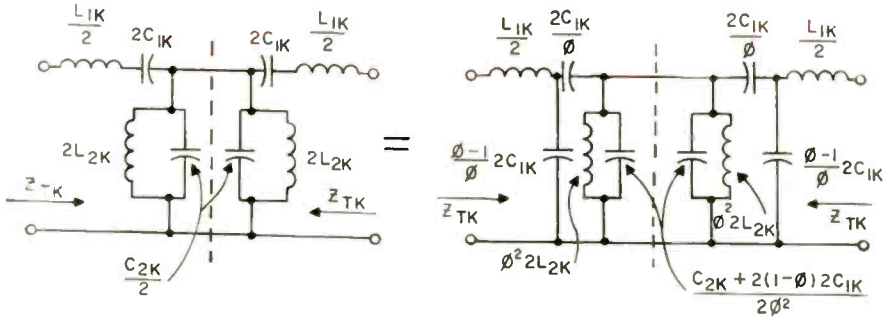
Note again that θ has to be greater than 1 (a real step-up) in order for $\frac{\theta}{\theta - 1} \frac{L_{1k}}{2}$ to be a positive inductance.

Step-down Transformations

(using constant-K π sections)

The equivalence of Fig. 1 can be applied to either of the shunt elements of Fig. 11, $2L_{2k}$ or $\frac{C_{2k}}{2}$. Then

Figure 6



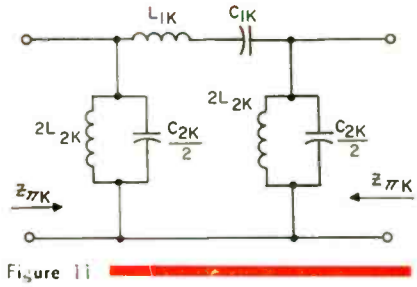
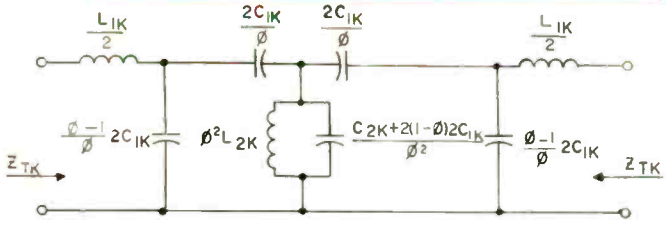


Figure 11

Figure 7



the impedance of all elements to the right of the chosen element is multiplied by θ^2. If $C_{2k}/2$ is the element selected, the transformation is shown in Figs. 12 and 13.

Note that θ has to be less than 1 (a real step-down) for $C_{2k}/_2(1-\theta)$ to be a positive capacitance.

The symmetrical form of this transformed filter section is shown in Fig. 14.

Figure 8

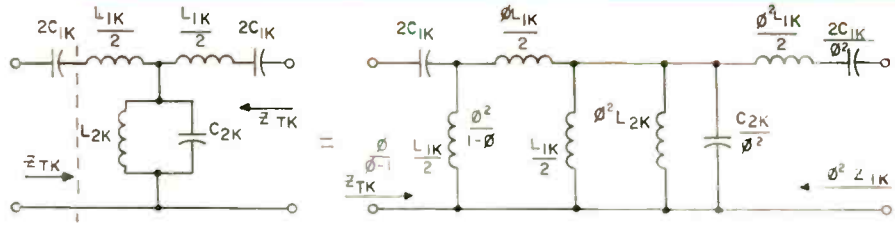


Figure 12

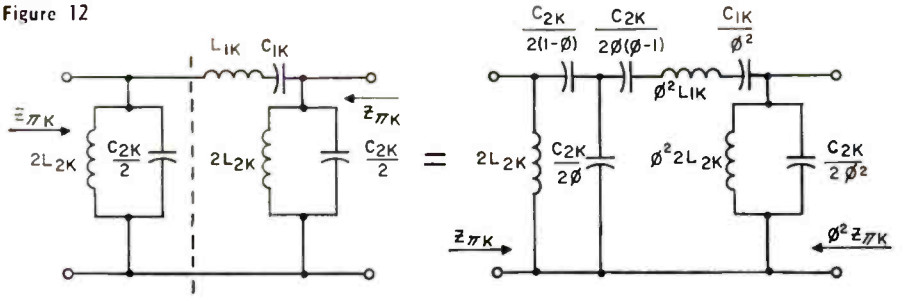


Figure 13

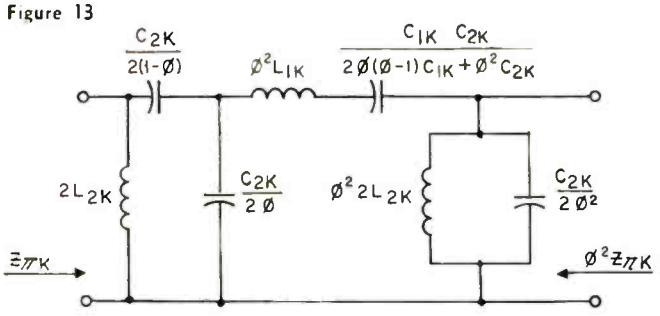
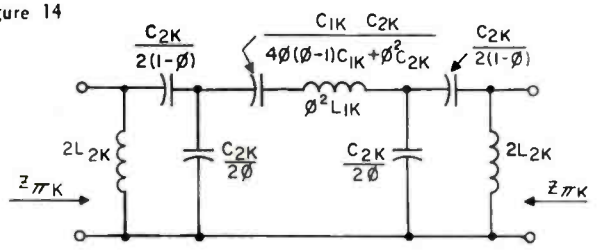


Figure 14



When $2L_{2k}$ is the element chosen in Fig. 11 to operate on, the transformation proceeds as in Figs. 15 and 16.

There are several additional band-pass filter configurations* that are not ordinary constant-K sections, but which also lend themselves to Norton's treatment. They are shown in Fig. 18.

* *Note:* Terman's "Radio Engineers Handbook," 1st ed., 1943, pp. 230, 231, for design equations of these filters.

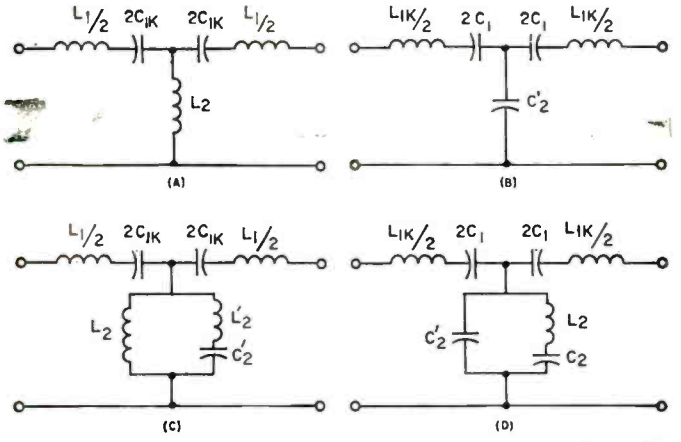


Figure 18

Figure 15

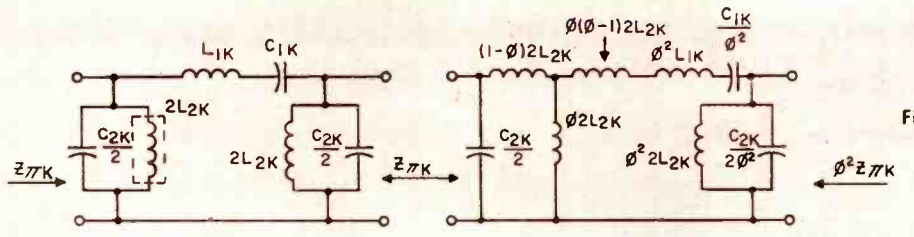
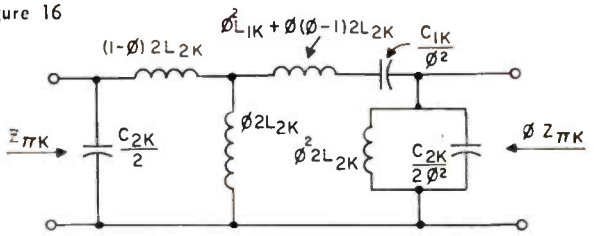


Figure 16



Again note that 0 has to be less than 1 (a true step-down) for $(1-0)2L_{2k}$ to be a positive inductance.

The symmetrical form of this filter section is shown in Fig. 17.

Figure 17

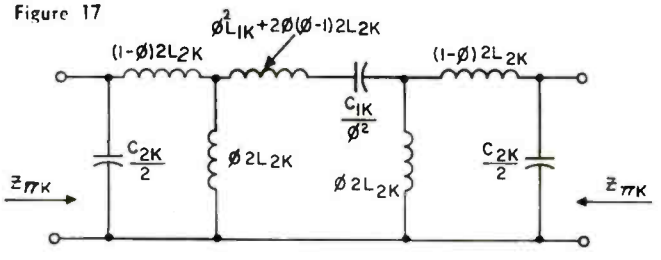
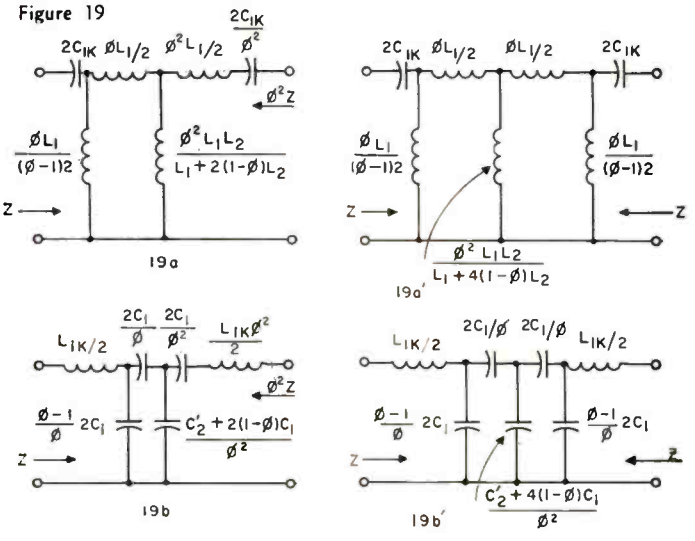


Fig. 19 shows asymmetrical and symmetrical forms of these filters after the transformations have been applied. *(Continued on following page)*

Figure 19



Filter Designing *(Continued)*

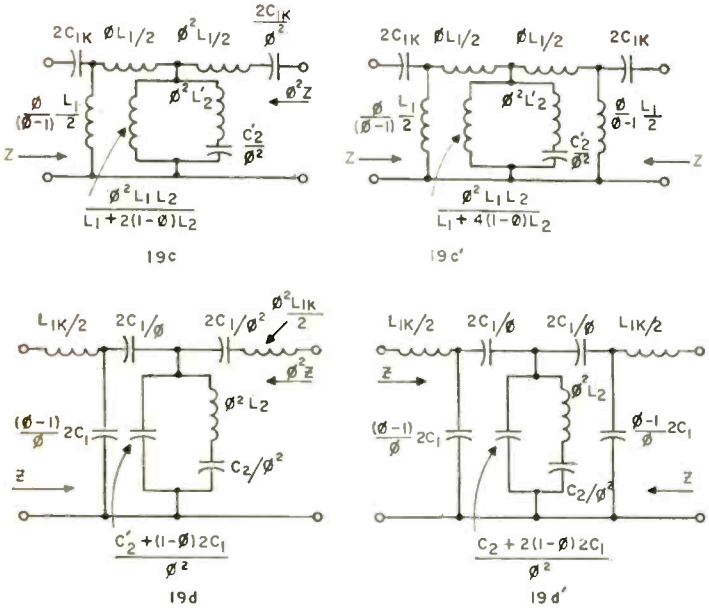


Figure 19 (Continued)

Problem Examples
Step-up Transformations

1. Construct a single-section constant-K band-pass filter with the following characteristics:

f_m = 10 KC, band-width (−3db pts.) = 780 CPS

f_1 = 9620 CPS, f_2 = 10400 CPS, R_{in} = 50, R_{out} = 5,000 ohms

The constant − K values (based on 50 ohms) are:

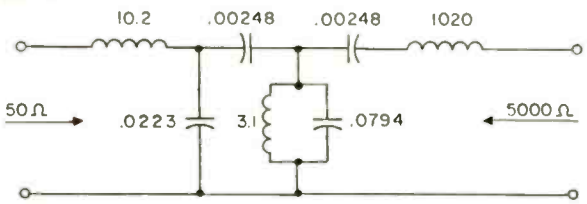
L_{1k} = 20.4 mhy, L_{2k} = 31 μhy

C_{1k} = 0.0124 μfd, C_{2k} = 8.16 μfd

Since θ^2 = 100, then θ = 10

Substitution of the above values in the Fig. 5 network gives Fig. 20.

Figure 20



2. Construct a filter with the same characteristics as in problem 1, except that R_{in} = R_{out} = 50 ohms. Using the constant-K values which were calculated for problem 1, it is seen that L_{2k} and C_{2k} are very unsatisfactory if one is to get high Q and small size. A convenient solution is to transform the section by substituting θ = 10 into Fig. 7. Fig. 21 is thus obtained.

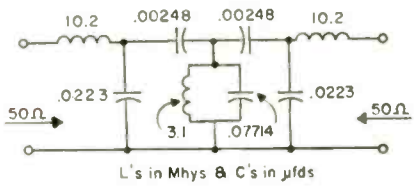


Figure 21

Here, all the coils and capacitors are of reasonably small size, and of values to give good Qs at 10 KC.

Note: If package size and cost of materials are critical items in the filter, Fig. 21, another type of transformation (a transformer-transformation) is possible, where 2 capacitors are eliminated. This is shown in Fig. 22.

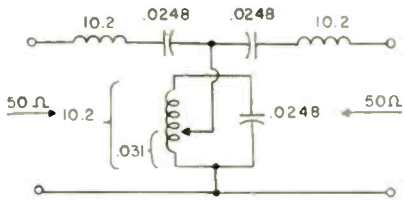


Figure 22

The principal advantage of the Fig. 21 filter over the one in Fig. 22 is that it generally has less insertion-loss in the passband.

Step-down Transformations

1. Construct a single-section constant-K band-pass filter with the following characteristics:

f_m = 10KC, Band-width (− 3db pts.) = 780 CPS,

f_1 = 9620 CPS, f_2 = 10400 CPS, R_{in} = 50,000 Ω, R_o = 500 Ω

The constant − K values (based on 50,000 Ω) are:

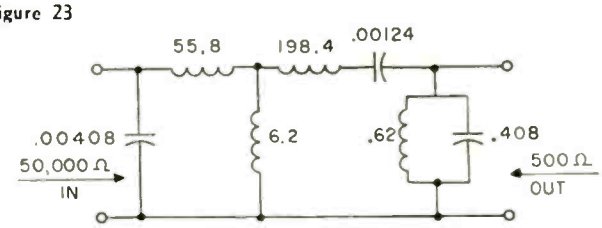
L_{1k} = 20.4 hy, L_{2k} = 31 mhy

C_{1k} = 0.0000124 μfd., C_{2k} = 0.00816 μfd

Since θ^2 = 1/100, then θ = 1/10.

By substituting these values into the Fig. 16 network, Fig. 23 is obtained.

Figure 23



2. Construct a filter with the same characteristics as in problem 1 except that R_{in} = R_o = 50,000 Ω.

Using the constant-K values which were calculated for problem 1, it is seen that L_{1k} and C_{1k} are very unsatisfactory if one is to get high-Q and small-size. Therefore, if the section is transformed by substituting θ = 1/10 into Fig. 17 the result is a filter whose components are all reasonably small in size, and whose values result in good Qs at 10 KC (See Fig. 24).

Note: If packaging size or cost of materials are

REFERENCE PAGES

The pages in this section are perforated for easy removal and retention as valuable reference material.

SOMETHING NEW HAS BEEN ADDED

An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed in standard three-hole notebooks or folders.

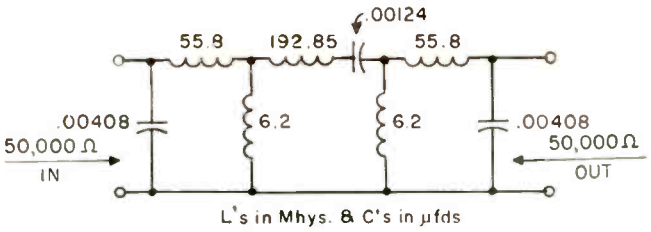


Figure 24

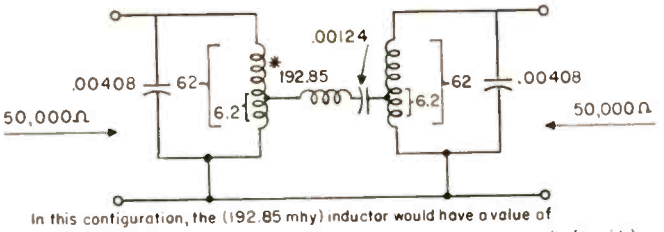


Figure 25

critical items for the filter in Fig. 24, the 2 extra coils (55.8 mhy) can be saved by winding both the (55.8 mhy) and (6.2) mhy coils on the same toroidal core.* The filter will then appear as in Fig. 25.

The filter section shown in Fig. 25 is essentially just as good as the one shown in Fig. 24, except that it may have slightly more insertion-loss in the pass-band.

* This will be a single 62 mhy coil, tapped at 6.2 mhy.

It was mentioned earlier that Norton's transformations do not apply for all types of band-pass filters. Further, it is sometimes better to use another method even when the Norton's procedure is allowable (as an example, see Fig. 22).

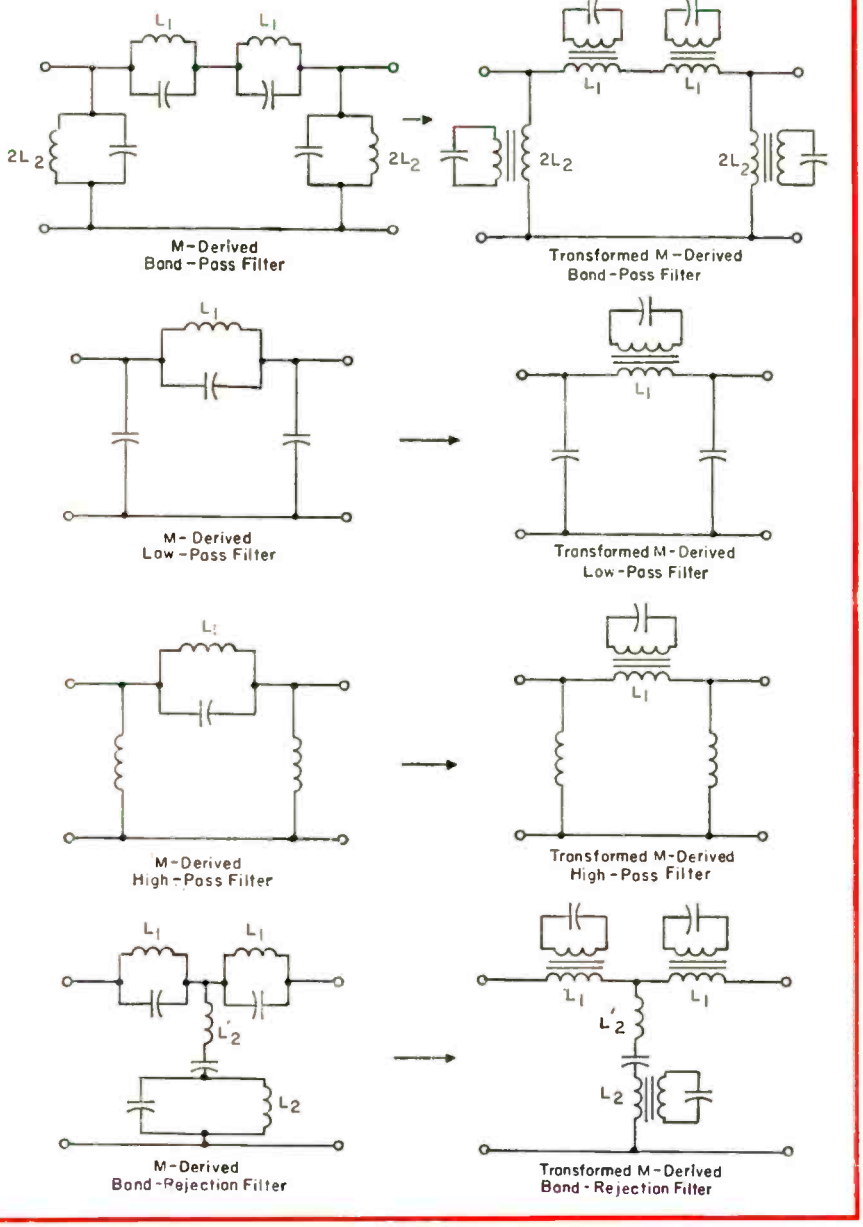
In m-derived band-pass, band rejection, and to a limited extent in m-derived high-pass and low-pass filters, it is possible to use a transformer-type of transformation. Essentially, this is done with double-wound inductors, and is used whenever the inductor of a parallel resonant circuit within the filter is too small to have an acceptable Q at the resonant frequency.

Fig. 26 shows typical filter configurations where this type of transformation is applicable.

Note that in each case the "low-Q" inductor which needs to be transformed becomes the primary of the transformer, while the secondary values of inductance and capacitance are chosen to give maximum or at least optimum Q at the desired frequency.

Although the illustrations above show the transformation as a two-winding transformer, it is just as feasible to use the principle of the auto-transformer as in Fig. 22. However, sometimes there is an advantage in the two-winding method. This method permits the adjustment of turns more easily in each winding during careful bridging and tuning.

Figure 26



Conclusion

In conclusion, it is important to remember that though these methods of impedance transformation are used in designing better filters, the real essence of whether the filter works as designed or not depends upon the degree of accuracy with which each coil is bridged and each circuit tuned. It is often important in narrow-band, critically-tuned filters to compensate for the inherent distributed capacity in each coil. This should be done by careful bridging of the coil, and then tune the cricuit by varying the fixed capacitor with which it resonates. ★★★

By DR. GRANINO A. KORN
Professor of Electrical Engineering
University of Arizona
Tucson, Arizona

For Greater Speed . . .

ASTRAC Offers

THE Arizona Statistical Repetitive Analog Computer (ASTRAC) combines a new memory-equipped repetitive analog computer with digital logic and control. The resulting synthesis of high-speed analog computation with digital automatic programming is interesting; especially in Monte-Carlo-type studies of random processes.[1, 2] These studies illustrate ASTRAC operation, Fig. 1.

In Fig. 1, an analog-computer simulated control system, communications system, queuing problem, etc. is supplied random inputs, initial conditions, or parameters from noise generators with Gaussian or random-impulse output. A simple digital control unit supplies reset pulses. These pulses cause repetitive simulation[3] of the studied process between 10 and 100 times per second. Accurate sample-hold (analog memory) units read selected process variables at push-button preset times, t_1, t_2, after the start of each repetitive computer run. A hybrid analog/digital statitics computer accepts these samples to compute statistical averages over 100 to 10,000 runs, as decided by a preset counter. Thus, one can estimate ensemble averages. Mean-square delay error, correlation functions, and probabilities for very complicated nonstationary, as well as stationary, random processes are examples of such averages.

The ASTRAC system is supported entirely by the Engineering College of the Univ. of Arizona. It is intended mainly for an academic program of graduate instruction and research. However, some of the new components and design philosophy may be of interest to industrial designers of hybrid analog/digital computing equipment.

ASTRAC Modules

Aside from the control unit, various display and recording devices, and ±300 volt and ±100 volt (± computer reference) power supplies, ASTRAC consists of modular units. Those modules are:

1. Summer/Integrator/Comparator Module
   2 Summer/integrator/memory amplifiers
   1 Summing amplifier
   1 High-gain amplifier/phase inverter
   1 Comparator
2. Free-Amplifier Module
   4 Free operational amplifiers and bias connections for special diode circuits, etc.
3. Potentiometer Module
   5 potentiometers and reference-voltage connections
4. Digital-Circuit Module
   2 Schmitt trigger/cathode followers
   2 Flip-flops
   2 Pulse inverter/differentiators
   2 Analog switches
5. Diode-Logic Module
   Patched diode gates and switches

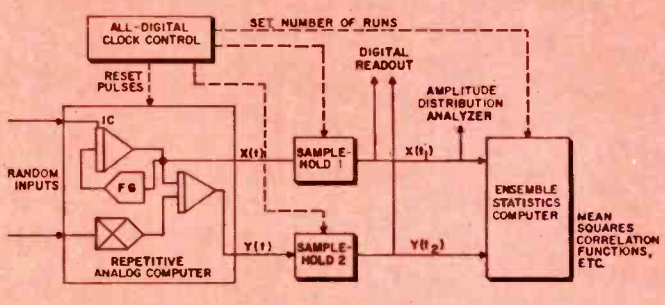
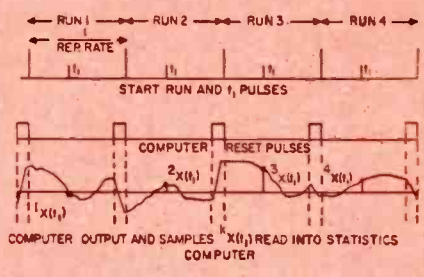


Fig. 1: ASTRAC system operation for random - process studies. Right is block diagram and left illustrates the pulses.



Take the high speed of analog computing and add digital programming—the result, some very interesting methods which aid random process studies. Here are the details on development and operation.

New Computing Methods

Amplifiers, Integrators, & Memory

Fig. 2 shows the chopper-stabilized feedforward design of the ASTRAC dc amplifiers.[4] Individual five-tube units are mounted on printed-circuit cards.

The electronically switched integrator,[5] Fig. 3, is the key element of the modern analog computer. It serves as an analog memory element as well as an integrator. With the electronic switch "on" (TRACK or RESET mode), the output tracks the IC input; "off" (HOLD or COMPUTE mode), it holds its last value or integrates an input sum. ASTRAC integrators have input summing networks with relative gains of 1, 1, 1, 5, 5. They use plug-in polystyrene integrating capacitors to operate with different time scales and repetition rates. Capacitance values between 1 nf and 1 μf permit real-time or slow operation as well as repetitive computation.

Each integrator has a bistable switch-control multivibrator. And, each can be individually reset by digital control pulses or by any comparator in the system. To minimize patching, a switch on each integrator panel selects separate, parallel, or "reversed" (alternating) resetting of the two integrators by pulses from the control units; or, through switching phone jacks, by patched digital or comparator inputs.

ASTRAC summer/integrator/comparator modules compute over a ± 100 volt range. They are self-contained, except for ±300 vdc and 115 vac (filament) power. These units permit analog-comparator and digital control of integrators. So, ASTRAC modules are compatible with many existing computers. And they can be used as accessory units to add rep-op/memory features to existing real-time analog computers.

Other Computing Elements

Potentiometer panels contain 5 General Radio 20,000 ohm, wire-wound, flat-card, single-turn potentiometers. They set coefficients and initial conditions. Each panel also has ±100-volt reference outputs and calibration push buttons which permit each "pot" to be set by reference to a digital voltmeter, with the load connected. Since phase shift can be a serious error source,[6] we intended to use switched, or plug-in phase-compensating capacitors (tap to HI or LO potentiometer terminals). This appears to be made unnecessary by the relatively low resistance chosen. Commercially available fast multipliers and function generators are now used.

Digital Control Unit[9]

The analog-computer repetition rate is counted down from a 10 KC crystal oscillator. In practice, the latter is slightly detuned from 10 KC. This avoids statistical sampling at a frequency commensurable with the 60 CPS line frequency.[10] A string of decimal and binary counters divides the 10 KC clock frequency to yield pulses at 10 times the desired repetition rates

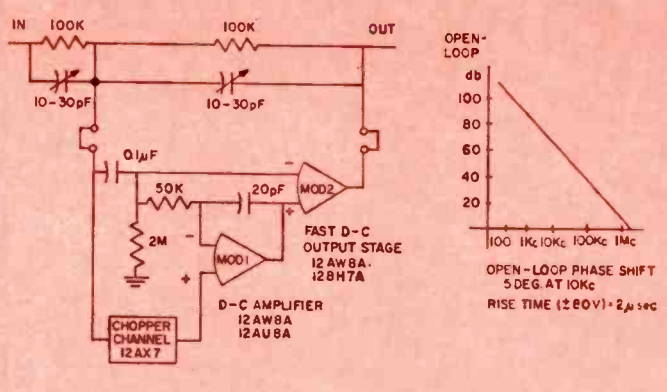
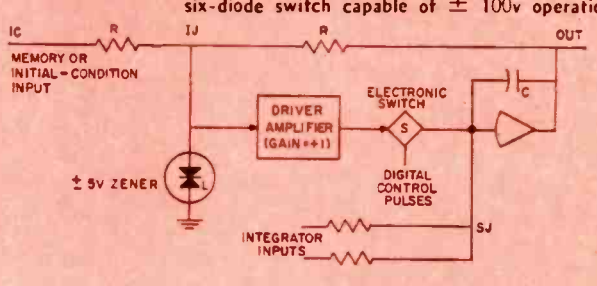


Fig. 2 (left): ASTRAC dc amplifier and phase-inverter network, chopper-stabilized.

Fig. 3 (below): Integrator/memory unit uses a six-diode switch capable of ± 100v operation.



of 10, 25, 50, and 100 CPS, Fig. 4 These pulse trains serve as display timing markers; and one of them is selected by the REP RATE SELECTOR switch to cycle a modified decimal scaler. The latter is a commercial unit reconnected to produce an integrator reset pulse during each tenth successive pulse period, i. e., during one-tenth of the desired repetition period T. The end of this integrator control pulse marks the beginning of a computer run and is counted in a run counter preset to start and stop statistical computations after a sample of 100 to 10,000 runs.

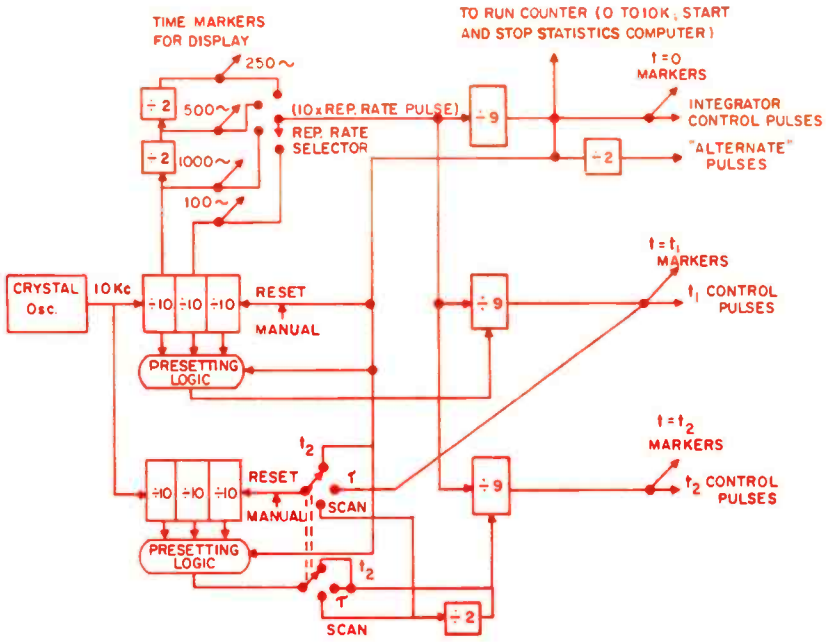


Fig. 4: Simplified functional block diagram of the digital control unit.

The end of each integrator control pulse also resets a string of decimal counters preset to furnish a sampling pulse at a push-button selected time t_1 after the start of each computer run; the sampling pulse length is determined by a second modified decimal scaler in much the same manner as the integrator reset period.

An additional string of decimal counters is similarly preset to furnish a second sampling pulse either t_2 seconds after the start of each computer run, or τ seconds after t_1. The latter feature provides for push-button selected delays in random-process studies.

The t_1 and t_2 pulses are used as precisely timed readout pulses controlling sample-hold readout, Fig 1.

The Scan Mode

The counter chain used to preset t_2 or τ has another interesting operating mode. In the SCAN position, the counter is preset to cycle every $(T + \Delta)/2$ seconds, like a ring counter. After all counters in the control unit are manually reset to zero, the computer integrators will now reset every T seconds, but the t_2 counter resets every $(T + \Delta)/2$ seconds to produce t_2 pulses every $T + \Delta$ seconds through a binary scaler stage. The t_2 readout takes place at $t = 0$ during the first computer run and advances by a push-button-selected step of Δ seconds for each successive computer run. This feature is used to read repetitive computer solutions $x(t_2)$, $y(t_2)$ at relatively slow push-button-selected rates into accurate recorders, printers, and associated analog or digital computers.

Besides its internal automatic operation modes, the control unit provides for control by external reset pulses and external t_1 and t_2 readout pulses. The latter come from control or instrumentation systems, or other computers.

Readout Switching & Solution Display

There is a readout toggle switch on each ASTRAC amplifier. Its output connects to a readout buss which leads to an oscilloscope and to a sample-hold (analog memory) unit. Normally, this memory is controlled by the t_1 readout pulse. A digital voltmeter then reads the amplifier output voltage at the push-button selec-

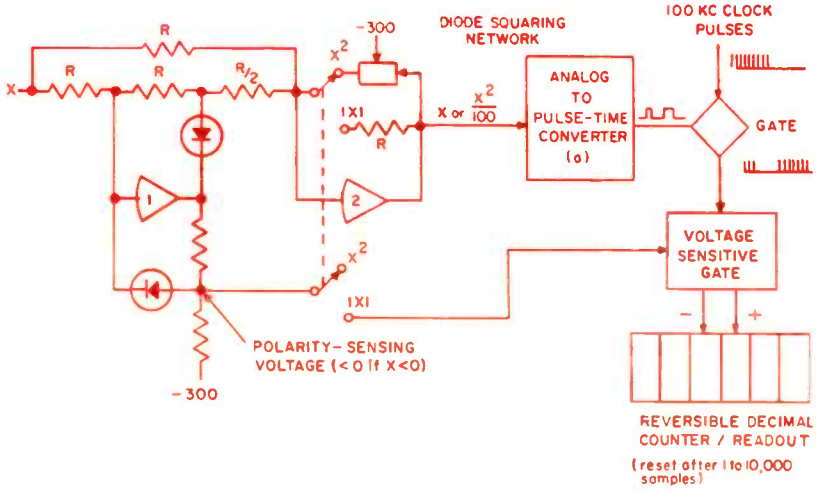


Fig. 5: Digital voltmeter and averaging circuit. A simple pulse-width modulated converter gates clock pulses into a reversible counter for 1 to 10,000 samples.

ted time t_1. The oscilloscope shows the amplifier output variation with time. To avoid simultaneous readout from two amplifiers, the double-pole readout switches operate a simple alarm circuit when two switches are depressed.

Other instruments, such as an averaging unit, printers, and digital computer inputs may be patched into the readout system.

Readout oscilloscopes include a conventional large-screen oscilloscope and a television-type display synchronized with timing pulses from the digital control unit.

The Statistics Computer

The statistical computer accepts successive samples ${}^k x(t_1)$, ${}^k y(t_2)$ from the t_1 and t_2 sample-hold readout units and can work relatively slowly.

The analog-digital averaging unit, Fig. 5, converts each voltage sample into a pulse of proportional length.[11, 12] It uses these pulses to gate clock pulses into a reversible readout counter which shows the resulting sum or sample average. A stop pulse from the run counter ends the count. This inexpensive circuit can be switched to average X, $|X|$, or $X^2/100$ to yield estimates of ensemble averages

$$E\{X\},\ E\{|X|\},\ \text{or}\ E\{X^2\}$$

for nonstationary and stationary random processes. Averages of products XY, e.g., correlation-function estimates, are obtained from

$$XY = \left(\frac{X+Y}{2}\right)^2 - \left(\frac{X-Y}{2}\right)^2.$$

The amplitude-distribution analyzer,[13] Fig. 6, enables its output counter to count one pulse per computer run if, and only if, the analyzer input voltage $x(t_1)$ for that computer run lies between preset values $X - (\Delta X/2)$ and $X + (\Delta X/2)$. The resulting count can estimate the probability

$$\text{Prob}\left[X - \frac{\Delta X}{2} < x(t_1) \leq X + \frac{\Delta X}{2}\right],$$

or, for sufficiently small ΔX, the probability density $\phi[x(t_1)]$ with direct decimal readout.

Automatic Programming Methods

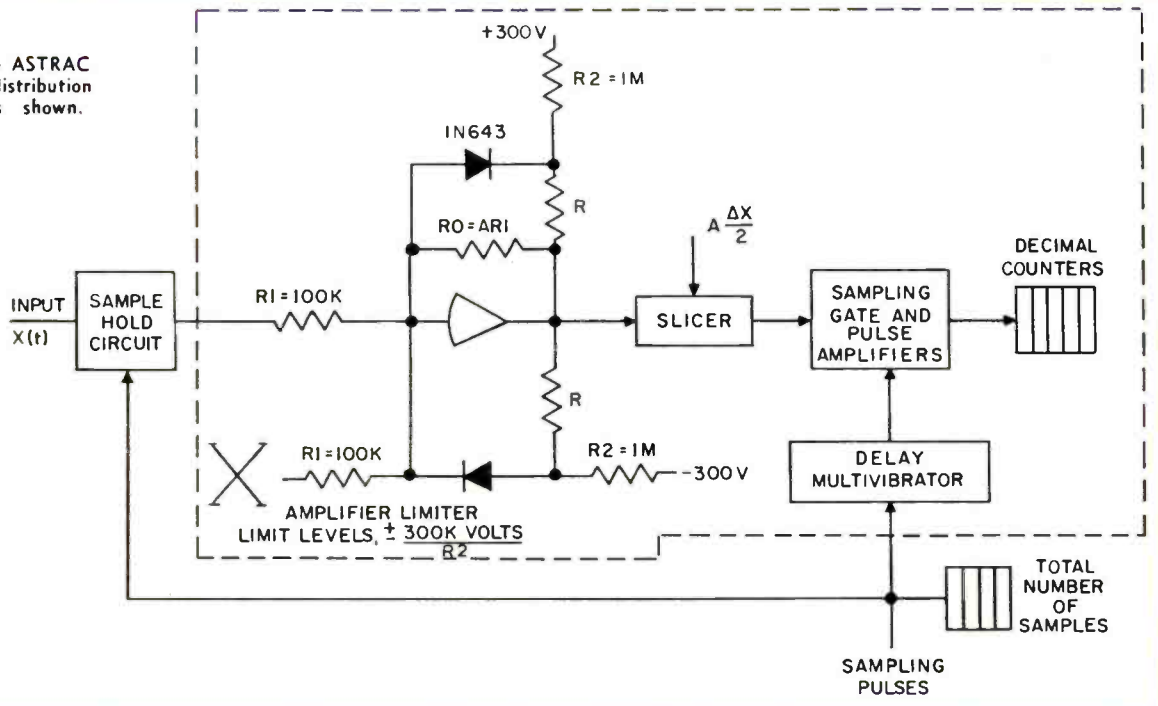
Besides conventional analog-computer components, ASTRAC has accurate memory circuits, decision-making comparators, and analog switches. The machine can tackle a whole new field of combined analog/digital computing methods. Some of these are automatic program changes, iterative sub-routines, multiplexing of difference-differential equation setups for partial differential equations, simulation of sampled-data or digital systems, and automatic parameter optimization.[14, 15, 16]

Another automatic-programming feature of the ASTRAC control system is the ALTERNATE mode. This yields alternate integrator RESET and COMPUTE periods of equal lengths, with t_1 and t_2 readout pulses available during either period, Fig. 4. Since a switch position on each integrator panel can select alternate operation of integrator pairs, the ALTERNATE mode yields very useful iterative routines with a minimum of patching. Such operation permits solution of difference equations[17] and alternate representation of two interacting physical systems (as in the simulation of duels, with or without random inputs). The entire sampling-readout system still functions in the ALTERNATE mode.

Component Accuracy

ASTRAC operational amplifiers permit computation with a full scale of ± 100 volts or ± 50 volts, depending on the complexity and frequency range of the problem. Frequency-response specifications for individual ASTRAC summers and integrators call for dynamic errors less than ⅓% of full scale for a 1 KC square wave (10 cycles in a 10 msec computer run),

Fig. 6: The ASTRAC amplitude-distribution analyzer is shown.



ASTRAC *(Concluded)*

i.e., about ⅓% and 3.3% for 1 KC and 10 KC sine waves, respectively.

Acknowledgments

The ASTRAC system was designed and built by a group of electrical engineering students under my nominal supervision. The project team was led by T. A. Brubaker. His doctoral dissertation comprises the detailed design of the control unit and repetitive computer, as well as the development and basic applications of statistical computer components.[5, 9, 13] H. Koerner designed the feedforward dc amplifier;[4] B. Barker and M. C. McMahan[12] developed the analog-to-digital converter from an original design by H. Koerner and myself; and, J. Hartmann, H. Koerner, and J. Manelis were responsible for the scintillation-detector noise generator.[20] R. H. Eckes assisted in control unit[9] development and designed the digital computer accessories as a master's thesis project. Numerous other graduate and undergraduate students at the Univ. of Arizona made contributions. I am grateful to the Engineering College and the Electrical Engineering Dept. of the university, and in particular to Drs. T. L. Martin and P. E. Russell, for their continuing support of the ASTRAC project. The presentation of this paper at the Third International Conference on Analog Computation in Belgrade, Yugoslavia was made possible by a travel grant from the United States Government (National Science Foundation). Finally, the writer is grateful to Presses Académiques Européennes, Brussels, Belgium, the publishers of the conference proceedings, for their permission to reproduce this paper in the United States.

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What's New

Saving Connector Space

SPECIALLY molded cable connector potting forms of glass epoxy have solved a space problem in an airborne monitoring unit. The forms are made by Stevens Tubing Corp., 86-88 Main Street, East Orange, N. J.

Standard cable connector forms were too large and restricted the wire take off direction. A special, shorter form was designed to snap fit over the connector receptacle. The form is filled with RTV Silastic compound, encapsulating the wire connections.

The resulting cable assembly—with its high resistance to moisture, temperature, and shock—is more economical than conventional connector components.

The inexpensive potting forms are made by cutting short pieces from lengths of glass laminated epoxy or silicone tubing, molded with tight tolerances to snap fit over the connector receptacle.

Cable connector potting forms of glass epoxy are molded with tight tolerances to snap fit over the connector receptacle.

Computers Aid Farmers

AMERICA'S farmers—faced with the task of doubling the nation's food production within 50 years to feed 370-million Americans—will use computers and other electronic devices in swiftly increasing numbers.

Some of America's leading farm and ranch specialists made this forecast during a recent three-day agricultural symposium. The symposium was conducted by the International Business Machines Corp. at its Endicott, N. Y., education center.

Among predictions of tools the farmer will be using in the near future are:

Electronic Sensing devices implanted under the skin of livestock to record health, growth rate and weight, and transmit this information to a computer. The computer will print a report advising the farmer of the best feeding formula and breeding and slaughtering times.

(*Continued on page* 109)

Soil Implant devices to relay to a computer the soil's precise moisture content. The computer will report to the farmer immediately when any part of a field or crop needs watering.

Automatic Processing of products—eggs, for example—with a computer controlling and monitoring egg production constantly. Other devices will electronically grade, clean and package the eggs. The computer, using information from sensing devices will advise the farmer how to vary poultry environment and feed to control production in order to meet market requirements.

Some of these methods are already being used in research, they said. Animals in space rockets, for example, carry sensing devices which report their body data and state of health to computers and monitoring devices.

New farming methods must be rapidly developed because America's population—projected to 370-million in the year 2010—will need twice as much food as is now required. And valuable acreage will be lost to urban growth, airports, highways and railroads.

Stanford Research Institute experts predict that the growing U. S. population will have eliminated any farm surplus before 1970.

Today's farmer can prepare now for these sweeping technological changes.

One answer is detailed record-keeping. Farmers throughout Michigan are now mailing data to Michigan State Univ., which processes it and issues reports to the individual farmer detailing his profits and losses.

Iowa State Univ. research farms and some of the largest commercial farms are using a computer technique called "linear programming" to process data.

In linear programming, a computer is used to determine the exact mix of land, equipment, labor, crops, livestock and other factors which will produce the highest profit for a particular farmer under any given set of conditions.

A computer is the only practical means of relating the hundreds and even thousands of factors with which a farmer must deal.

Computer facilities are now available to many farmers on a part-time basis from university schools of agriculture. In the future, most farmers will rent computer services from computer centers, farm management firms, banks and other institutions. Some large-scale farm co-operatives and large individual farms will also operate their own computer systems.

Editor: For further reading on this subject, your attention is invited to "Electronics and the Future of Agriculture," *Electronic Industries*, August 1960, pp 91-106.

Dieless Forming of Parabolas

HIGHER strength, less costly precision aluminum radar antenna reflectors are now available. They are made by a new manufacturing process called "dieless forming" developed by the Ordnance Dept., General Electric Co., Pittsfield, Mass.

The new process is used to make close-tolerance aluminum reflectors for radar antennas in diameters from 6 ft. to approximately 12 ft. The method uses a template as a contour guide on a large vertical boring mill to form a flat sheet of aluminum to the desired parabolic contour. Dieless forming produces considerably better surface tolerances at lower costs. With conventional processes, bulky and costly dies, forms, or molds are necessary.

Manufacturing tooling is less expensive and faster to develop for a wide range of reflector sizes or quantity requirements. The new process also is reported to offer greater mechanical strength for comparable or less weight because of the use of 6061 Series aluminum in the heat-treated rather than the annealed condition.

Surface tolerances and contours remain as originally produced because the materials are rolled and stretched into the desired shape, putting both the inner and outer surfaces of the material in tension, with the neutral axis located outside the material, thus minimizing springback.

Template serves as a contour guide on a large vertical boring mill to form 6061 Series sheet aluminum to the desired parabolic contour.

Though our series has treated linear and non-linear receivers, this article deals with noise for linear receivers only. But the effects of ionosphere reflection, troposphere refraction, and atmosphere absorption are also thoroughly discussed.

Problems of Space Communication —Part III

Antenna Noise & Propagation

By C. T. McCOY
Research Division
Philco Corporation
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Philadelphia 44, Penna.

Third of a Series

IN Part 1 (April 1961, p. 110), we treated linear receiver noise capabilities; also, receiver sensitivity, T_s, the arithmetic sum of both receiver and antenna noise. This total sensitivity noise, T_s, determines the needed magnitude of the received signal power, P_r, Eq. (3).

For transmitter-receiver uses which must work through the earth's atmosphere, signal attenuation, a (atmospheric absorption), in Eq. (1) must also be considered. The space loss factor, L, can be minimized by choice of antenna gain and frequency. This will be treated in Part IV. However, the reduction is limited by atmospheric factors.

Antenna and Background Noise

The Quiet Sun

The sun can be by far the greatest contributor to antenna noise. Between 100 MC and 100,000 MC, its contributing noise for the narrow antenna beam to be filled completely by the sun (which has about ½° diameter) is the top curve in Fig. 6. The antenna noise[22] above 5000 MC is 6000°K. This is also the thermal temperature of the sun's main body. Also, Fig. 6, at the low microwave frequencies, the sun's noise increases inversely with the square of the frequency. This noise comes from the corona and is as much as one million degrees at 250 MC, which represents a quiet sun; but during sun-spot activity, there are bursts of as much as 20 to 40 db above this level.[22] The peak of each of these bursts lasts for some seconds; after which, it quiets down to 10 db above the quiet level for periods that may last hours.

Sun Bursts

For most uses, sharp beam antennas can be controlled to avoid pointing the main beam at the sun; however, there is no way to prevent the noise from entering the antenna through sidelobes. The radio astronomers by careful antenna design are able to keep the sidelobe level isotropic, i.e., no gain, for all angles more than 6 beam widths away from the antenna main lobe; then, for the burst condition of 40 db above quiet level and isotropic antenna gain, the antenna noise is represented by the "sun burst and galaxy" line. This amount of antenna noise would be expected no matter where the antenna is pointed for any receiver system during the burst condition whether the system is on the earth or in space. This indicates clearly that very low-noise receivers, less than 100°K, in the low VHF would be swamped by sun-burst noise.

Galaxies

The strongest source of galactic noise is the galactic center of our own milky way in the region of the constellation Sagitarius.[22, 23] When this galactic center completely fills the antenna beam, the noise would again be represented by the line marked "sun burst and galaxy." Although the frequency dependency is not identical with that of the sun, being inversely proportional to a power[24] between 2 and 3, it is close enough to be roughly represented by this same line.

Aurora

When the ionosphere is excited by auroral condi-

tions, it can absorb radiation to the extent of about 3 db at 30 MC.[25] This loss (in db) decreases with the square of the frequency and would be about 0.3 db (1.08 power ratio) at 100 MC. One effect of this aurora absorption is to decrease the galactic antenna noise by this loss factor. A second effect of the aurora is to add to the antenna noise, in temperature units, a magnitude equal to the product of the ionosphere electron temperature times its emissivity. The absorption loss ratio minus one equals the emissivity for a good approximation of the small values considered here, e.g., 0.08 at 100 MC, and decreases with the square of the frequency. The ionosphere electron temperature seems to be less than a few hundred degrees Kelvin,[25] so that at 100 MC the aurora would contribute less than 20 to 30°K to the antenna, and much less for higher frequencies.

These facts indicate that for frequencies above 100 MC, the auroral contribution to the antenna noise is negligible compared to the galactic noise.

Hydrogen Line

In galactic space there are scattered sources of atomic hydrogen radiation. The frequency of this radiation is 1421 MC when not receding from the observer. Since all matter in the universe is separating, the hydrogen line radiation is expected at 1421 MC or less. The radio astronomers have indicated that some of the sources have a noise intensity almost equivalent to that of a 100°K blackbody radiator, as shown by the H^1 line in Fig. 6.

Atmosphere Moisture

The higher the moisture content of the atmosphere, the greater the emissivity of the thermal radiation of the moisture. Emissivity of any blackbody for any frequency of radiation is identical to the absorptivity for that frequency of radiation. As will be shown in the next section, high moisture content can, at high microwave frequencies, absorb practically 100% of the radiation passing through it. For such conditions, the antenna noise temperature becomes equal to the thermal temperature of the moisture, which for most earth conditions is approximately 300°K. This is represented by the flat portion of the curve marked "atmosphere" in Fig. 6.

The lower the microwave frequency, the lower is the moisture emissivity, so that the antenna temperature will approach that of the background noise beyond the atmosphere, here represented by the "sunburst and galaxy" line at the left of Fig. 6. The exact "atmospheric" curve in the figure was calculated using Eq. (22) assuming the "sun burst and galaxy" curve for the source noise generator T_g, and the atmosphere absorption loss $(1/G_m)$, explained in the next section, for a 50-km. path of 100-ft. visibility fog. This bad weather condition, picked arbitrarily, would arise if the earth were surrounded by a belt of fog to a depth of 5 km. and be viewed by an antenna elevation angle of 5°. As indicated in the following section, this fog emissivity of 100-ft. visibility is also duplicated with rain at a 16 mm/hr falling rate. Such weather conditions are not the worst that can occur, but are a reasonable criteria to assure "all weather" performance.

Conclusions on Antenna or Background Noise

The lower darkened area beneath the "galaxy" and "atmosphere" curves in Fig. 6 represents a background base noise that must be expected occasionally for terrestrial antennas that scan practically any position of the hemisphere and operate in almost any weather conditions. The left hand portion of the UHF and VHF must be avoided if the best receiver sensitivity is to be achieved. Therefore, the upper microwave frequencies should be used for receivers out in space, but must be avoided for terrestrial applications because of the atmosphere moisture. For ground-based receivers, 30°K antenna noise is the minimum all-weather value to be expected, and occurs at frequencies somewhere between UHF and S-band as shown by the saddle in the curve of Fig. 6.

Moisture Attenuation

The loss a is given quantitatively in power ratio units by the formula:

$$a = 10^{\frac{0.0844 g R_f}{\lambda^2}} \qquad (26)$$

where,

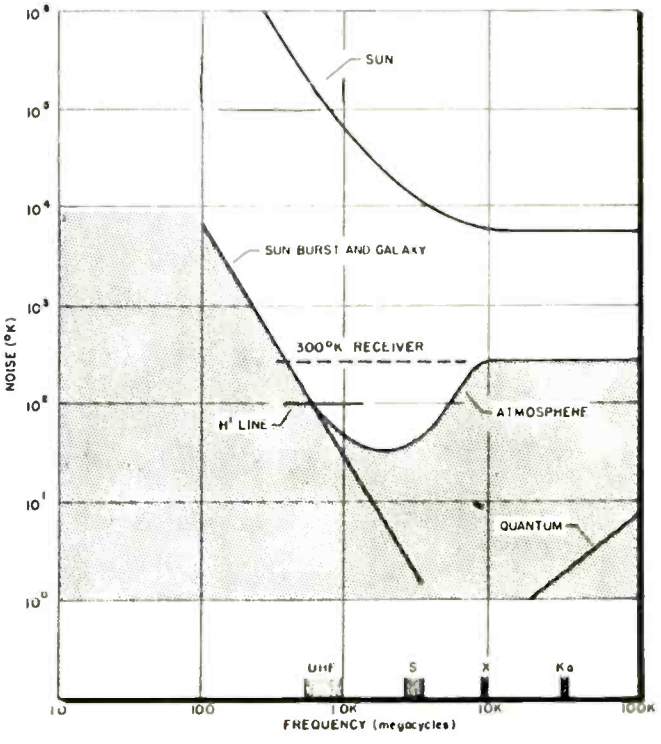
g = fog water content (g/m³ of atmosphere),
R_f = distance of the fog path (km), and
λ = wavelength of the radiation (cm).

The attenuation in db/km will be:[26]

$$a = \frac{0.434 g}{\lambda^2} \qquad (27)$$

With wavelength converted to frequency, this formula is plotted in Fig. 7 by the line marked "fog" for a g value of 2.3 g/m³, which corresponds to the arbitrarily chosen bad weather condition of 100-ft. visibility. Rainfall at the rate of 16 mm/hr has approximately the same attenuation, as shown by the curve marked "rain." (*Continued on following page*)

Fig. 6: Contributing factors to antenna background noise.



For the 50-km bad weather path criteria of the *Atmosphere Moisture* section, frequencies above X-band would have severe absorption, whereas at S-band or lower, the absorption would be negligible. Even in fair weather, for a 50 km or longer path, the normal water vapor and oxygen content of the atmosphere can cause excessive attenuation, as indicated by the curves marked "oxygen" and "water vapor" in Fig. 7. The oxygen absorption at about 60 GC is so great that satellite communication would be quite free from ground interference.

Atmosphere Refraction and Reflection

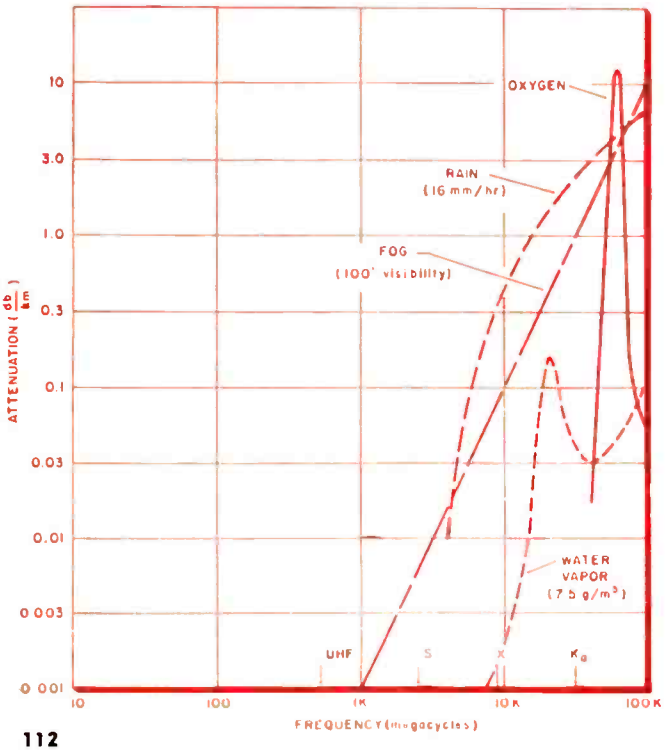
Meteors

The earth's atmosphere is invaded daily by a tremendous number (10^{10}) of micrometeorites larger than 0.008 cm in radius.[27] The number of these meteorites decreases as their size increases, so that a few hundred per day have a radius larger than a few centimeters. There are few large enough to give a direct radar reflection, but their ionized trails through the atmosphere are a source of radar echoes or attenuation in a one-way path. The meteors are presumed to be 100% vaporized and ionized by heat in their passage through the atmosphere. It has been calculated that the critical frequency f_c, for a spectral reflection from an ionized layer at normal incidence is given by:

$$f_c = 9\sqrt{N} \qquad (28)$$

in cycles, and N is the electron density expressed in number per cubic meter. Thus, with an electron density of 10^{14}, total reflection occurs for all frequencies below 90 MC. Echo power attenuation would depend not only on electron density, but also on the thickness of the ion trail, the diffusion time, and the intercept angle relative to the radar beam. Very little is known quantitatively about meteor trails, but it has been estimated[27] that meteors large enough to cause disturbances in VHF enter the sky above an elevation angle of about 30° and at a rate of more than one per second. Since the ion density required for total reflection from an ionized layer increases as the square of the frequency and because, owing to meteor size, the rate of occurrence of echo is inversely proportional to the ion density, the rate of occurrence of meteor echo should vary, approximately, inversely as the square of the frequency. This implies, therefore, that interference from meteor trails can be avoided by using frequencies above VHF.

Fig. 7: Effect of various atmospheric conditions on attenuation.



Aurora

Under auroral activity the upper atmosphere ionization density increases, although about 10^{13} electrons/m^3 is the highest ever indicated.[28] For such density, all frequencies below 30 MC, the critical frequency, would be totally reflected at normal incidence (from Eq. 28). However, for angle of incidence θ less than 90°, frequencies f higher than the 30 MC would be totally reflected as related by the formula:

$$= \frac{f_c}{\cos\theta} \qquad (29)$$

Thus, for a beam elevation angle, or incidence angle θ, as small as 6°, the total reflection could occur for a frequency 10 times higher than that for total reflection at 90°, or normal incidence. This would explain why amateur radio hobbyists occasionally get aurora-reflected signals [29] at frequencies as high as 220 MC.

Faraday Rotation

The earth's magnetic field causes the ionosphere to be a magneto-ionic medium which will rotate the plane of polarization of any electromagnetic radiation passing through it. This rotation amounts to about 1500° for a two-way pass at 120 MC,[30] and will decrease with the square of the frequency to about 15° at 1200 MC. Since the electron density of the ionosphere is not uniform but occurs in "blobs," the magnitude of the rotation will be different for different parts of the sky and will also vary with time for any certain part of the sky. This variation amounts to about 20% of the rotation, and has a time period of about one minute.[31] To avoid drastic signal fades (20 to 40 db) with UHF and VHF frequencies, the receiver antennas must be omnipolarized.

Refraction Error

The ionosphere and troposphere are nonhomogeneous mediums with varying indices of refraction in both space and time. This variation in refraction will cause apparent variations in the direction of arrival of electro-magnetic radiation. In addition, this changing index of refraction causes phase variations in the arriving waves, and also variations in the apparent path lengths which would cause errors in radar range.

According to radio astronomers,[31] the refraction effects of the ionosphere for frequencies above UHF are negligible compared with the effects of the troposphere. The troposphere seems to be composed of

drifting and shifting "blobs" of slightly different indices of refraction. These blobs vary in size from 20 ft. across under stormy conditions at sea level, up to 200 ft. across in the upper troposphere. The index of refraction changes between these blobs, and with time, by several parts in a million. Both theory and practice[32] indicate that these variations in refraction in the troposphere can cause, under the most turbulent conditions, an angular path deviation of about one milliradian, and that they are independent of frequency. This deviation is about 3 times greater than that reported by radio astronomers,[31] who state that by simple corrections from site-based weather instrumentation, the absolute angle of arrival of radio waves can be established within 0.3 milliradian (1′ prime of arc). Corrections appreciably more accurate than this are not possible because of the turbulences.

Troposphere blobs can cause phase variations of about 3° at 1000 MC. This phase variation is proportional to frequency. The period of these changes is in the order of minutes. This phenomenon sets a limit on the phase information that can be secured.

The phase variation can be converted to equivalent variation in path lengths, which turns out to be a small fraction of an inch and independent of frequency. This is generally a negligible error in radar range.

Conclusions

The atmospheric or propagation effects, which are factors in system reliability, all indicate the use of UHF or higher frequencies for space communication.

In Part V, on system optimization for ground based receivers, it will be seen that the low microwave frequencies provide an optimum between the undesirable high background noise of the UHF-VHF and the high-atmosphere moisture attenuation of the millimeter region.

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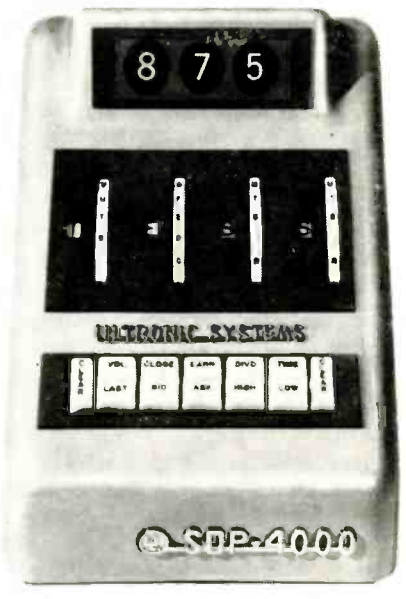


Voltage regulation and stability are the prime considerations in the design of power supplies. In the design of high voltage power supplies these problems have been considered particularly formidable. Only, however, because the components suitable for this work, as well as the design techniques, have not been fully understood.

Design Information for . . .

Regulating and

Part Two of Two Parts

A GRAPHIC analysis of a simple power supply will show what is required to solve a particular problem. This simplified supply is shown in Fig. 7. In this simplified circuit,

E_{gen} is the open circuit dc voltage at filter output.

R_{gen} is the dynamic resistance of the unregulated supply including the resistance of the rectifier, transformer, filter, etc.

R_{series} is the dropping resistor between the filter and the corona regulator.

$E_{nominal}$ is the operating voltage of the corona regulator tube.

$R_{dynamic}$ is the dynamic resistance of the regulator tube (slope of the regulating curve).

Across the operating curve, Fig. 8, for the regulator tube involved (line A-B), the load line for the power supply (line C-D) may be drawn. This will extend from the open circuit voltage at zero current and have a slope equal to the sum of $R_{gen} + R_{series}$. The two curves cross at (point 0) the operating or quiescent point. Thus, for nominal input voltages, the output voltage will be regulated at E_0 and the current flowing through the regulator will be I_0.

and the dynamic resistance of the supply is presumed to remain constant, 2 new load lines may be drawn, one from $E_{gen} + 10\%$ and the other from $E_{gen} - 10\%$. The 2 new points of intersection locate the maximum and minimum operating points and show the accompanying changes in output voltage (E_{01} and E_{02}), and regulator current (I_{01} and I_{02}). The ratio of ΔE_{in} *to* ΔE_{out} gives the stabilization ratio.

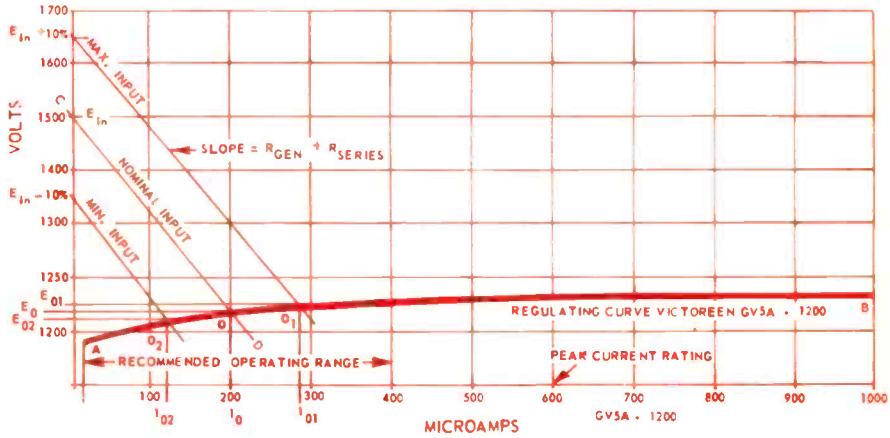


Fig. 8: The operating curve for a regulator tube with load line (C - D) is shown.

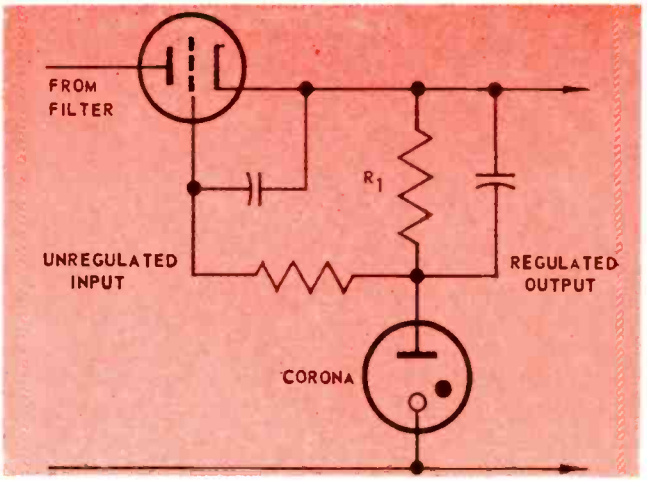
Series Resistors

At this point we see that the higher the value of series resistors chosen, the better will be the stabilization ratio. Of course, it is also true that the higher the value of series resistors, the greater must be the unregulated voltage. A given stabilization ratio, will be approximately achieved by selecting a series resistor whose value is found by the dynamic resistance of the corona multiplied by stabilization ratio. For instance, if an output voltage change no greater than 1 v. is needed, for every 10 v. change in input voltage the value of series resistance must be 10 times the dynamic resistance of the particular corona resistor.

Now, if a fixed value of load current (I_{load}) is needed, points I_0, I_{01}, and I_{02} may be moved to the left by an amount equal to I_{load}. Where these new current values cross the corona line, the new values of output voltage will be found, replacing E_0, E_{01}, and E_{02}.

If the I_{load} is assumed to be variable between two values: $I_{load\ max.}$ and $I_{load\ min.}$ for both high input and low input, then point I_{02} must be moved to the left

Fig. 9: A corona tube supplies a bias to the series pass tube for regulation.



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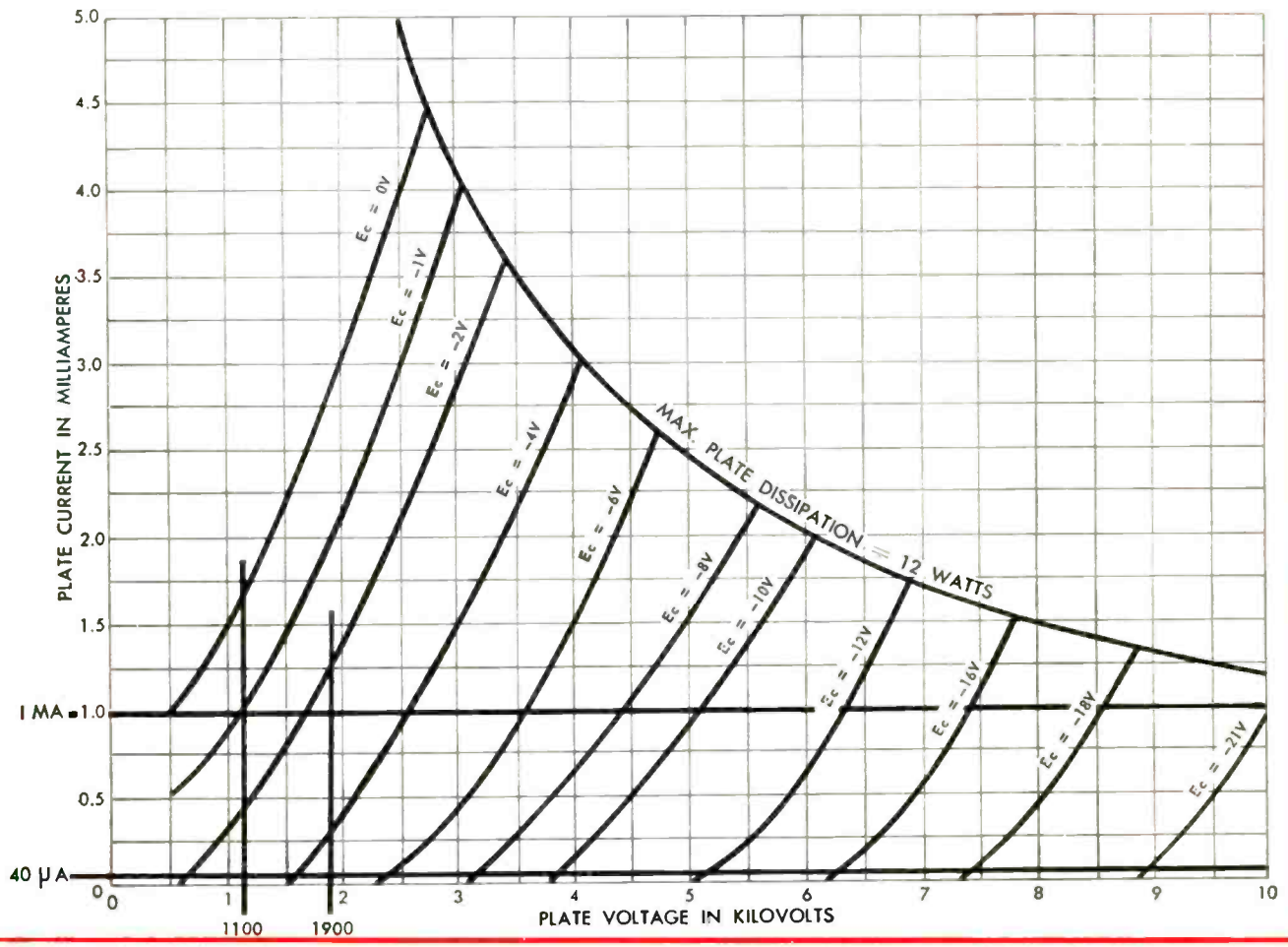
Stabilizing HV Power Supplies

by an amount equal to $I_{load\ max.}$, while E_{01} is moved to the left by an amount equal to $I_{load\ min.}$ These 2 new values of current cross the corona regulating curve at values of E which indicate the output voltage under conditions of highest input voltage with least load current, and lowest input voltage with greatest load current.

For voltage variations caused by changes in ambient temperature, 2 new corona regulation curves may be drawn: One representing the VA characteris-

Fig. 10: The plate curves for a 7235 are shown. Simplicity would recommend the triode for a series pass tube.



HV Power Supplies
(Concluded)

TABLE 2

Typical Voltage and Current Data for the Type GV3S Series Corona Tubes

Type	Nominal Voltage at 50 μa Test Point	Tolerance Volts	Current in Microamperes			Regulation Volts	Altitude (Feet)
			Min.	Max.	Peak		
GV3S-400	400	±10	2	300	400	10	72,000
GV3S-600	600	±10	3	300	400	15	70,000
GV3S-800	800	±12	3	450	600	15	68,000
GV3S-1000	1000	±15	5	500	750	18	65,000
GV3S-1200	1200	±18	10	600	750	20	63,000
GV3S-1500	1500	±23	15	650	750	25	60,000
GV3S-1800	1800	±27	20	550	850	50	57,000
GV3S-2000	2000	±30	20	500	950	65	55,000
GV3S-2200	2200	±33	25	450	1000	65	53,000
GV3S-2400	2400	±36	25	410	1200	65	51,000
GV3S-2600	2600	±39	25	380	1200	65	49,000
GV3S-2800	2800	±42	25	350	1200	65	47,000
GV3S-3000	3000	±45	25	330	1200	65	45,000

voltage under conditions of maximum input voltage, while its maximum plate current must be at least equal to maximum load current. Two or more pass tubes may be connected in parallel to increase the current capabilities of the circuit. In this case, regulation is improved at some loss of stabilization.

Regulated, Adjustable Supplies

Power supplies are often required to have an output voltage which is both regulated and adjustable. An example is the power supply whose output voltage must be tailored to fit a klystron or voltage controlled TWT. The previously described circuit can be modified as shown in Fig. 11.

Here the reference tube is biased by a portion of the regulated output voltage. The bias voltage must be by-passed to prevent dc feedback. Where a more stable adjustment is needed, the bias voltage may be stabilized by glow tubes or zener diodes (Fig. 12).

In the circuit (Fig. 12), the output voltage may be adjusted by 300 v., regulated by two VR-150 tubes across the center tapped potentiometer.

For high current power supplies, transmitting power tubes may be used for the pass tube. While the series regulator circuit is often considered to be more efficient than the shunt type, there are times when the shunt regulator is recommended. Such an occasion might be the design of a power supply operating from a stabilized source voltage, but requiring good regulation over wide ranges of output current. The circuit in Fig. 13 is suggested.

Here the shunt regulator tube has plate voltage capabilities equal to the desired regulator output voltage, and has the plate current capabilities slightly greater than the maximum variations in output load current. Under conditions of maximum input voltage and minimum load current (maximum shunt regulator current) the required grid bias is ascertained. A glow tube or zener diode, capable of passing the maximum regulator current, is picked as a bias voltage. The minimum operating bias of the shunt regulator is then subtracted from the operating voltage of the bias supply previously selected. This difference voltage is the minimum voltage to be developed across the potentiometer at minimum reference current. From these 2 figures, the value of the potentiometer can be computed. When this voltage is subtracted from the desired output voltage, the nominal value of the reference tube is found.

The total output voltage change becomes the change in grid bias for the shunt tube, plus the change in reference voltage. The regulation for the circuit again becomes about equal to the transconductance of the shunt tube, while the stabilization is about equal to the ratio of the series resistor to the reciprocal of the transconductance of the shunt tube. Here, again, two or more shunt tubes may operate in parallel with an improvement in regulation, and an increase in load variations.

Tighter Control

If a much tighter control of output voltage is needed than is provided by any of the foregoing circuits, particularly at high voltage, the circuit similar to that in Fig. 14 can be used.

In this circuit, the entire output error voltage appears across R1, with the corona reference tube of the required nominal voltage providing the current through R1. Here, again, the noise region of this tube may be used provided the filter circuit associated with R1 is included. This entire error voltage is then amplified by the HV pentode tube and the amplified error signal appears across R2, where it is applied as grid bias to the series pass tube. The screen voltage of the pentode can be supplied from a tap on the HV transformer, using a separate rectifier and filter for this screen voltage, and regulating the screen with glow tubes. The cathode bias for the pentode can be taken from a pot. included in a voltage divider string across the regulated screen voltage. This circuit can provide an open loop gain for the undivided error signal, which is about equal to the transconductance of the pentode multiplied by its plate load resistor. In this manner, a degree of regulation may be provided which even exceeds the percentage regulation from the standard "preferred circuits."

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ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

ELECTRON TUBE INTERCHANGEABILITY CHART

By C. P. MARSDEN, W. J. KEERY and J. K. MOFFITT

National Bureau of Standards
Washington 25, D. C.

Part Three B:

Domestic to Foreign Power Tubes

Foreign to Domestic Power Tubes

The degree of interchangeability is indicated by the prefixed number sign (#) which indicates that the type number is a direct replacement or a replacement requiring only very minor modification in the circuit or of the voltage.

CODE:
The three-letter code for Kind and Type, is listed below.

Kind	*Type*
BEA—Beam	BEA—With Beam Type
DIO—Diode	GAS—Gaseous Type
DWD—Double Diode	HEX—With Hexode
HEX—Hexode	IND—Indicator
PNP—Pentode	PND—With Pentode
PTG—Pentagrid	PTG—With Pentagrid
TET—Tetrode	SIN—Single Type
TRI—Triode	TRI—With Triode
TRD—Triple Diode	TWN—TWN Type

The code used for "Country of Origin or Availability" is:

A—Australia	F—Fronce	I—Italy
C—Canada	G—Germany	J—Japan
E—England	H—Holland	S—Sweden

(*) = Type numbers registered by a foreign manufacturer with Electronic Industries Association, which may or may not be manufactured by domestic companies.

"The interchangeability of Domestic Types is appended in the Tabulation of Data on Receiving Tubes, National Bureau of Standards Handbook 68, issued November 1, 1959."

Domestic vs. Foreign Power Tubes

No.	Type/Similar to or Interchangeable With
C1A	DIO XE #AFX203 @F. #3G15 @J
2C39A	TRI SIN #1D1-100A @E. #5V2C39A @E. 2C39A @E.G.H.J CV2516
3B24W	DIO SIN #4Z3W @E. TH3B24W @F. 3B24 @E.G.H. CV2858
3B28	DIO XE #RR3-250 @E. #AX224 @E. #DCX4/1 @G #2-128 @J. 3B28 @E.F.I. CV1835
3C24	TRI SIN #2T24 @J. #B1109 @E. 3C24 @E. CV789. CV2736
3C45	THY H #XH3-045 @E. PL345 @G.H. 1G45P @J. FX227 @E. CV372
3D22	THY GAS CX1113 @F. 3D22 @E. CV2851
4B32	DIO XE #RR3/1250 @E. #DCX4/50 @G.H. #4M32 @J GU20/21 @E. #AX230 @E. 4B32 @E. CV2518
4C35	THY H #1G35P @J. #XH8-100 @E. #FX225 @E #PL435 @G.H. 4C35 @E.F# CV1787
4D21	TET SIN QX3-125 @E. QB3-300 @G. #PL4D21 @G. CV2130 #RS685 @G. C1108 @E
4D32	BEA SIN #C1123 @E. 4D32 @E. CV3543
4PR60A	TET SIN #QV20-P1B @E. C1111 @E. C1133 @E. CV2752
4X150A	TET SIN #QV1-150A @E. #5V4X150A @E. #4F15R @J. #QE1/150 @G.H. CV2519
4X500A	TET SIN #QE04/800 @G. #QV4-500A @E. #6F5 R @J
4-65A	TET SIN #QV3-65 @E. #QB3/200 @G. #3F65 @J. CV1905
4-125A	TET SIN #QV3-125 @E. #4F21 @J. #RS685 @G. C1108 @E #-125A @G. QB3/300GA @G. CV2130
4-250A	TET SIN QB3.5/750 @G.H. #AX4-250A @G.H. #5F22A @J. #RS685 @G. RS1002 @G. C1112 @E. #QV4-250 @E. 4-250A @G. CV2131
4-400A	TET SIN #PL4-400A @G.H. #5F23A @J. C1136 @E
4-1000A	TET SIN #7F25 @J
5C22	THY H #TH5C22 @F. #PL5C22 @G.H. XH16-2 @E. #FX219 @E. PL522 @G.H. 5C22 @E. CV2520
5D22	TET SIN QV4-250 @E. #QB3.5/750 @G.H. #PL5D22 @G.H #RS686 @G. C1112 @E
6D4	THY GAS #AFX212 @E. CV1949
9C21	TRI SIN #B#137C @E. #B721 @J
9C22	TRI SIN #BR137B @E. #B721R @J
KU25	THY H #FX231 @E. CV2993
100TH	TRI SIN #TB3/350 @G.H. #4T17 @J. #TH100TH @F 100TH @1
100TL	TRI SIN #4T16 @J
250TH	TRI SIN #TB4/800 @G.H. #5T21 @J. TH250TH @F. 250TH @1. 3C200 @F. CV2587
250TL	TRI SIN #5T20 @J
393A	THY AHG #4G93 @J. CV2638
394A	THY AHG #3G94 @J. CV2639
HT415	THY H FX219 @E
436A	TET SIN A2674 @E
450TH	TRI SIN #5T31 @J. CV2572
450TL	TRI SIN #5T30 @J
673	DIO HG #4H73 @J. 673 @G.H.I
807	BEA SIN 4Y25N @F. #QV05-25 @E. #QE06/50 @G. #P807 @E. #UY807 @J 807 @E.F.I. CV124
813	BEA SIN #QB2/250 @G. #QY2-100 @E. #4B13 @J #5V813 @E. #C143 @E. 813 @E.I. CV26
816	DIO HG #1H16 @J. DCG4/1000G @G.H.
826	TRI SIN #2T26 @J. CV630
827R	BEA SIN #CR139 @E. 827R @E
828	BEA SIN #5V828 @E. CV631
829B	BEA TWN #P2-40B @F. #QQE06/40 @G.H. #C144 @E. #QQV07-40 @E. 829B @E.F.I. CV2666
832A	BEA TWN #QQE04/20 @G.H. #QQV04/15 @E. #C180 @E 832A @E.F.I. CV788
833A	TRI SIN #TY4-350 @E. #5T33 @J. B142 @E. TH833A @F. CV635. CV1927
837	TRI SIN #TC-522-B @J
837	PND SIN #PE04/10E @G.H. CV637
857B	DIO HG #G100A @1. #7H57 @J. #AH205 @E. 857B @E.I. DCG7/100 @G.H. CV2673
866A	DIO HG #2H66 @J. #RG3-250A @E. DCG4/1000G @G.H. GU12 @E. 866A @E.I.J. CV32
869B	DIO HG #DQ-4 @G.H. #5H69A @J. #G40 @1. #AH213 @E. DCG9/20 @G. 869B @E.I. CV2720
872A	DIO HG #DCG5/5000GB @G.H. #4H72 @J. AH217 @E. #G5B @1. 872A @E.F.I. CV642. CV1449
884	TRI GAS #T666-GT @J. 884 @F.CV647
889A	TRI SIN #3A12Y @E. 889A @G.H.I
889R	TRI SIN #BR12Y @E. 889R @G.H.I. CV2687
892	TRI SIN BW175 @E. ESW892 @E.
892R	TRI SIN BT92R @J. BR175 @E. BR1132 @E. CV904
1000T	TRI SIN #7T40 @J
1257	THY H #TH1257 @F
1500T	TRI SIN #7T45 @J. CV2711
2050	THY XE #1G50 @J. #PL6574 @G.H. CV2565
5544	TRI GAS #XR1-3200 @E. #5G44 @J. #PL5544 @G. 5544 @E.G.H. CV2210
5545	TRI GAS #XR1-6400A @E. #5V5545 @E. #PL5545 @G #6G45 @J. 5545 @E.G.H. CV2215
5550	IGN #BK66 @E. 5550 @G.H.J
5551A	IGN #BK42 @E. #PL5551A @G. 5551A @G.H.J
5552	IGN #BK24 @E. PL5552 @G. 5552 @G.H.J
5553	IGN #BK34 @E. #PL5553 @G.H
5555	IGN #BK46 @E. #PL5555 @G. 5555 @E.G.H.
5557	THY HG #2G57 @J. #XG5-500 @E. #MT17 @E. #PL17 @G.H. #PL5557 @G.H. CV2957
5559	THY HG #XG1-2500 @E. #PL57 @G.H. PL5559 @G.
5563	THY HG #4G63 @J
5671	TRI SIN #8T71R @J
5684	THY XE PL5684 @G.H. CV2753
5696	THY GAS ASG5696 @G. CV3512
5713	TRI SIN BR154 @E
5762	TRI SIN #BR1918 @F. 5762 @E. CV2383
5763	TET SIN #QV03-12 @E. CV2129
5770	TRI SIN #9T21 @J
5796	TRI SIN #XR1-1600 @E. CV3706
•5861	TRI SIN #TD03-10 @E. #DET22 @E. #EC55 @G.H. CV273
5866	TRI SIN #TB2.5/300 @G. #TY2-125 @E. #RS613 @G. #RS1006 @G CV1924
5867	TRI SIN #TB3/750 @G.H. #TY3-250 @E. #RS630 @G. #B1135 @E. 5867 @G. CV1350
5868	TRI SIN #TB4/1250 @G.H. #TY4-500 @E. RS631 @G #RS1016 @G.
5869	TRI SIN DCG6/6000 @G
5870	TRI SIN #DCG12/30 @G
5894	BEA TWN #2B94 @J. #QQE06/40 @G.H. QQV06-40A @E. C178A @E. 5894 @E.G.H. CV2797
5895	TET TWN #QQC04/15 @G.H. 5895 @G.H
5923	TRI SIN #TB#6/6000 @G. #TY6-5000W @E
5924	TRI SIN #TBL6/6000 @G. #TY6-5000A @E. CV3926
5949	THY H #XH25-500 @E. FX229 @E. TH5949 @F. CV3521
6011	TRI SIN #PL6011 @G.H
6017	TRI SIN #TMF6017 @F
6018	TRI SIN #TMF6018 @F
6019	TET SIN #TMF6019 @F
6075	TET SIN #QBWD/3500 @G. #C#1100 @E. 6075 @G.H
6076	TET SIN #ACS4 @E. #QBL5/3500 @G. #QY5-3000A @E #CR1100 @E. 6076 @G.H.I
6077	TRI SIN #TB#12-100 @G. TY12-50A @E
6078	TRI SIN #TBL12/100 @G. #TY12-5 W @E. 6078 @G
6079	TET SIN #QB5/1750 @G.H. #QY5-500 @E. RS687 @G. 6079 @G.H. CV3522
6083	PND SIN #PE1/100 @G. 6083 @G.H
6130	THY H FX227 @E. 6130 @J. CV3629
6146	BEA SIN #QE05/40 @G.H. QB3/300 @G. #QV06-20 @E. 6146 @E.G.H. CV3523
6155	TET SIN #QB3/300 @G. #QY3-125 @E. #RS685 @G. #C1108 @E. 6155 @G.H.I. RS1007 @G. CV2130
6156	TET SIN #QB3.5/750 @G.H. #QY4-250 @E. RS686 @G. RS1002 @G. 6156 @G.H.I. CV2131
6159	BEA SIN #QE05/40H @G.H. 6159 @G.H
6166	TET SIN #CR192 @E. #8F66R @J. 6166 @E
6181	TET SIN #CR1101 @E. 6181 @E
6252	TET TWN #QQE03/20 @G. #QQV03-2 A @E. #TT20 @E. #C1134 @E. 6252 @G.H. CV2799
6263	PEN 6263 @G.H
6264	PEN 6264 @F.G.H
6268	THY H #1G35 @J. #PL435 @G.H. 6268 @G.H
6279	THY H PL522 @G.H 6279 @G.H

Domestic vs. Foreign Power Tubes (Continued)

No.	Type/Similar to or Interchangeable With
6346	IGN #BK42A @E
6347	IGN #BK24A @E
6348	IGN #BK34A @E
6360	TET TWN #QQE03/12 @G.M. #QQV03-10 @E. 6360 @G.M.J. CV2798
6508	DIO HG DQ6 @G.M. #DCG9/20 @G. AH213 @E. 6508 @G.M
6550	PND SIN #KT88 @E. CV5220
6569	TRI SIN #RS630 @G. #PL6559 @G.
*6574	TET GAS #EN32 @E. PL6574 @G. CV2253
6587	THY H #TH6587 @F 6587 @E
6617	TRI SIN #TBW12/25 @G. TY12-25W @E. 6617 @G
6618	TRI SIN #TBL12/25 @G.M. #TY12-25A @E. 6618 @G.M
6693	DIO HG #RG4-3000 @E. DCG6/18 @G. 6693 @G.M
6755	THY GAS PL6755 @G.M
6807	TRI GAS #XR1-6400A @E. 6807 @E
6883	BEA SIN #QE05/40F @G.
*6885	TRI SIN #TH6885 @F
*6886	TRI SIN #TH6886 @F
6939	TET TWN QQE02/5 @G . QQV02-6 @E
6942	TET SIN #TH6942 @F
6960	TRI SIN #TBW7/8000 @G. TY7-6000W @E. 6960 @G
6961	TRI SIN #TBL7/8000 @G. TY7 6000A @E. 6961 @G
7004	TRI SIN #TBL2/300 @G.M. 7004 @G.M
7034	TET SIN QEL1/150 @G. QV1-150A @E. #SV4X150A @E. 4F15R @J. CV2519
7092	TRI SIN #TB5/2500 @G.M. #TY6-800 @E. #RS635 @G. 7092 @G.M
7377	TET TWN #QQE04/5 @G.M. 7377 @G.M
7378	TET SIN QE08/200 @G
7384	THY H #CX1119 @E. 7384 @E. CV5268
7527	TET SIN #QB4/1100 @G. 7527 @G.M
7753	TRI SIN #TBL6/4000 @G.M
7804	TRI SIN #TBL6/14 @G.M. 7804 @G.M
7805	TRI SIN #TBW6/14 @G.M. 7805 @G.M
7806	TRI SIN #TBL12/38 @G.M. 7806 @G.M
7807	TRI SIN #TBW12/38 @G.. 7807 @G.M
7873	TRI SIN BW137 @E.I. 7873 @I
7875	TET SIN KT67 @E.I. 7875 @I
7875A	TET SIN KT678 @I
7876	PND SIN 5J180E @E.I. 7876 @I. CV445
7877	THY HG TG1 @I
7880	TET SIN F400 @I
7881	TRI SIN ACT9A @I
7883	TRI SIN BR169C @I
7885	TRI SIN BW199 @I
7886	TRI SIN DET3 @I
7915	TRI SIN T450S @I
•7974	TRI SIN #16P12 @E. 7974 @E
•7981	TRI GAS #XR1-3200A @E. 7981 @E
8008	DIO HG #4H88 @J. 8008 @G.M. DCG5/5000SG @G
8012A	TRI SIN #2T25 @J
8020	DIO SIN #RY12-100 @E. #V40 @F. 8020 @G.M.F. CV2567
•8063	TRI GAS #XR1-1600A @E. 8063 @E
•8078	TRI SIN #14D12 @E. 8078 @E

Foreign vs. Domestic Power Tubes

No.	Type/Similar to or Interchangeable With
QQE02/5	TET TWN 6939
QQE03/20	TET TWN #6252
QQE03/12	TET TWN #6360
QQV03-10	TET TWN #6360
QV03-12	TET SIN #5763
QQV03-20A	TET TWN 6252
TD03-10	TRI SIN #5861
PE04/10E	PND SIN #837
QQC04/15	TET TWN #5895
QQE04/5	TET TWN #7377
QQE04/20	BEA TWN #832A
QQV04/15	BEA TWN #832A
QE05/40	BEA SIN #6146
QE05/40F	BEA SIN #6883
QE05/40H	BEA SIN #6159
QV05-25	BEA SIN #807
QE06/50	BEA SIN #807
QQE06/40	BEA TWN #829B. #5894
QQV06-40A	BEA TWN #5894
QV06-20	TET SIN 6146
QQV07-40	BEA TWN #829B
QE08/200	TET SIN #7378
PE1/100	PND SIN #6083
QEL1/150	TET SIN #4X150A. 7034
QV1-150A	TET SIN #4X150A. 7034
TB1/60G	TRI SIN 834
TD1-100A	TRI SIN #2C39A
TG1	THY HG 7877 @I
XG1-2500	THY HG 5559
XR1-1600A	TRI GAS #8063. #5796
XR1-3200	TRI GAS #5544. #7981
XR1-6400A	TRI GAS #6807. 5545
1G35	THY H 626B
1G35P	THY H 4C35
1G45P	THY H #3C45
1G50	THY XE #2050
1M16	DIO HG #816
GXU2	DIO XE 4B32
P2-40B	BEA TWN #829B
QY2-100	BEA SIN #813
QB2/250	BEA SIN #813
SV2C39A	TRI SIN #2C39A
TBL2/300	TRI SIN #7004
TY2-125	TRI SIN #5866
2B94	BEA TWN #5894
2G57	THY HG 5557
2G/402A	DIO XE 3B28
2G/4728	DIO XE 4B32
2H28	DIO XE #3B28
2H66	DIO HG #866A
2T24	TRI SIN #3C24
2T25	TRI SIN #8012A
2T26	TRI SIN #826
TB2.5/300	TRI SIN #5866
DET3	TRI SIN 7886
QB3/200	TET SIN #4-65A
QB3/300	TET SIN 4D21. 6146. #6156
QB3/300GA	TET SIN 4-125A
QB3.5/750	TET SIN #5D22. 4-250A. 6156
QY-3-125	TET SIN #4D21. #4-125A. #6156
RG3-250A	DIO HG #866A
RR3-250	DIO XE #3B28
RR3/1250	DIO XE #4B32
TB3/350	TRI SIN #100TH
TB3/750	TRI SIN #5867
TH3B24W	DIO SIN #3B24W
TY3-250	TRI SIN #5867
XH3-045	THY SIN #3C45
3C200	TRI SIN 250TH
3F65	TET SIN #4-65A
3G15	THY GAS #C1A
3G94	THY HG #394A
3H/151J	TRI SIN 2C39A
ACS4	TET SIN #6076
AX4-250A	TET SIN #4-250A
DCG4/1000G	DIO HG #866A. 816
DCX4/1000	DIO XE #3B28
DCX4/5000	DIO XE 4B32
DQ-4	DIO HG #869B
PL4C35	THY XE #4C35
PL4D21	TET SIN #4D21
PL4-400A	TET SIN #4-400A
QB4/1100	TET SIN #7527
QBL4/800	TET SIN #4X500A
QY4-65	TET SIN #4-65A
QY4-250	TET SIN #4-250A. #5D22. #6156
QY4-500A	TET SIN 4X500A
RG4-3000	DIO HG #6693
SV4X150A	TET SIN #4X150A
SV4-150A	TET SIN #4-150A
TB4/800	TRI SIN #250TH
TB4/1250	TRI SIN 5868
TY4-350	TRI SIN #833A
TY4-500	TRI SIN #5868
4B13	BEA SIN #813
4F15R	TET SIN #4X150A
4F21	TET SIN #4-125A
4G63	THY HG #5563
4G93	THY AHG #393A
4H32	DIO XE #4B32
4H72	DIO HG #872A
4H73	DIO HG #673
4H88	DIO HG #8008
4T16	TRI SIN #100TL
4T17	TRI SIN #100TH
4Y25N	BEA SIN 807
DCG5/5000GB	DIO HG #872A
G5B	DIO HG #872A
PL5C22	THY H #5C22
QB5/1750	TET SIN #6079
QBL5/3500	TET SIN #6076
QBW5/3500	TET SIN #6075
QY5-500	TET SIN #6079
QY5-3000A	TET SIN #6076
QY5-3000W	TET SIN #6075
TB5/2500	TRI SIN #7092
TH5C22	THY H #5C22
XG5-10	DIO SIN #6786
XG5-500	THY HG 5557
5F22A	TET SIN #4-250A
5F23A	TET SIN #4-400A
5G24	TRI GAS 5544
5G44	TRI GAS #5544
5H69A	DIO HG #869B
5J180E	PND SIN 7876
5T20	TRI SIN #250TL
5T21	TRI SIN #250TH
5T30	TRI SIN #450TL
5T31	TRI SIN #450TH
5T33	TRI SIN 833A
DCG6/18	DIO HG #6693
DCG6/6000	TRI SIN 5869
DQ6	DIO HG 6508
TBL6/14	TRI SIN #7804
TBL6/4000	TRI SIN #7753
TBL6/6000	TRI SIN #5924
TBW6/14	TRI SIN #7805
TBW6/6000	TRI SIN #5923
TY6-800	TRI SIN 7092
TY6-5000A	TRI SIN #5924
TY6-5000W	TRI SIN #5923
6F50R	TET SIN #4X500A
6G45	TRI SIN 5545
DCG7/100	DIO HG 8578
TBL7/8000	TRI SIN #6961
TBW7/8000	TRI SIN #6960
TY7-6000A	TRI SIN 6961
TY7-6000W	TRI SIN 6960
7F25	TET SIN #4-1000A
7H57	DIO HG #857B
7T40	TRI SIN #1000T
7T45	TRI SIN #150CT
XH8-100	THY H 4C35
8F66R	TET SIN #6166
8T21	TRI SIN #9C21
8T21R	TRI SIN #9C22

As part of the function of the Electron Devices Data Service of the National Bureau of Standards, these tables were prepared as a service to the engineers, procurement and service personnel engaged in the field of electronics. All information was taken from manufacturer's published specifications and every effort has been made to assure accuracy and completion. However, the Bureou cannot assume responsibility for omissions nor for results obtained with these data.

Foreign vs. Domestic Power Tubes (Continued)

No.	Type/Similar to or Interchangeable With
8T71R	TRI SIN #5671
8T92R	TRI SIN 892R
ACT9A	TRI SIN 7881
DCG9/20	DIO HG #6508, 8698
9T21	TRI SIN #5770
DCG12/30	TRI SIN #5870
GU12	DIO HG 866A
RY12-100	DIO SIN #8020
TBL12/25	TRI SIN #6618
TBL12/38	TRI SIN #7806
TBL12/100	TRI SIN #6078
TBW12/38	TRI SIN #7807
TBW12/100	TRI SIN #6077
TY12-25A	TRI SIN #6618
TY12-25W	TRI SIN #6617
TY12-50A	TRI SIN #6077
TY12-50W	TRI SIN #6078
14D12	TRI SIN #8078
TY-16G	THY A 885
XH16-200	THY H #5C22
16P12	TRI SIN #7974
MT17	THY HG 5557
PL17	THY HG #5557
GU-20/21	DIO XE 4B32
QV20-P1B	TET SIN #4PR60A
TT20	TET TWN 6252
DET22	TRI SIN #5861
BK24	IGN #5552A
BK24A	IGN 6347
XH25-500	THY H #5949
EN32	TET GAS 6574
BK34	IGN #5553
BK34A	IGN 6348
G40	DIO HG #8698
V40	DIO SIN #8020
BK42	IGN #5551A
BK42A	IGN 6346
BK46	IGN 5555
EC55	TRI SIN #5861
PL57	THY HG #5559
BK66	IGN #5550
T66G-GT	TRI GAS #884
KT67	TET SIN 7875
KT67B	TET SIN 7875A
KT88	PND SIN 6550
G100A	DIO HG #8578
TH100TH	TRI SIN #100TH
BR129	TRI SIN #889R
BW129	TRI SIN #889A
BR137B	TRI SIN 9C22
BW137	TRI SIN 7873
BW137C	TRI SIN #9C21
CR139	BEA SIN #827R
B142	TRI SIN #833A
C143	BEA SIN #813
C144	BEA TWN #829B
BR154	TRI SIN 5713
BR169C	TRI SIN 7883
PL174	THY H 6587
BR175	TRI SIN 892R
BW175	TRI SIN 892
C178A	BEA TWN #5894
C180	BEA TWN #832A
BR191B	TRI SIN #5762
CR192	TET SIN #6166
AFX203	THY GAS C1A
AH205	DIO HG #8578
AFX212	THY GAS #6D4
AH213	DIO HG #8698, 6502
AH217	DIO HG #872A
FX219	THY H #5C22, HT415
AX224	DIO XE #3B28
FX225	THY H 4C35
FX227	THY H 3C45, #6140
FX229	THY H 5949
AX230	DIO XE #4B32
FX231	THY H #KU25
A239	DIO SIN #3B24W
TH250TH	TRI SIN #250TH
PL345	THY H #3C45
F400	TET SIN 7880 #1
PL435	THY H #4C35, 6268
T450S	TRI SIN 7915
PL522	THY H #5C22
TC-552-R	TRI SIN #834
RS613	TRI SIN #5866
RS630	TRI SIN #5867, 6569
RS631	TRI SIN #5868
RS635	TRI SIN 7092
RS685	TET SIN #4D21, #4-125A, 6155
RS686	TET SIN #5D22, #4-250A, 6156
RS687	TET SIN #6079
P807	BEA SIN #807
UY807	BEA SIN #807
SV813	BEA SIN #813
SV829	BEA SIN #829
TH833A	TRI SIN #833A
ESW892	TRI SIN #892
RS1002	TET SIN 4-250A, 6156
RS1006	TRI SIN #5866
RS1007	TET SIN #6155
RS1016	TRI SIN #5868
CR1100	TET SIN #6076
CW1100	TET SIN #6075
CR1101	TET SIN #6181
C1108	TET SIN 4-125A, #6155
B1109	TRI SIN #3C24
C1111	TET SIN 4PR60A
C1112	TET SIN 4-250A, 5722
CX1113	THY GAS 3D22
CX1119	THY H #7384
C1123	BEA SIN #4D32
BR1132	TRI SIN 892R
C1133	TET SIN 4PR60A
C1134	TET TWN #6252
B1135	TRI SIN #5867
C1136	BEA SIN 4-400A
TV1250A	TRI SIN 6077
TH1257	THY H #1257
A2674	TET SIN 4-65A
PL5544	TRI GAS #5544
PL5545	TRI GAS #5545
SV5545	TRI GAS #5545
PL5551A	IGN #5551A
PL5552A	IGN #5552A
PL5553A	IGN #5553A
PL5555	IGN #5555
PL5557	THY HG #5557
PL5822	IGN #5822
PL5559	THY HG #5559
PL5684	THY XE #5684
TH5949	THY H #5949
PL6011	TRI SIN #6011
THF6017	TRI SIN #6017
THF6018	TRI SIN #6018
THF6019	TET SIN #6019
PL6574	TET GAS 6574
TH6587	THY H #6587
PL6755	THY HG 6755
TH6885	TRI SIN #6885
TH6886	TRI SIN #6886
TH6942	TET SIN #6942

No.	Type/Similar to or Interchangeable With
CV26	BEA SIN 813
CV32	DIO HG 866A
CV124	BEA SIN 807
CV273	TRI SIN 5861
CV445	TET SIN 7876
CV372	THY H 3C45
CV630	TRI SIN 826
CV631	BEA SIN 828
CV635	TRI SIN 833A
CV637	PND SIN 837
CV642	DIO HG 872A
CV647	TRI GAS 884
CV788	BEA TWN 832B
CV789	TRI SIN 3C24
CV904	TRI SIN 892R
CV1350	TRI SIN 5867
CV1449	DIO HG 872A
CV1787	THY H 4C35
CV1835	DIO XE 3B28
CV1905	TET SIN 4-65A
CV1924	TRI SIN 5866
CV1927	TRI SIN 833A
CV1949	THY GAS #6D4
CV2129	TET SIN 5763
CV2130	TET SIN 4-125A, 6155, 4D21
CV2131	TET SIN 4-250A, 6156, 5D22
CV2210	TRI GAS 5544
CV2215	TRI GAS 5545
CV2253	TET GAS 6574
CV2383	TRI SIN 5762
CV2516	TRI SIN 2C39A
CV2518	DIO XE 4B32
CV2519	TET SIN 4X150A
CV2520	THY H 5C22
CV2552	TRI SIN 100TH
CV2565	THY XE 2050
CV2572	TRI SIN 450TH
CV2587	TRI SIN 250TH
CV2629	THY H 3C45
CV2638	THY AHG 393A
CV2639	THY AHG 394A
CV2666	BEA TWN 829B
CV2673	DIO HG 8578
CV2687	TRI SIN 889R
CV2711	TRI SIN 1500T
CV2720	DIO HG 8698
CV2736	TRI SIN 3C24
CV2753	THY XE 5684
CV2797	BEA TWN 5894
CV2798	TET TWN 6360
CV2799	TET TWN 6252
CV2861	THY GAS 3D22
CV2858	DIO SIN 3B24W
CV2868	THY GAS C1A
CV2957	THY HG 5557
CV2967	DIO SIN 8020
CV2993	THY H KU25
CV3512	THY GAS 5696
CV3521	THY H 5949
CV3522	TET SIN 6079
CV3523	BEA SIN 6146
CV3540	THY H 5C22
CV3543	BEA SIN 4D32
CV3629	THY H 6130
CV3706	TRI SIN 5795
CV3926	TRI SIN 5924
CV5268	THY H 7384

New Tech Data for Engineers

Transistor Data

A Designers Data Sheet with a different concept of specifying transistor characteristics, is being introduced with the high-frequency switching transistor, type 2N964A. The Designers Data Sheet gives a complete set of limit curves covering essential design parameters needed for worst-case design. The sheet is accompanied by an application report illustrating the use of the specified data in a typical worst-case design problem involving an RCTL inverter circuit. Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 150 on Inquiry Card

Epoxy Dermatitis

Ply No. 9 Gel, a aqueous dispersion of a plasticized film-forming polymer, is designed to prevent severe skin irritation or dermatitis sometimes developed by workers handling epoxy resins. More information is available from the Milburn Co., 3246 E. Woodbridge, Detroit 7, Mich.

Circle 151 on Inquiry Card

Resolver Catalog

More than 40 units are presented, including control transmitters, control transformers, control differential transformers, transolvers, winding compensated resolvers, and Kearfott equivalents to Bu/Ord components. Resolvers range from Size 5 to Size 28, and have accuracies down to 20 sec. max. error from electrical zero. Information is included on both 60 and 400CPS types. Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.

Circle 152 on Inquiry Card

Germanium Diodes

This 4-page, illustrated booklet describes a line of high-reliability Germanium Gold Bonded Diodes for government and industrial markets. Included are characteristics and physical specs. for approximately 150 subminiature glass diodes, including computer types, high reverse resistance types, and high forward conductance types. Bulletin A-101 available from National Transistor Mfg., Inc., 500 Broadway, Lawrence, Mass.

Circle 153 on Inquiry Card

Synchro Bridge Analysis

"An Analysis of Synchro and Resolver Bridges," 16 pages, is available from Gertsch Products, Inc., 3211 S. LaCienega Blvd., Los Angeles, Calif. The text gives details on the operation of high-accuracy synchros and resolvers used in data-transmission servo systems. Compensated and uncompensated instruments are covered. Included are bridge angle charts and equivalent angular error charts, equations for calculating errors—impedance unbalance and tap ratio deviations.

Circle 154 on Inquiry Card

LC Filters

This 12-page, 2-color, catalog gives frequency response curves, prices and complete specs. on 254 standard LC filters. The data covers telemetering, power, interstage and line, telegraph transmitting and receiving filters for use from 5CPS to 500KC. Bulletin 78 also includes photographs, applications data and characteristic charts. Polyphase Instrument Co., E. Fourth St., Bridgeport, Pa.

Circle 155 on Inquiry Card

Heat Sinks

Tech data is available in the thermal characteristics of low and medium power transistors. Information is included on internal heat flow paths, the purpose of heat sinks or dissipators, methods of contact between the transistor and heat sink, and performance data of the Thermalloy "positive contact" heat sink. Thermalloy Co., 4417 N. Central Expressway, Dallas 5, Tex.

Circle 156 on Inquiry Card

Waveguide Bends

This 43-page, multi-colored catalog includes information on the theory of rectangular waveguide bends and the styles available. Information is included on bends in the WR 28-WR 62 band, both E- and H-plane bends; WR 5-WR 112 band; WR 137-WR 284 band; and WR 430-WR 650 band. All of these in both E- and H-plane bends. Also included is a cross reference; a section on applications; and information on how to order. Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick Industrial Center, Natick, Mass.

Circle 157 on Inquiry Card

Quartz Crystal Brochure

"How to Specify Frequency Control Quartz Crystals," 6 pages; includes freq. vs temp. curves for many types of crystal cuts in freq. ranges from 800CPS to 120MC; inductance and capacitance ratios for most types of low freq. filter and oscillator designs; and types of crystals for extreme environments and missile uses. Monitor Products Co., Inc., 815 Fremont Ave., S. Pasadena, Calif.

Circle 158 on Inquiry Card

Connectors

A detailed, 16-page, 3-color catalog on "Reli-Acon" connectors is subdivided into broad headings of card receptacles, card plugs and patch cords. Included are descriptions, dimensions, photographs of the products plus schematics of each item, and a listing of its physical characteristics. Some of the items covered include terminal blocks, patch cords for programming system connectors, taper tab card receptacles, and card receptacles for programmed automatic machine wiring. Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago, Ill.

Circle 159 on Inquiry Card

Logic Components

Micrologic elements are described in a 12-page full-color brochure available from Fairchild Semiconductor, 545 Whisman Rd., Mountain View, Calif. The brochure describes the manufacture of a typical micrologic element from silicon crystal growing through to final test. Micrologic elements include a flip-flop, gate buffer, half-shift register, half-adder and counter adapter.

Circle 160 on Inquiry Card

Saturable Core Reactors

"Saturable Core Reactors for Proportional Control of AC Power" is available from Instrument Systems Corp., 129-07 18th Ave., College Point 56, L. I., N. Y. Bulletin No. C-30011 points out design advantages of: high power gain; variable load capacity; automatic current limiting; constant current regulation; no transformer action; and reduced size and investment.

Circle 161 on Inquiry Card

Gallium Compounds

"Gallium and Gallium Compounds", 10 pages, 2 colors, provides a comprehensive outline of basic information concerning this element. The publication describes properties, uses (primarily in semiconductor manufacture), potential applications, technical service, and available types. Alcoa Chemicals Div., 645 Alcoa Bldg., Pittsburgh 19, Pa.

Circle 162 on Inquiry Card

Selector Switches

Tech Data No. 182B, 4 pages, contains supplementary engineering data on CTS' line of 1⅛ in. dia. compact molded selector switches. Technical details include information on rotor contacts, stator contacts and terminals, voltage and current ratings, torque requirements, military applications, materials and finishes. CTS Corp., Elkhart, Ind.

Circle 163 on Inquiry Card

Power Supply Catalog

"1962 Power Supply Catalog", 32 pages, 3 colors, contains information on approximately 500 models of power supplies, voltage regulators, frequency changers, high voltage testers, inverters and converters. Information is also included on transistorized power supplies, variable output dc supplies, miniature component-type transistorized dc supplies, high voltage dc supplies to 150kv and tubeless ac line voltage regulators. Eight pages of background information on definitions and characteristic terms and interpretive data on parameters used to specify controlled power equipment is included. Sorensen Products, Raytheon Co., Richards Ave., South Norwalk, Conn.

Circle 164 on Inquiry Card

Cinch ELECTRONIC COMPONENTS

CONNECTORS, ENGINEERED FOR SPECIFIC RELIABILITY REQUIREMENTS

New Monoblock construction—One-piece insulator eliminates moisture traps . . . prevents possible shorting and contact deterioration.

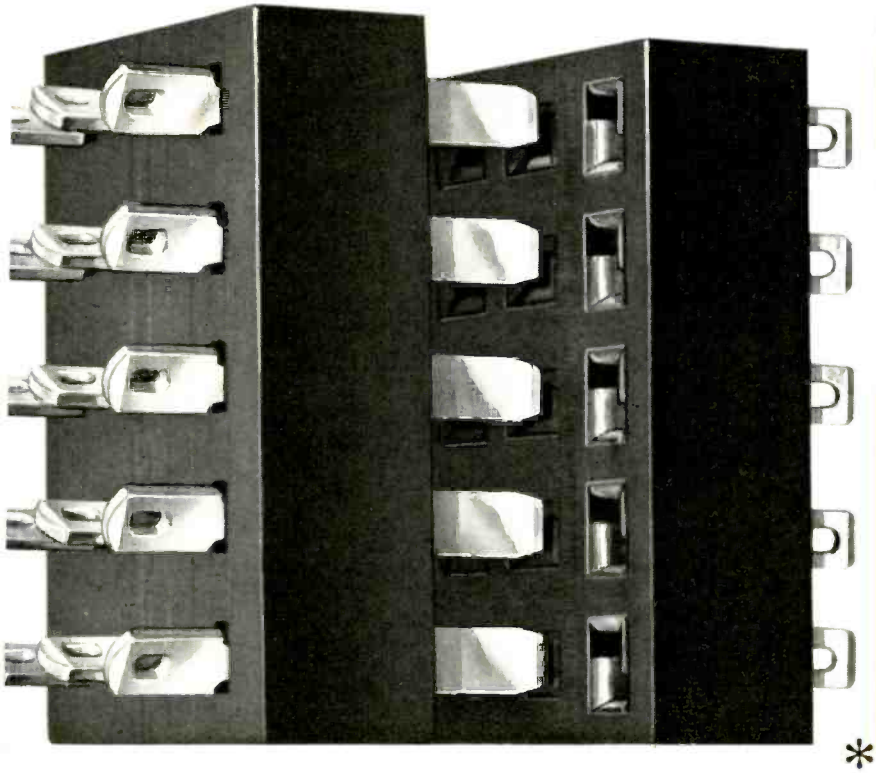
New snap-in socket contacts—Permits external prewiring. Allows you to remove and replace individual contacts if necessary.

New locking feature of socket contacts and insulator—Insures positive orientation of contacts with mating terminals under wiring stress.

New "300" Series plugs and sockets and hardware are interchangeable with all standard "300" Series—The widest line in the industry!

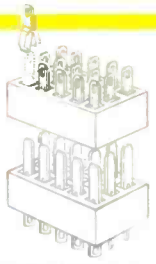
New "300" Series are available now at no increase in price—This complete new line is covered by **U. S. Patent Nos. 2,688,123 and 2,980,881.**

For further information contact your Cinch representative or local Cinch-Jones distributor or call direct.

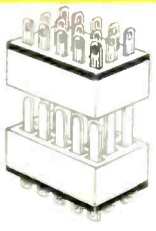


announcing NEW JONES MONOBLOCK "300" SERIES* PLUGS & SOCKETS

...WITH EXTRA RELIABILITY BUILT IN!



NEW "300" SERIES plugs and sockets showing Monoblock insulators and new snap-in socket contacts.



STANDARD "300" SERIES showing two-piece insulator construction.

*For Medium-Duty Applications

Circle 83 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

New Tech Data for Engineers

Solar Heat

"Solar Heat Simulation," 6 pages, discusses problems encountered in simulating the heating effects of solar radiation on satellites and other space vehicles. Typical space-environment chambers and infrared heat sources are described with emphasis on the use of programmed controls in reproducing flight path conditions. Research Inc., Box 6164, Minneapolis 24, Minn.

Circle 165 on Inquiry Card

Marking Ink

Bulletin #1/16/62, 5 pages, describes in detail the properties and application of Wornowink, a permanent marking type ink for the electronic industry. Wornow Process Paint Co., 1218 Long Beach Ave., Los Angeles 21, Calif.

Circle 166 on Inquiry Card

Voltmeter Applications

A fully illustrated 12-page brochure giving detailed engineering notes on the applications of the Boonton 91 Series R-F Voltmeters is available from Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N. J. Applications are described under the 4 general classifications of transistor testing, VSWR or return loss, gain and loss measurements, and peak and null detector.

Circle 167 on Inquiry Card

New Products

Boeing Associated Products. The Boeing Co., Seattle 24, Wash., is offering a 17-page brochure on "New Products—New Processes Inventory." Some of the products covered include a 3-dimensional Function Generator, Compact VHF-UHF Slotted Line, Blast Fence, Mechanical Instrument Damper, Creep Tester, Manual Punch Card Reader, Lead Tinning Device, and Dynamic Foot Seal. Included are photographs, and descriptions.

Circle 168 on Inquiry Card

Multiplex System

The B121R Radio Multiplex System permits the adding of up to 62 carrier-derived voice freq. channels on point-to-point microwave radio systems. This product bulletin is available from Lynch Communication Systems Inc., 695 Bryant St., San Francisco 7, Calif.

Circle 169 on Inquiry Card

Continuous-Line Diffusers

Form 10622, a Comprehensive Selection Guide, covers Barber-Colman Co.'s line of continuous-line diffusers. Information includes installation dimensions, accessories, and various types of cores available for each. Barber-Colman Co., 1300 Rock St., Rockford, Ill.

Circle 170 on Inquiry Card

Silicone Varnishes

"Silicone Varnishes for Dipping, Impregnating," 6 pages, 2-colors, is a selection guide to 6 different impregnating materials. The brochure describes 4 varnishes for use at AIEE Classes 180 and 220°C and 2 for use at temps. below Class H. Brochure 07-009 available from Dow Corning Corp. Midland, Mich.

Circle 171 on Inquiry Card

Tantalum Capacitors

A wide range of solid electrolytic tantalum capacitors in both insulated and uninsulated types is described in a catalog available from Electric Mfg. Co., 800 N. 21st St., Independence, Kans. Capacitors equivalent to Mil-C-26655A are listed. This 8-page pamphlet is entitled "Tantalum Topics."

Circle 172 on Inquiry Card

Rotating Joints

Tech data, 4 pages, 2 colors, covering a line of ultramicrowave and microwave waveguide broadband rotating joints, is available from De-Mornay-Bonardi Corp., 780 S. Arroyo Pkwy, Pasadena, Calif. Included are specs, typical applications, dimensional charts and drawings.

Circle 173 on Inquiry Card

SCR

VecTrol Engineering Technical Paper No. VTP-1 entitled "The Silicon Controlled Rectifier and Proportional Power Control" is available from VecTrol Engineering, Inc., 85 Magee Ave., Stamford, Conn. Included in the 21-page manual are formulas, characteristic curves, schematics, and drawings.

Circle 174 on Inquiry Card

Microwave Capabilities

A 20-page brochure describing the plant, facilities and capabilities of American Electronic Laboratories, Inc., Colman, Pa. is available. Information on countermeasures, surveillance, electronic warfare and other microwave components and systems is included.

Circle 175 on Inquiry Card

Thermocouples

The results of over 2 years of developing, testing and applying 2 ultra high temp. refractory meter thermocouple combinations (unalloyed tungsten vs. tungsten-26% rhenium and tungsten-5% rhenium vs. tungsten-26% rhenium) are published in detailed technical report available from Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich. Information includes a comparison of physical properties, established temp.-millivolt equivalent tables covering the range from 0° to 4200°F (2320°C), and a description of calibration procedures.

Circle 176 on Inquiry Card

Calorimeter Set

Hy-Cal Engineering, 12105 Los Nietos Rd., Santa Fe Springs, Calif., is offering tech. data on their C-1300K Water Cooled Asymptotic™ Calorimeter Set (5 calorimeters of different values). Information includes photograph, dimensional drawing, millivolt output curve, and specs.

Circle 177 on Inquiry Card

Motion Compensators

A 4-page, 2-color product bulletin describing "Compen-Theta" precision angular motion compensators is available from American Aerospace Controls, Inc., a sub. of Univis, Inc., 123 Milbar Blvd., Farmingdale, N. Y. Photographs, charts, outline drawings and complete specs. are included on the Compen-Theta Models AAC-100 and AAC-200.

Circle 178 on Inquiry Card

Torque Valves

Delevan Electronics Corp., 77 Olean Rd., East Aurora, N. Y., is offering an engineering report entitled, "Evaluation of Various Deleform Torque Values Under High Frequency Vibration Conditions." The object of the investigation was to determine the effects of a range of Deleform torque settings, on their variable inductors, under conditions of high freq. vibration per MIL-STD 202B, Method 204A, Test Condition B.

Circle 179 on Inquiry Card

Gyro Spin Rotors

A 16-page brochure on precision mechanisms and subassemblies for guidance and control, electro-optical, computer, and electronic systems is available from The Barden Corp., 200 Park Ave., Danbury, Conn. The brochure highlights the Barden Research Precision Mechanisms Div.'s activities in the areas of gyro spin rotors and motors, inertial gyro ball bearings and cartridges, gas bearing cartridges, friction canceling ball bearings, and miniature slow speed motors. Also included is information on their R&D programs on friction, wear, high temp. and space environments, relating to rotating devices.

Circle 180 on Inquiry Card

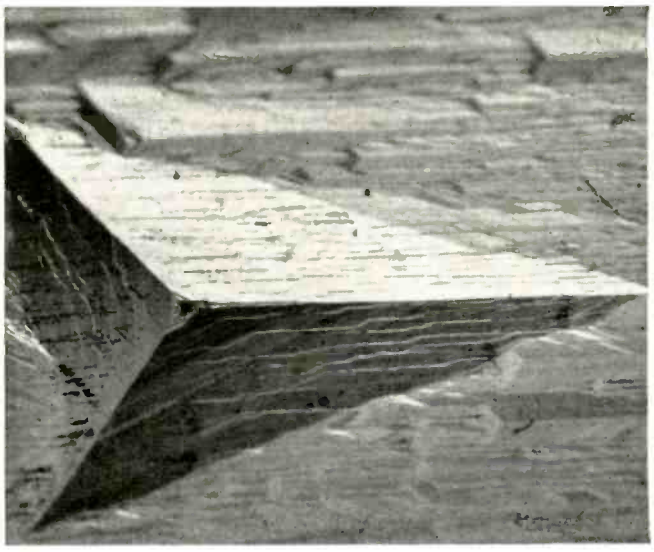
Vacuum Calculator

Determine the pumping capacity needed to evacuate a given volume to a specified pressure level in a given time, or the time required to reach the desired vacuum in a given volume with a pump whose capacity is known, is easily done with the Stokes Vacuum Calculator. The calculator is a form of a slide-rule for many quick computations in vacuum processing work. F. J. Stokes Corp., 5500 Tabor Rd., Phila. 20, Pa.

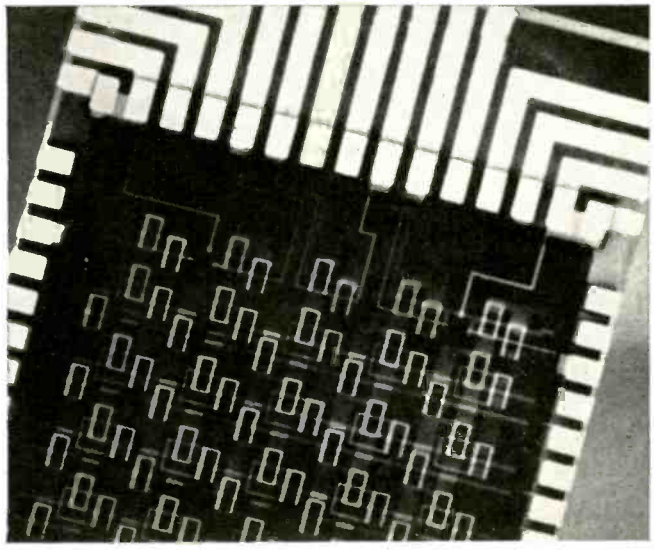
Circle 181 on Inquiry Card

IBM asks basic questions in components

How can we make invisible parts?



In this high-vacuum vapor-deposition process (enlarged 11x), the film material is nucleating in a fine-grained structure upon a coated glass base.



This thin-film memory cell, consisting of 135 cryotrons built up in a 19-layer "sandwich," combines storage with elementary logic operation.

Science and engineering are speeding up computer logic. And improving reliability. *And* maintaining economy. IBM engineers are studying new kinds of components: devices like tunnel diodes and thin films which may switch within a fraction of a nanosecond, and microscopic solid-state circuits which can cut transmission time by reducing the distance electrical signals must travel. But switching speed is only one aspect of components development. Before these minute new devices can be put to use, automatic manufacturing techniques must be found to make them highly reliable and economical.

In manufacturing solid-state components, the quantities of material involved are so small that it is extremely difficult to manipulate them. During deposition, it is necessary to precisely control geometry, purity, and other physical properties which determine electrical characteristics. For example, in the manufacture of thin-film cryotrons, residual gases tend to contaminate metal surfaces freshly deposited upon a substrate. In addition, tapered gradients develop at the edges of the microscopically thin film, destroying its uniform thickness.

To solve these problems in the production of a 19-layer cryogenic memory plane, IBM engineers evaporated metals and insulators at a very high rate onto a heated substrate in a vacuum of 10^{-7} millimeters of mercury. Heating the substrate assisted in the nucleation process to produce sharply defined edges. Once the 17 perforated deposition masks were aligned properly, this process was able to duplicate cryogenic memory planes automatically.

Precision masks play an important role in the production of other components beside cryotrons. IBM's ability to make masks quickly and economically has made it possible to experiment extensively with new device geometries. By diffusing both P- and N-type impurities into germanium through masks of silicon monoxide, IBM engineers have produced an all-diffused ultrahigh-frequency mesa transistor (and a process for manufacturing it efficiently). They have also perfected a masking technique for making silicon devices with different geometries. IBM scientists in other areas are searching for better ways to make magnetic cores, recording heads, and photoconductors. Out of their work may come the components which will set speed records on tomorrow's computers.

If you have been searching for an opportunity to make important contributions in components, software development, manufacturing research, optics, machine organization or any of the other fields in which IBM scientists and engineers are finding answers to basic questions, please contact us. Manager of Professional Employment, IBM Corporation, Dept. 557T, 590 Madison Avenue, New York 22, New York. IBM is an Equal Opportunity Employer.

New Tech Data for Engineers

Solid State Amplifiers

Detailed information on fully transistorized amplifiers is contained in a new brochure "Solid State Amplifiers" available from Quan-Tech Laboratories, Inc., Boonton, N. J. Complete specs., photographs and outline drawings are included. Information on the design of special transistorized amplifiers is given, as is a listing of accessory adaptor plugs.

Circle 182 on Inquiry Card

Waveguide Bulletin

This bulletin describes a line of 3- and-4 sided, solenoid-driven single-pole double-throw, waveguide switches. The switches feature low VSWR, insertion loss, and a max. body width of 1.865 in. (X-band model). Waveguide, Inc., 851 W. 18th St., Costa Mesa, Calif.

Circle 183 on Inquiry Card

Computer Diodes

This 4-page, 2-color catalog entitled "Subminiature and Microminiature Diodes" includes a listing of a new line of planar epitaxial silicon diodes for ultra-fast switching low capacitance applications. Units are available with 2nsec. switching speeds and with forward conductance levels from 10 to 200 ma. Microwave Associates, Inc., South Ave., Burlington, Mass.

Circle 184 on Inquiry Card

Magnetic Memory Drums

Digital Development Corp., 7541 Eads Ave., La Jolla, Calif. is offering a useful design chart for memory systems using Magnetic Memory Drums. Surface speeds of various diameter drums at common rotational speeds; bits per track at representative logic freqs. up to 350KC; and bit density per inch vs. bits per track per revolution of different diameter drums are given in convenient empirical chart form.

Circle 185 on Inquiry Card

Magnetic Metals

"High Q Reactors for Low Frequencies," 24 pages, 2 colors, is presented to develop simple methods of designing and predicting the performances of F-lamination constructed high Q reactors using nickel alloy materials for low-audio and sub-audio freq. use. The booklet covers: choice of lamination shape, basic design calculations, design permeability, Q calculations, optimum Q curves, and reactor design for optimum Q. Magnetic Metals Co., Hayes Ave. at 21st St., Camden 1, N. J.

Circle 186 on Inquiry Card

Quartz Crystals

Five 2-color, catalog-type folders give typical examples and some technical information on quartz crystals, freq. sources, voltage-controlled oscillators, miniaturized low-freq. crystal filters, and L-C filters. Hill Electronics, Inc., Mechanicsburg, Pa.

Circle 187 on Inquiry Card

Film Resistors

"The Story Behind the Corning C Resistor" describes a new series of metal oxide film resistors that tie high performance to low cost. The brochure includes information on low noise characteristics and electrical properties of the units. The booklet is available upon request under company letterhead. Corning Electronic Components, Corning Glass Works, Bradford, Pa.

Capacitors

Tech. Bulletin 1-62 is a study report on the stability of Type SS standard capacitors. Type SS is a plug-in precision unit with ranges from 0.0001 to 1μf and nominal tolerance of ±0.1% to +0.5pf. Arco Electronics, Inc., Community Driver, Great Neck, N. Y.

Circle 189 on Inquiry Card

Toggle Switches

A new series of Panel Sealed Toggle Switches and a new Hermetically Sealed unit, which meet applicable requirements of Mil-S-3950, are described and illustrated in a bulletin available from Electrospace Corp., 12 Morris Ave., Glen Cove, L. I., N. Y. They have electrical ratings of 10a at 125vac, or 30vdc. Bulletin No. 5400.

Circle 190 on Inquiry Card

Test Instruments

Specs. and application data on Industrial Instruments Inc. electrical/-electronic test, measuring and control equipment are contained a 48-page 2-color, catalog, Form #21689 D. The equipment is arranged by field category. Products include dielectric breakdown testers, arc-resistance testers, megohmeters, resistor standards, decade attenuators, Wheatstone bridges and voltage breakdown testers. Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, Essex Co., N. J.

Circle 191 on Inquiry Card

Cable Capabilities

Dynamic Cable Systems Co., 8421 Telfair Ave., Sun Valley, Calif., is offering a brochure listing their capabilities in the manufacture and installation of multi-conductor electronic harness and cable assemblies, for aerospace and industrial use. Included are photographs and drawings of the company's products.

Circle 192 on Inquiry Card

Insulating Parchment

Bulletin #105 discusses the physical characteristics and performance capabilities of Patapar Brand Insulating Parchment, an insulating material for dry-type electric transformer coils. Paterson Parchment Paper Co., Bristol, Pa.

Circle 193 on Inquiry Card

Hermetic Seals

Tech data is available on hermetic seals between metal inserts integrally molded in Havelex glass bonded mica components. Information is included on Havelex to metal hermetic seals, Havelex to metal hermetic terminals, and Havalex to metal hermetic components. Haveg Industries, Inc. Taunton Div., 336 Weir St., Taunton, Mass.

Circle 194 on Inquiry Card

Mesa Transistors

National Semiconductor Corp., Danbury, Conn., is offering tech data, 6 pages, 2 colors, on NPN Silicon Diffused Mesa Transistors which feature low noise, high gain, and low leakage currents. Electrical data includes: Total device dissipation at 25°C, 500mw; operating and storage temp. —65° to 200°C; and collector is in electrical contact with the case.

Circle 195 on Inquiry Card

Metal Film Resistors

Engineering Brochure #362, available from Daven Div. of General Mills, Inc., Livingston, N. J., contains information of Daven's DA line of precision metal film resistors available in 1/10, ⅛, ¼ and ½w sizes. Information in this 10-page brochure includes specifications, ratings, characteristics, curves, temp. coefficient information which includes resistors offered in 2 standard T.C. grades: C—±50 PPM/°C and E—±25 PPM/°C.

Circle 196 on Inquiry Card

Microwave Diodes

"Varactor Diode Measurements," 2 color, 5 pages, contains comprehensive information on ways of measuring varactor diodes. Information includes: Nomograph for calculation of series resistance of varactor diodes; reflectometer measuring diagram; characteristic curves; and impedance measuring block diagram. Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

Circle 197 on Inquiry Card

Computer Capacitors

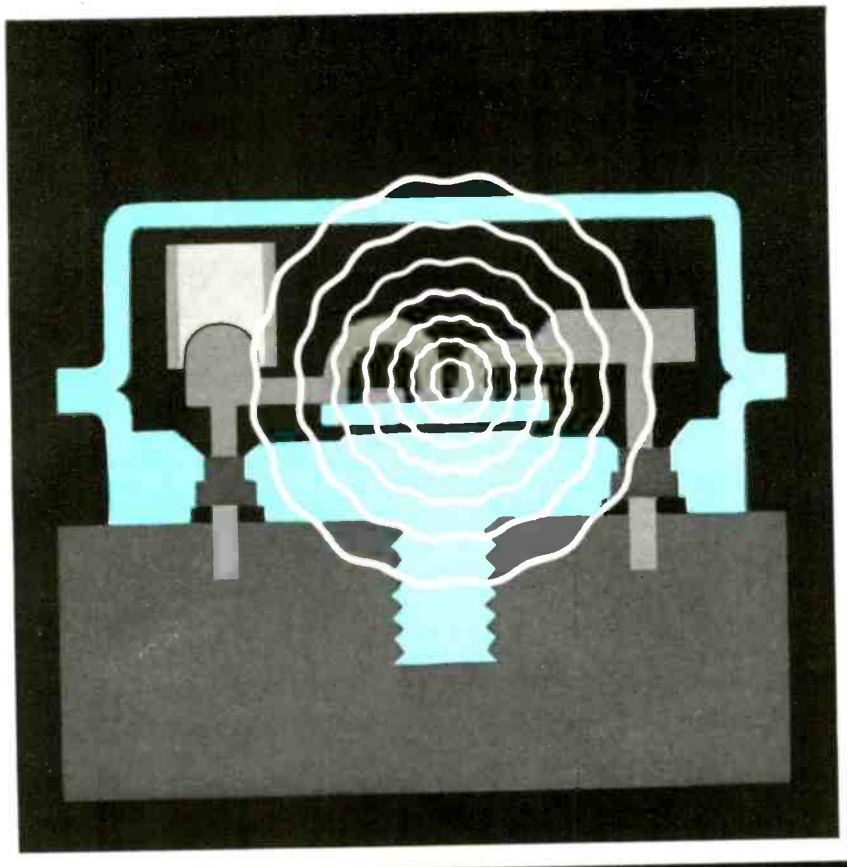
"Computer-grade Electrolytic Capacitors," 12 pages, Bulletin 2231A, 2 colors, contains up-to-date design and application data, in addition to an extensive listing of sizes and ratings in which these high reliability capacitors are available. Graphs, charts, photographs, specifications and outline drawings are included. Sangamo Electric Co., Springfield, Ill.

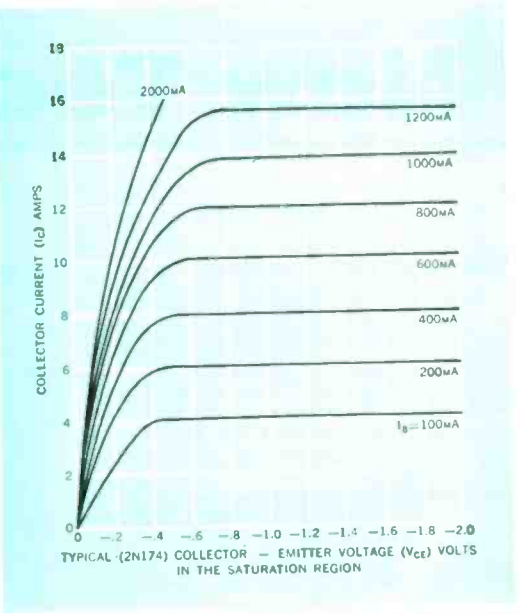
Circle 198 on Inquiry Card

Time Delay Relay

This 8-page brochure describes an Electronic Time Delay Relay, Model 591. Included are application notes, outline drawings and schematics. G. C. Wilson & Co., 1035 26th St., Huntington, W. Va.

Circle 199 on Inquiry Card





Saturation voltage V_{CE} (sat) is an extremely important transistor characteristic. When the collector to base voltage of a transistor is either zero or in the forward direction and the emitter to base voltage also is in the forward direction the transistor is said to be in saturation. Low saturation voltage improves circuit efficiency and reduces transistor dissipation in applications in which the transistor is driven into saturation. This results in lower junction temperature and improved temperature stability.

TUNG-SOL MINIMIZES V_{CE} (sat)

TO PRODUCE POWER TRANSISTORS THAT DELIVER FULL POWER

Power transistors can be rated by at least a score of characteristics. For most of these, the ratings of an ordinary transistor may be equivalent to the ratings of a Tung-Sol transistor—*under optimum conditions.*

But Tung-Sol engineers have long recognized that power transistors are rarely operated under the so-called optimum conditions. Circuit requirements vary widely and so do operating environments. A better measure of power transistor quality and capability are the characteristics which contribute to transistor reliability and performance under less-than-optimum conditions.

One such characteristic is saturation voltage. Tung-Sol transistors are designed with the lowest possible saturation voltage consistent with other performance requirements.

Low saturation voltage results in lower transistor dissipation and lower junction temperature. This reduces the variation of the temperature dependent parameters of the transistor with resultant improvement in circuit and operational stability. Low saturation voltage decreases internal resistance and temperature and increases useful power-handling. Therefore, a low saturation voltage becomes increasingly important as the transistor is operated closer to its maximum power or in a high-temperature environment.

Low saturation design is typical of the care taken by Tung-Sol to provide the industry with transistors that reliably deliver full power. Ratings, based on stringent environmental and electrical tests, are given for junction temperatures of 110°C. Thermal resistance is low, while breakdown voltages are high.

Two more power pluses are Cold-Welded copper cases, for better heat dissipation and prevention of contamination, and flat-ground mounting surfaces, for full contact with heat sinks. Talk to Tung-Sol about your transistor problems. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193.

TUNG-SOL® FULL POWER
POWER TRANSISTORS

Circle 84 on Inquiry Card

New Tech Data for Engineers

Thermoelectric Cooling

This tech brochure describes thermoelectric cooling modules and materials. Information covered includes: 3 graphs—temp. difference vs. hot junction, temp. difference vs. heat load and temp. difference vs. input current; mathematical analysis of Figure of Merit (Z) with equations to determine Z for both materials and modules; and important characteristics on the various shapes and sizes of thermoelectric material which are available. Intermetallic Products Div., Joseph Waldman & Sons, 133 Coit St., Irvington 11, N. J.

Circle 200 on Inquiry Card

R-F Plug Catalog

This catalog lists an extensive line of Cannon coaxial r-f plugs. The plugs are designed to connect and terminate coaxial lines used in radio freq. transmission with a min. loss of energy. Information includes all the important electrical and mechanical characteristics, dimensions and photographs. Catalog RF-1, 83 pages, is available from Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Circle 201 on Inquiry Card

Computer Capacitors

"Computer-Grade Alumalytic™ Capacitors", GEA 6819C, 4 pages, illustrated, describes the extended line of GE's aluminum electrolytic capacitors which now feature up to 165,000μf in a single case size. The brochure details features, applications, performance characteristics, life test data and shows dimensions, ESR and ripple current values and performance curves. General Electric Co., Schenectady 5, N. Y.

Circle 202 on Inquiry Card

Terminal Catalog

A catalog introducing a complete line of "Teflon" insulated terminals is available from Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif. This 16-page catalog contains information on miniaturized terminals, which mount directly to either plastic or metal chassis, are of 1-piece "Teflon" bushing construction and are pressed into place by simple installation tools.

Circle 203 on Inquiry Card

Magnetic Memory Drum

A booklet describing the Dynastat digital magnetic memory drum is available from Consolidated Controls Corp., a sub. of Consolidated Diesel Electric Corp., Bethel, Conn. The drum has a fixed signal level, regardless of speed; high output level; parallel or series readout to eliminate the necessity for buffer storage, and no mechanical wear because of no contact between magnetic heads and the drum surface.

Circle 204 on Inquiry Card

Counters

This 21-page, 2-color catalog covers 22 models divided into 5 types: electro-impulse counters, pre-determining counters, time counters, revolution counters, and ratchet counters. Information includes complete technical capabilities, mounting dimensions, schematics and pictures. Other information is included on magnifying lenses, dozens counters, labelling frames and elapsed time counters, showing hours, minutes, seconds and 1/120 sec. The Rowan Controller Co., 26 Bridge Ave., Red Bank, N. J.

Circle 205 on Inquiry Card

Thermostat Metals

Bulletin TRU-13 on Truflex® PR Series thermostat metals contains information on P30R through Truflex P600R series of thermostatic bimetals which feature controlled electrical resistivity with high flexivity. The complete series features from 30Ω/circular mil foot to 850Ω/circular mil foot. Metals & Controls, Inc., 34 Forest St., Attleboro, Mass.

Circle 206 on Inquiry Card

Punched Tape Reader

Tech data describing the EECO TP-523 general-purpose, sequential punched tape reader, which requires only 3 in. of panel height and provides economical automatic programming, is available from the Automation Div., Electronic Engineering Co. of California, Box 58, Santa Ana, Calif.

Circle 207 on Inquiry Card

Solid State Isolators

Convenient, accurate selection of solid state isolators and circulators, and garnet materials is in a 16-page, 2-color, illustrated catalog available from Sperry Microwave Electronics Co., P.O. Box 1828, Clearwater, Fla. This short form catalog gives specs. and dimensions, typical performance curves and applications for a line of miniaturized UHF, broadband and high power coaxial isolators; miniaturized circulators; and the nominal characteristics for available garnet materials.

Circle 208 on Inquiry Card

Power Supplies

Up-to-date specs. and design details of Isoplys (Isolated Power Supplies) and Isoformers (Isolation Transformers) are covered in tech data available from Elcor Inc., 225 W. Broad St., Falls Church, Va. Information is included on transistor regulated Isoplys (2w and 8w dc output series); VR-tube Isoplys (2 series with output voltages ranging from 75-300 vdc and regulation to less than 1%); Zener-Diode-Regulated Isoplys (2 series, 1½ and 6w); and Isoformers (a 4 and 25w output series). Isoplys/Isoformers, Cat. 3-362-10M.

Circle 209 on Inquiry Card

Reflective Tape

Tech data is available on Type AGV, a flexible glass fabric with a thin aluminum foil surface on one side and a high temp. silicone pressure sensitive adhesive on the other side. Type AGV is designed to provide protection from radiated heat energy. The Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.

Circle 210 on Inquiry Card

Strain Gage Catalog

This 32-page catalog covers BLH's line of standard and special types of strain gages giving detailed pricing information, background data on gage selection, characteristics, temp. ranges, temp. compensation and other material. Information is also included on types of strains which can be measured, the strain-sensing materials used, lead wire materials and insulation, plus various accompanying tables and curves. Catalog No. 4310-62 is available from Electronics Div., Baldwin-Lima-Hamilton Corp., 42 4th Ave., Waltham 54, Mass.

Circle 211 on Inquiry Card

Microwave Antennas

"Microwave Antennas and Accessories" catalog M, 2nd Edition, 13 pages, 2-color, contains information on parabolic antennas in the 890-960MC and the 12,200-12,700MC ranges and plane polarized antennas in the 1700-2700MC and 5925-7425MC range. Included are Government band antennas; dual polarized antennas; antenna mounts; anti-icing equipment; and microwave waveguides. Also covered are characteristic charts, outline drawings, and photographs. Andrew Corp., P. O. Box 807, Chicago 42, Ill.

Circle 212 on Inquiry Card

Hose Fittings

Tech. data is available discussing Lenz: fittings; adapters; hose; single wire braid medium pressure hose assemblies; single wire braid medium pressure stripped rubber cover assemblies; and single fabric braid low pressure hose "push-on" assemblies. The Lenz Co., 3301 Klepinger Rd., Dayton 1, Ohio. Form No. DM-661H.

Circle 213 on Inquiry Card

Component Catalog

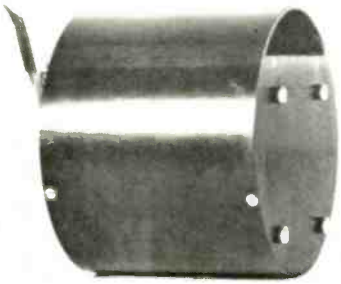
PIC Design Corp., 477 Atlantic Ave., East Rockaway, N. Y., is offering their 1962 Consolidated Catalog #30. This 576-page book lists over 25,000 precision instrument parts and components available from stock, and features many new precision items and enlarged tech data pages. Among the products described are, Geneva Mechanisms, Fine-Pitch Chain and Sprockets, Miniature Anti-Backlash Gears, Precision 1, 2 and 3 Pinion Shafts, Servo Gear Boxes and Precision Gear Racks.

Circle 214 on Inquiry Card

New Products . . . for the Electronic Industries

DC-DC CONVERTERS

Model C2800-0.1 converts nominal 28vdc input to 2800vdc output.

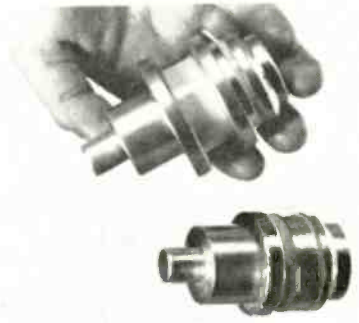


Output of this solid state airborne supply is regulated against line and load variations. Other specs: Ripple is 1.5v. P.P. (max.); Regulation is ±0.25% for input change of 25vdc to 33vdc; Input is 25vdc to 33vdc; Output is variable, external adjustment, 2600vdc to 2900vdc at 90ma. Output voltage change from starting to full load is max. of 3% (using starting load of 500KΩ; Weight is approx. 10 lbs.; package is aluminum cylinder 6 x 5 in. Temp. range is −20° to +50°C. Universal Electronics Co., 1720 22nd St., Santa Monica, Calif.

Circle 215 on Inquiry Card

HIGH-GAIN TETRODES

The ZP-1015 and the ZP-1018 are designed for L-band uses.



The uses of these 2 high-grain metal-ceramic tetrodes include airborne IFF radar. As a grid-pulsed amplifier in IFF interrogators, the ZP-1015 has a gain of 8.5db and delivers a typical peak power output of 10kw under a 0.01 duty cycle at 1030MC. The ZP-1018, designed for grid-pulsed amplifier service in IFF transponders, has a gain of 10db and delivers a typical peak power output of 2kw under a 0.02 duty cycle at 1090MC. The tubes also feature heat sink cooling. Power Tube Dept., General Electric Co., Schenectady 5, N. Y.

Circle 217 on Inquiry Card

TRAVELING WAVE TUBE

Delivers 200w pulsed power at 1% duty at the 30db gain level.

To drive the Model M2602C 200w TWT, MEC offers 1 and 2w PPM focused tubes with insulated collectors for use in either instrument or system applications where grounded cathode operation is required. Operating in X-band from 7.5 to 11.0GC, the waveguide coupled tube weighs 8 lbs. and is 16 in. long. Other features include high-mu grid, oxide coated cathode and a conservatively rated 4w heater. The 200w tube and its drivers withstand 15g shock and 15g vibration between 5 and 2000 CPS. Microwave Electronics Corp., 4061 Transport St., Palo Alto, Calif.

Circle 219 on Inquiry Card

FREQUENCY METER

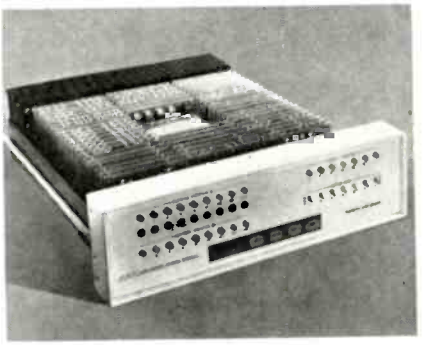
This direct reading unit covers the entire X-band.

Model X1301A Precision Direct Reading Frequency Meter covers from 8.2 to 12.4GC. This meter uses a TE_{m} resonant cavity coupled to WR-90 waveguide, with a dip of approximately 1db in the transmitted power at resonance. The freq. can be read directly from the scale with an overall accuracy of 0.08%. The high Q cavity is tuned by means of a choke plunger and no sliding contacts are used. A precision lead screw, spring loaded to prevent backlash, gives a resetability of 0.01%. Budd-Stanley Co., Inc., 175 Eileen Way, Syosset, N.Y.

Circle 216 on Inquiry Card

MAGNETIC CORE MEMORIES

Capacities to 4096 words; word lengths to 32 bits are available.

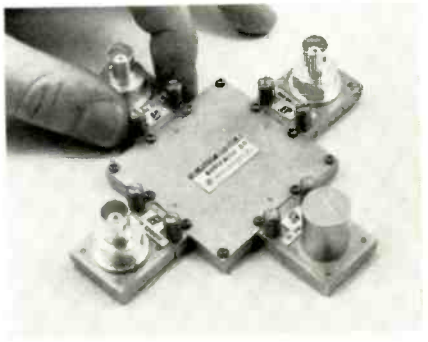


This line of memories is capable of command rates up to 100KC. Three basic operation types available: Random access; Sequential; and Sequential-Interlace. Address codes may be binary or binary-coded-decimal. Standard features are: indicators on address registers; indicators on output register; manual test logic to permit rapid operation checks; modular construction; slide mounted chassis within a chassis; and integral regulated power supply. Systems Engineering Laboratories, Inc., 4066 Northeast Fifth Ave., Fort Lauderdale, Fla.

Circle 218 on Inquiry Card

HYBRID JUNCTIONS

Four models offered for use in breadboarding new circuit designs.



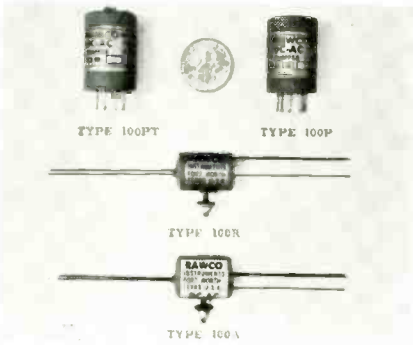
These Hybrid Junctions in TRI-PLATE® Strip Transmission Line are for use with power dividers, balanced mixers, filters or duplexers. The 4 Junctions conform closely to model MHJ20. With 50Ω impedance characteristics, the MHJ20 has a center freq. of 3.0GC, a bandwidth of 2.2-3.8GC, coupling at 3.2 (+0.6, −0.3) db and a min. isolation of 20db. The 4 models are the: MHJ11 — 0.6-0.9GC; MHJ15 — 1.1-1.9GC; MHJ19—2.5-3.4GC; and MHJ20—2.2-3.8GC. Sanders Associates, Inc., Microwave Products Dept., Nashua, N. H.

Circle 220 on Inquiry Card

New Products . . . for the Electronic Industries

SOLID STATE CHOPPERS

This line designed for military and airborne applications.

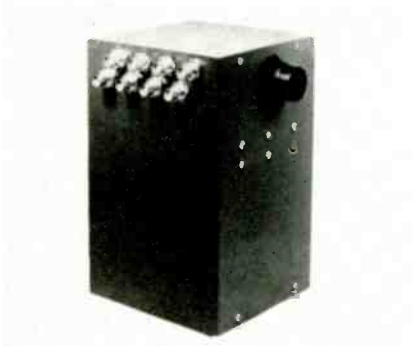


Type 100 line has a noise level of 3 to 10μv at 1K impedance and a noise level of 20 to 150μv at 10K impedance. The drift as well as dc offset is in the low μv range from $-65°$ to $+125°$C. For shielding, these units are potted in a steel casement containing a transformer and (when required) a phase shift network to provide up to a 50° phase lag. These 400CPS units need only a 6v sine or square wave drive. RAWCO Instruments, Inc., P.O. Box 7393, Ft. Worth 11, Tex.

Circle 233 on Inquiry Card

RF SWITCHING MATRIX

It offers a 1.5 db max. insertion loss and a max. VSWR of 1.1.

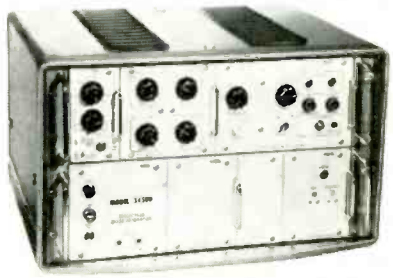


Model CP-10, solid-state diode switch, can be furnished in crossbar-type matrix configurations up to 10 x 10. Its characteristics, over any 20MC band between 0.5 and 60MC are: 1.5db max. insertion loss; 1.1 max. VSWR; $\pm$0.25nsec max. differential delay between any 2 circuit paths; 60db min. crosstalk attenuation; and low intermodulation distortion. Sylvania Electric Products, Inc., Sylvania Electronic Systems-West, P.O. Box 188, Mountain View, Calif.

Circle 235 on Inquiry Card

PULSE GENERATOR

Servopulse TM3450D has a repetition rate of 2CPS to 2MC.



It offers twin-pulse capability as a standard feature. Can be switched in wherever desirable to generate 2 pulses on a common time basis, each pulse having the same width, polarity, and amplitude. Basic instrument specs.: 0 to 10,000μsec. delays; 0.05 to 10,000μsec. widths; $\pm$50v into 50Ω; and better than 15nsec. rise time. Standard modules plug into both front and rear of the rack frames. Servo Corp. of America, 111 New South Rd., Hicksville, N. Y.

Circle 237 on Inquiry Card

TEST CHAMBER

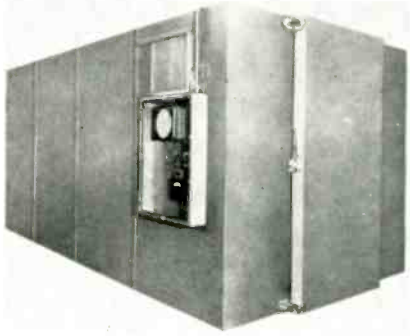
Features high accuracy non-cyclic temperature control.

The Model SD-6 features 24 lineal inches of calibrated setpoint scale; proportional control of heater power by all solid-state control circuitry; and temp. readout by a deviation meter calibrated in 1° increments referenced against set-point. This chamber has fast temp. response and uses liquid CO_2 for cooling. The SD-6 is a bench-type unit with 10 x 10 x 7 in. test area. Temp. range is $-100°$F to $+525°$F with control accuracy of $\frac{1}{4}°$F. Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 46, Calif.

Circle 234 on Inquiry Card

ENVIRONMENTAL CHAMBER

All-weather, walk-in, explosion-proof unit may be located outdoors.



Designated Model WF-1280-100+200X, it has a capacity of 1280 cu. ft. and provides temps. from $-100°$ to $+200°$F, with an accuracy of $\pm 3°$F at any set point. It can be used for research, development, and production applications where an outdoor chamber is desirable. Instrumentation includes a recorder and controller meeting requirements for Classes I, II, III, Groups A, B, C, D, E, F and G hazardous areas. They are mounted in a visible all-weather housing. Webber Mfg. Co., P. O. Box 217, Indianapolis 6, Ind.

Circle 236 on Inquiry Card

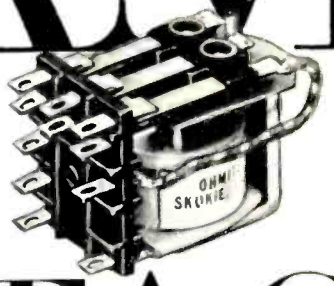
MOTOR GENERATOR

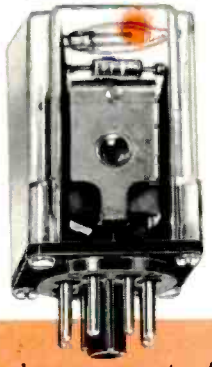
This unit measures 1.375 in. long (size 10 frame) and weighs 2.3 oz.

Designated the FV-6000-1-A1, it consists of a 2 ϕ, 4-pole, 400 CPS induction motor and a 1 ϕ generator. The rotors of both elements are mounted on a common shaft in a single housing. One motor phase is center-tapped, the other has a split winding for either parallel or series operation. The generator produces a 1 ϕ output, proportional to speed, of 0.42v at 1000RPM, with a linearity of 0.5% up to 4000RPM. Operating temp. range is $-55°$ to $+125°$C. Eclipse-Pioneer Div., The Bendix Corp., Teterboro, N. J.

Circle 238 on Inquiry Card

10-AMP CONTACTS





NEW INDICATOR LIGHT, TOO

now available in Ohmite GPR relays

■ Model GPR relays represent a fresh design approach in the field of good, economy-type relays. Construction is simplicity itself, and with the elimination of complexity has come compactness, versatility, and unusual ruggedness.

CONTACTS: 5 and 10 amps at 115VAC or 32VDC (non-inductive). Gold flashed, fine silver (5-amp); silver cadmium oxide (10-amp).

COILS: Up to 230VAC, 60 cycles, or 115VDC; DC, 1.4 watts; AC, 2 volt-amperes (AC latching type, 3.7 volt-amperes).

CONTACT COMBINATIONS: SPDT, DPDT, and 3PDT for single relays; 4PDT and 6PDT on latching relays.

ENCLOSURES: Clear plastic.

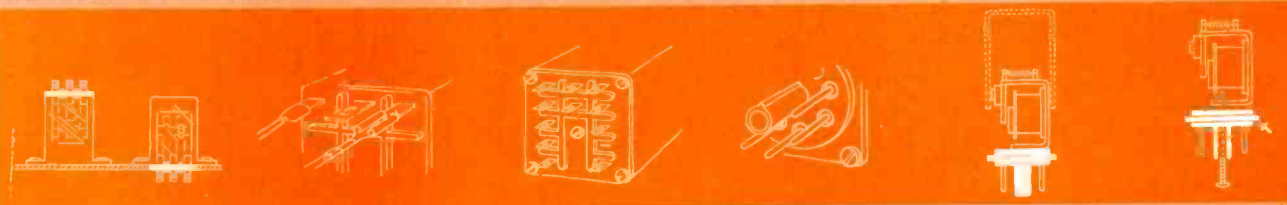
TERMINALS: Barrier type or octal plug.

LATCHING RELAYS: Enclosed with plug-in mounting; or unenclosed.

PLATE CIRCUIT RELAYS: Supplied in 2500, 5000 and 10,000-ohm coil resistances.

Write For New Relay Catalog 700.

POPULAR "COST-SHAVING" FEATURES OF MODEL GPR RELAYS



CHOICE of below-chassis or above-chassis connecting in plastic enclosures.

MULTI-USE terminals allow soldering, insertion in printed circuit board, and use of AMP Style 110 push-on terminals.

ALL TERMINALS on *one* panel . . . permits insertion in printed circuit board.

OCTAL PLUG relays up to DPDT have recessed pin bases . . . meet UL spacing requirements to 150 V.

ALL ENCLOSED relays mount solidly on base . . . *not* on covers.

INTEGRAL plug-in base up to DPDT avoids wiring between contact terminals and pins.

ENTIRE LINE STOCKED FOR FAST SERVICE FROM DISTRIBUTORS AND FACTORY

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

OHMITE

OHMITE MANUFACTURING COMPANY
3662 Howard St., Skokie, Illinois

OHMITE

Circle 86 on Inquiry Card

New Products ...for the Electronic Industries

DEVIATION METER

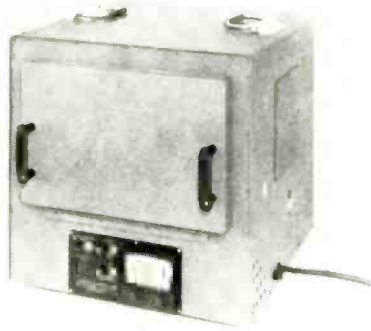
Freq. range: 20 to 500MC. Operates from either line or batteries.

This lightweight, fully-transistorized portable deviation meter is designed for use in servicing communications equipment. It has direct-reading freq. deviation ranges of 1.6, 8 and 16KC full scale with accuracy of ±5% on the latter 2 ranges. The unit measures 10¼ x 6½ x 5¾ in. and weighs 7 lbs. It can be operated from 117vac or, as a portable, from 2 internal low-cost mercury batteries. Motorola Inc., Communications Div., 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle 221 on Inquiry Card

TEMPERATURE CHAMBER

Designed for use in testing microwave devices.

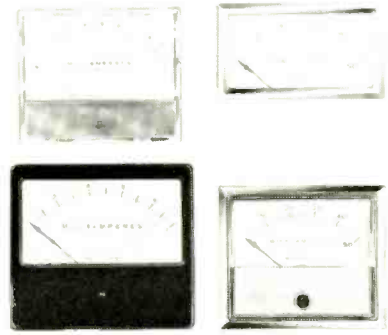


Model 1060X has easy accessibility, with a completely removable front door and 6 in. dia. removable panels on each side. For bench use, the 1060X requires 4 sq. ft. of space with overall dimensions of 23 x 23 x 24 in. and test volume of 16 x 16 x 10 in. Preset temps. from −100° to +600°F may be automatically cycled with Delta's Automatic Time Sequencer or MR-2 Programmer (automatic control according to Mil Std. 202B). Delta Design, Inc., 8000 Fletcher Pkwy., La Mesa, Calif.

Circle 223 on Inquiry Card

PANEL METERS

Mountings in flush and recessed styles, full or half-frame, now offered.

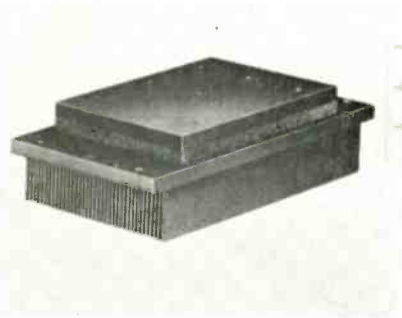


Half and full-frame mountings are available in Weston 1900 Series. The series consists of: 1921 2½ in. instruments, the 1931 3½ in., and the 1941 4½ in. instruments. The model 1951 5½ in. instruments are offered in half-frame style only. Meters are available with 1% or 2% accuracy. Mechanisms available in 3 types: unshielded external magnet; shielded, core magnet moving coil; and ac iron-vane. Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 14, N. J.

Circle 225 on Inquiry Card

THERMOELECTRIC COOLING

The "Peltron" TU-6 can pump up to 400 BTU/hr. in a 90° ambient.

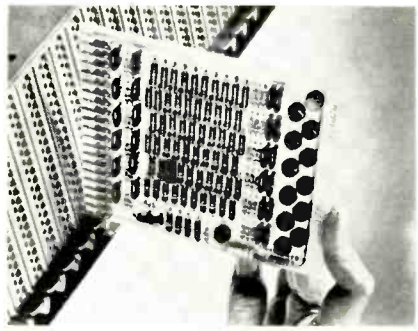


This complete, compact thermoelectric cooling unit has a cold-side to hot-side temp. difference of 64°F with performance of 200 BTU/hour at a cold-plate temp. of 40°F. A max. cold plate temperature of −28°F is possible under no load conditions in a 90°F ambient. It measures 4¾ x 9 x 4¼ in. The complete unit weighs 4.5 lbs. The heat exchanger is composed of a finned aluminum plate. Heat removal is by known techniques and depends on the user's design parameters. Ohio Semiconductors, 1205 Chesapeake Ave., Columbus 12, Ohio.

Circle 222 on Inquiry Card

DIGITAL MODULES

VersaLOGIC units feature high performance at low cost.



Three basic circuits, flip flop, gate amplifier, and power amplifier, perform all logic and signal restoring operations at clock rates up to 2MC. Propagation time through one flip flop and 2 gate amplifiers is 0.25μsec or less under max. logic and stray capacitive load. Large fan-in and fan-out is coupled with high density packaging of up to 6 flip flops on a 4¼ x 5¼ in. card. Circuits are packaged on glass-epoxy etched circuit cards with 40 plug-in pins. Decisional Control Associates, Inc., 644 Terminal Way, Costa Mesa, Calif.

Circle 224 on Inquiry Card

CONNECTOR

Non-environmental unit with crimp contacts and heavy duty insert.

This connector design features crimp terminated, insertable-removable contacts and a single-piece, heavy duty insert and is a non-environmental type. It also features a push-pull, quick-disconnect coupling mechanism. Designed for GSE and test harness uses. Designated the MDR series, it intermates with all Deutsch ball-lock coupling lines and offers a variety of insert configurations, shell sizes and styles, including rack-and-panel plugs. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 226 on Inquiry Card

New Products . . . for the Electronic Industries

R-F POWER AMPLIFIER

Model VPAP-50 is for use in aircraft, missiles and spacecraft.

This pressurized VHF Telemetry Power Amplifier has an output of 50w. The anode is mechanically and electrically connected to the housing, providing a thermal connection for vacuum tube cooling. This 6 lb. amplifier, of 115 cu. in., is designed for application in FM Telemetry systems in the 215 to 260MC range. The unit features compactness and overall efficiency is typically 35%, with a power gain of 10db and operates from a standard 28vdc source. Vector Mfg. Co., Inc., Southampton, Pa.

Circle 227 on Inquiry Card

X-BAND CIRCULATOR

This X-band circulator, model CMX9, covers the 9.0-10.0GC band.

The CMX9 handles up to 2kw peak and 20w average power, and can be supplied for operation at more than 100kw peak power. It has 20db min. isolation with a 0.3db max. insertion loss; VSWR 1.30 max. A three-port wye circulator made of aluminum, it is approximately 2½ in. in dia. and 1⅝ in. high. It mates with UG135/U flange and 1⅝ waveguide. The CMX9 can be used in parametric amplifier applications. Microwave & Power Tube Div., Raytheon Co., Foundry Ave., Waltham 54, Mass.

Circle 229 on Inquiry Card

TIME DISPLAY UNIT

Series 8729 is a digital code format translator and visual indicator.

Designed to accept one of several standard time codes and present a visual indication of the time-of-day, it's completely self-contained including power supply and removable indicator section, and of solid-state modular design. Each display unit can drive as many as 12 remote indicator units. The optional feature of conversion from one time code to another, while still presenting decimal display, is available (ex., AMR to IRIG time codes). Metric Systems Corp., 736 N. Beale St., Ft. Walton Beach, Fla.

Circle 231 on Inquiry Card

HIGH VOLTAGE MODULE

The TR-700A develops 600vdc, 100μa or a nominal 700vdc open circuit.

The TR-700A is an epoxy-encapsulated, dc-to-dc step-up module designed for use with CRT's and related equipment wherever a compact source of high-voltage dc is required. The 6.0v, 75ma input may be supplied by a battery pack or by a pre-existing filament line through a simple half-wave rectifier. Ambient temp. operation range is 0°C through +55°C. Overall size is 1.0 dia. x 2.5 in. and weight is 2.4 oz. avoir. Base is a standard 9 pin miniature. Technique Research Laboratories, 3723 N. Lakewood Ave., Chicago 13, Ill.

Circle 228 on Inquiry Card

SCR

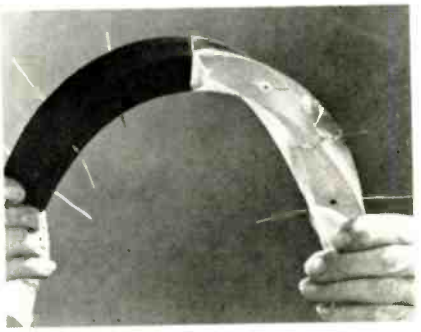
An improved all-diffused version of the SCR 2N681-2N689 Series.

This series carries JEDEC Registration No. 2N681A-2N689A. The surge current rating is increased from 150a to 250a. The I^2t rating is increased from 75a²sec. to 150a²sec. Average rectified forward current at 65°C is increased from 16a to 18a max. Forward and reverse leakage currents are 1ma max. at 125°C. Types 2N681A through 2N687A have 200v/μsec min. and types 2N688A and 2N689A have 100v/μsec min. Texas Instruments Incorporated, Semiconductor-Components Div., P.O. Box 5012, Dallas 22, Tex.

Circle 230 on Inquiry Card

SILICONE CASTING RESIN

For encapsulation; offers high heat resistance and low cost.



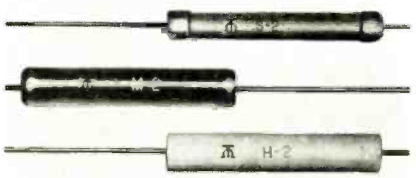
Sylgard 183 Resin, an opaque companion product to clear Sylgard 182, has a wider operating temp. range, from −65° to 400°F, and will cost 25% less than the clear resin. Sylgard 183 has low viscosity for a filled material, mixing easily with the curing agent and flowing readily around intricate parts such as coils, connectors and other components. The resin cures completely upon heating even when completely confined in sealed assemblies. Curing time can be adjusted by varying the temp. Dow Corning Corp., Midland, Mich.

Circle 232 on Inquiry Card

New Products . . . for the Electronic Industries

CARBON RESISTORS

Deposited, molded deposited, and hermetically sealed units offered.



Deposited carbon units, with 40°C ambient temp. at full load, have type range from S-2 to S-110 with wattage ratings from 2 to 1/10. Molded deposited carbon resistors, with 70°C ambient temp. at full load, have type range from SM-2 to SM-18 with wattage ratings from 2 to ⅛. Hermetically sealed deposited carbon resistors, with 70°C ambient temp. at full load, have type range from SH-2 to SH-18 with wattage ratings from 2 to ⅛. Tru-Ohm Products, Div. of Model Eng. & Mfg., Inc., 3426 W. Diversey Ave., Chicago 47, Ill.

Circle 239 on Inquiry Card

DC POWER SUPPLIES

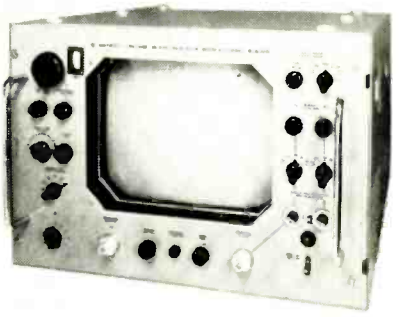
This line of 48v supplies is completely transistorized.

The QM Series component-type supplies are in a military-type can. They have a max. output rating of 30w; voltage regulated to ±0.05% against line and load variations. Insensitive to input freq. variations, they operate on 50, 60, or 400CPS. With ripple less than 1mv RMS, the supplies are self-protecting against overloads or output short circuits. The Sorensen QM series also includes 43 other standard units from 3 to 36v and 2, 4, 8, 15, and 30w. Raytheon Co., Sorensen Products, Richards Ave., So. Norwalk, Conn.

Circle 241 on Inquiry Card

SWEPT-FREQUENCY SYSTEM

The Polyskop II is a multipurpose integrated swept-freq. unit.

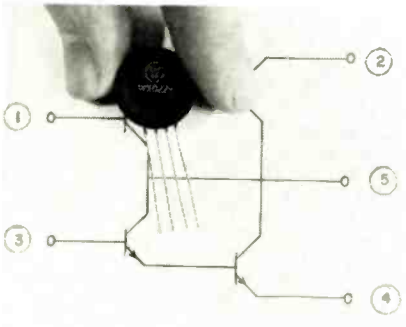


It is a swept-freq. system, type SWOB, that functions as a swept-freq. generator, an attenuator, a marker generator, an electronic switch and a large-screen oscilloscope, all in one cabinet. It has 2 channel freq. response display for 2 and 4 network measurements, with a range of 500KC to 1200MC. It gives automatic display of the response a given quantity exhibits with freq. change. Dual trace display factor permits simultaneous checking of 2 mutually independent quantities. Rohde & Schwarz, 111 Lexington Ave., Passaic, N. J.

Circle 243 on Inquiry Card

POWER AMPLIFIER

Available with current gain of 500. Operating voltages: 50 to 200v.



This push-pull unit is a molecular functional electronic block with an audio-freq. range up to 10KC and a power output up to 30w. It performs the function of two, 2-state Darlington amplifiers with a common collector output. It can be used as the power output stage of an audio-amplifier system, to drive a servo motor, or for dc to dc and dc to ac inverters. Hermetically sealed, it measures 0.75 in. dia. by 0.19 in. thick. Westinghouse Semiconductor Div., Molecular Electronics Dept., Youngwood, Pa.

Circle 240 on Inquiry Card

SCR

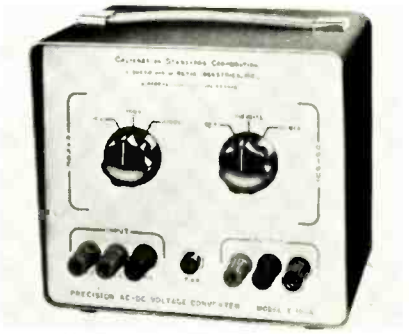
The C37, 16a (RMS), is designed for consumer and light industrial uses.

This medium current silicon controlled rectifier is available in 6 voltage grades. The 6 models of the C37 differ by V_{RO} ranging from 25v for the C37U to 400v for the C37D. The C37D will handle transient voltages up to 500v. The I_F is 10adc (half wave) at 65°C (stud temp.) and 11.5a (full wave rectified) at the same stud temp. The max. I_{GF} is 80ma. The device will operate at junction temps. from −20° to +105°C. The I_{SURGE} is 125a. General Electric Co., Rectifier Components Dept., W. Genesee St., Auburn, N. Y.

Circle 242 on Inquiry Card

AC/DC CONVERTER

Model C-100A is completely solid-state, accurate, and low priced.

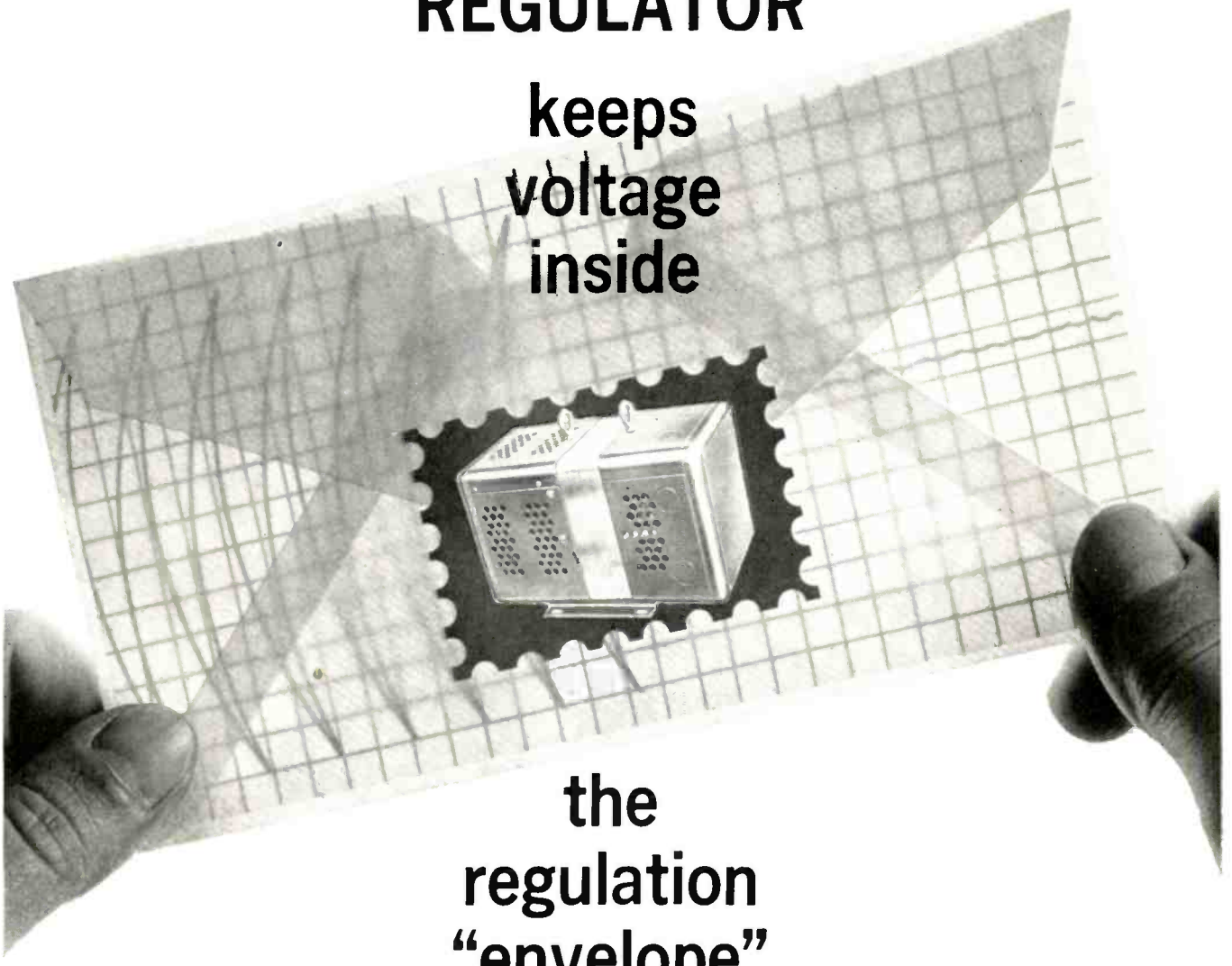


Available in both cabinet and rack mount models, it features a wide freq. range of 30CPS to 10KC with accuracy of 0.15%. Voltage ranges are 0.5 to 10, 10 to 100 and 100 to 1000vac. Voltage linearity is better than 0.02% typical and freq. linearity better than 0.05% typical. Input voltage is 115vac, 50-60CPS with output of 0 to 10vdc. into 10megs or infinite load Response time is 500msec. typical to within 0.15% for either voltage or freq. change. Calibration Standards Corp., 1031 Westminister Ave., Alhambra, Calif.

Circle 244 on Inquiry Card

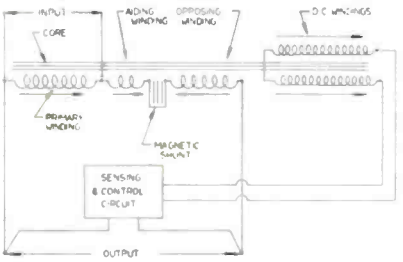
SOLAtron LINE VOLTAGE REGULATOR

keeps voltage inside



the regulation "envelope"

Starts corrective action the instant output departs from nominal... long before voltage even approaches the boundaries of the regulation envelope. In fact, response is *10 times faster* than mechanical regulators. Even under extreme conditions, return to nominal will *never* exceed 10 cycles. And no moving parts means no electro-mechanical wear. Maintenance is reduced to insignificant static-design proportions. A solid-state sensor triggers a magnetic flux "valving action" to maintain nominal voltage.



SOLA

Division of Basic Products Corporation

SOLA ELECTRIC CO., Dept. E1-72, 1717 Busse Road, Elk Grove Village, Illinois, HEmpstead 9-2800

IN CANADA, **SOLA BASIC PRODUCTS, LTD.**, 377 Evans Avenue, Toronto 18, Ontario

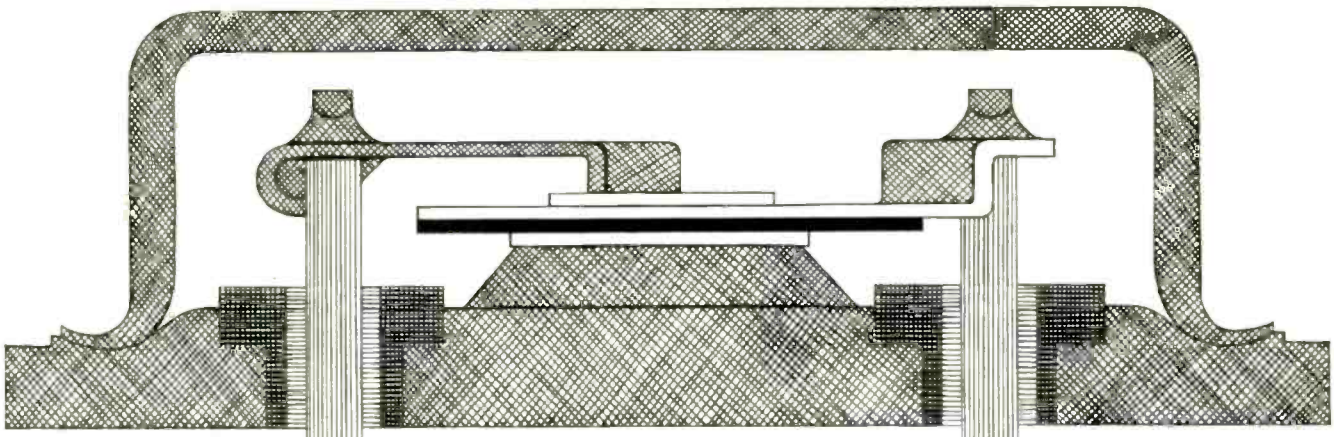
Excellent regulation — for specified input range, zero to full load.

Efficiency — 95% at full load.

Ultra Compact — smaller and lighter than other equivalent regulators.

Complete Mounting Flexibility — designed for either horizontal or vertical orientation. Adaptable for mounting inside OEM equipment or can be externally employed on any surface or support.

New Solatron Line Voltage Regulators are available in 3-100 kva ratings for 120 and 240 vac, indoor applications. Write today for complete details and prices. S-20-62



DELCO RADIO INTRODUCES "NU-BASE"*

For high voltage—high speed

A non-uniform distribution of impurities in the germanium base region between the collector and emitter junctions gives Delco Radio's NU-BASE Germanium Power Transistors a low input resistance and a high cut-off frequency while maintaining a high breakdown voltage. Capable of handling 120 volts maximum . . . with faster switching speeds, higher frequency response and gain that is less dependent on current . . . these new units offer such exclusive Delco advantages as: a TO-3 cold-weld package; planar junctions that are the best in the industry for increased reliability; thermal resistance of .8° C/W; and saturation voltage of .6V, lowest available. This efficient, high current switching at high frequencies gives Delco's NU-BASE Germanium Power Transistors wide applications in solid state ignition systems, hi-fi systems, ultrasonics and computer print-out. For more information, contact one of our sales offices listed below or your nearest Delco Radio Semi-conductor distributor.

*non-uniform base germanium power transistors

TYPE	Vcbo	Vcer*	Vce**	hfe Ic @ 5A	Icbo @ 85°C	Tj
2N1073	40V	40V	0.6	20-60	10MA @ 25V	110°C
2N1073A	80V	80V	0.6	20-60	10MA @ 60V	110°C
2N1073B	120V	120V	0.6	20-60	10MA @ 100V	110°C

*Reb = 100 Ω **Ic = 5A, Ib = 0.5A

Sales Offices

Union, New Jersey
324 Chestnut Street
MUrdock 7-3770
AREA CODE 201

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560
AREA CODE 313

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807
AREA CODE 213

Syracuse, New York
1054 James Street
GRanite 2-2668
AREA CODE 315

Chicago, Illinois
5151 N. Harlem Ave.
775-5411
AREA CODE 312

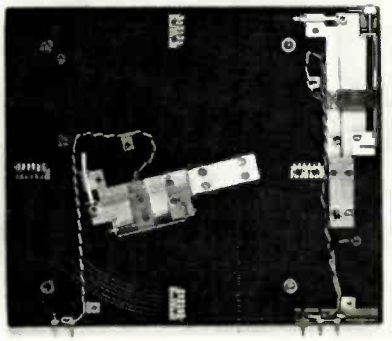
General Sales Office: 700 E. Firmin, Kokomo, Ind., Gladstone 2-8211—Ext. 500 • AREA CODE 317 • Division of General Motors
Kokomo, Indiana

DELCO RADIO
DEPENDABILITY
RELIABILITY

New Products

DELAY LINE

Model TD-2 is one of a new series of low cost magnetostrictive units.

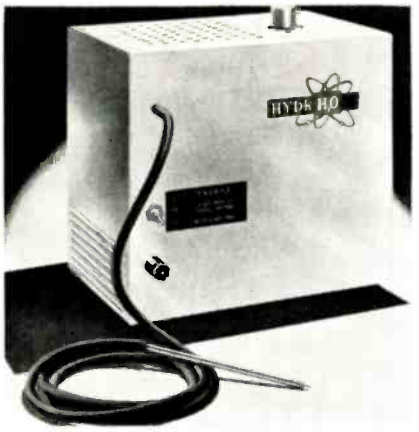


This magnetostrictive delay line, Model TD-2, has a maximum delay of 1,000 microseconds. The digit rate is 1MC in a return-to-zero (RZ) mode, and 2MC in a non-return-to-zero (NRZ) mode. Its case size is 8⅛ inches x 7 inches x 7/16 inches. Sonic Memory Corp., 494 Oak St., Copiague, N. Y.

Circle 245 on Inquiry Card

WELDING MACHINE

This 30 lb., 9¼ x 10¼ x 6 in. machine produces a 6000°F usable flame.



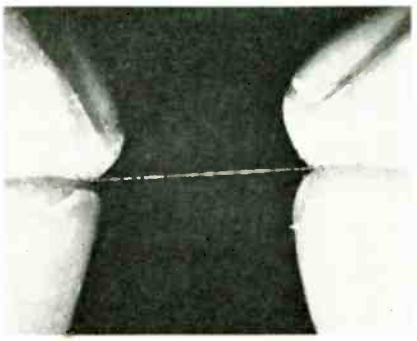
It produces this 6000°F flame by burning the component elements of water at the rate of ½ oz./hr. The machine is powered by 300w from any 110—120vac, 60CPS current source. Using only distilled water and ac current, the welder produces, mixes, and conducts hydrogen and oxygen to a 0.016 in. pencil torch tip where they are burned. The flame is adjusted to any required size with a variable voltage transformer. Soldering, welding, brazing, heating, fusing, etc., can then be done on very minute metallic parts. The Hydro-Water Welder requires no special equipment of any kind. Henes Mfg. Co., 1340 N. 21st Ave., Phoenix 9, Ariz.

Circle 246 on Inquiry Card

New Products

MICRODIAMETER WIRE

Diameter is 5.0 x 10^{-4} (0.25 circular mils).

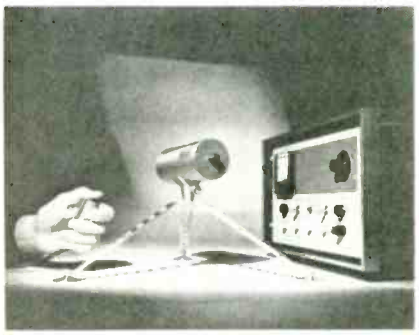


This microdiameter wire is drawn from high permeability Co-Netic AA alloy. Diameter is 5.0 x 10^{-4} inches (0.25 circular mills). The wire displays magnetic properties and is offered for experimental investigation as to applications. It is available from stock. Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.

Circle 247 on Inquiry Card

LASER

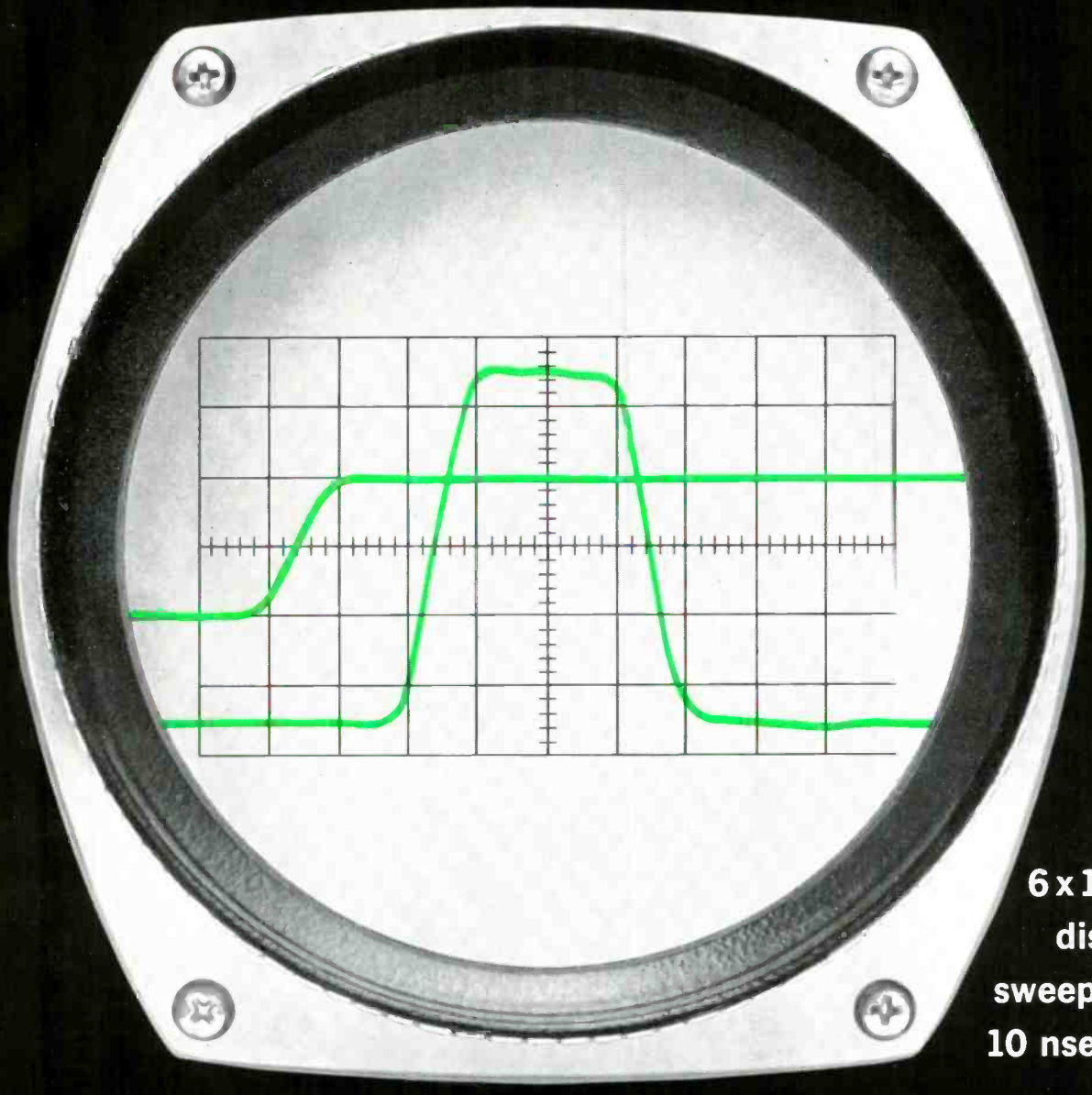
Total beam energy is 1 joule min. with 750 joules input.



The Model 200 laser weighs 1 lb., and contains a flashlamp, ruby crystal, and trigger transformer. It may be operated in any position, without special cooling provisions for intermittent use. An external power supply, such as the Hughes Model 250 Laser Power Supply, is used to supply energy to the flashlamp. Specs: peak optical power output is 5-10kw at 6943A (angstrom); max. input energy is 750 joules at 1350v; laser crystal is a 1½ x ⅜ in. high quality ruby; flashlamp is a specially designed xenon-filled quartz helix; cooling—unit may be fired every 30 sec. for short intervals without cooling. Hughes Aircraft Co., Florence Ave. & Teale St., Culver City, Calif.

Circle 248 on Inquiry Card

ACTUAL SIZE



6 x 10 cm
display;
sweep time
10 nsec/cm

DUAL TRACE FAST PULSE DISPLAY *on the*

New hp 50 MC UNIVERSAL OSCILLOSCOPE

Turn the page for details!

175A 50 MC OSCILLOSCOPE

- Bright, 6 x 10 cm display with no parallax, reflections or astigmatism
- Over 50 MC main vertical amplifier
- Dual trace, dc to 40 MC vertical plug-in
- Horizontal and vertical plug-ins for specific applications
- Easier to calibrate and maintain—no distributed amplifiers
- Positive preset syncing over entire bandwidth

Now you can have a universal oscilloscope with dual trace vertical bandwidth capacity greater than 40 MC—with no sacrifice in sensitivity. Seven separate vertical and horizontal plug-in units give the new hp 175A the greatest versatility ever offered in a general purpose 50 MC scope. Available are dual-channel, single-channel and high-gain vertical plug-ins, plus these horizontal plug-ins: auxiliary, time mark generator, display scanner and sweep delay generator.

The new hp developed 12 Kv CRT presents an easy-to-measure 6 x 10 cm calibrated display without distortion or defocusing. The front panel astigmatism control common to other scopes is no longer necessary. In addition, phosphor and graticule are on the same plane—thus eliminating CRT parallax error. The front panel is engineered for the simplest possible operation.

hp 175A features simplified circuitry for more reliable performance and easy maintenance. Simple triode circuits (6DJ8 tubes) are used in the vertical amplifier. Complicated distributed amplifiers are not employed. In addition, an hp developed cable delay line eliminates still more adjustments. Only 7 tube types and 5 transistor types are used throughout.

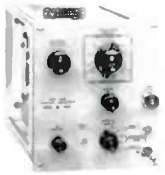
The hp 175A Universal Oscilloscope is housed in the new hp modular cabinet . . . a single instrument for both bench use and rack mount. Cover, bottom and sides are easily removed for simple servicing and routine maintenance. The hp 175A is as easy to service as it is to use!

These Plug-ins Give Utmost Versatility to the hp 175A OSCILLOSCOPE:

Vertical plug-ins

hp 1750A 40 MC Dual Channel Amplifier (pictured in 175A opposite)

Permits viewing of two phenomena simultaneously, bandpass dc to 40 MC, rise time 9 nsec, sensitivity 50 mv/cm. Differential input for common mode rejection. $285.00



hp 1752A High Gain Amplifier

Provides 5 mv/cm sensitivity dc to 18 MC with differential input for high common mode rejection. $225.00

hp 1753A 40 MC Single Channel Amplifier

Bandpass dc to 40 MC, rise time 9 nsec, sensitivity 50 mv/cm. $155.00

Horizontal plug-ins

hp 1780A Auxiliary Plug-In (shown in 175A opposite), normal and single sweep, $25.00

hp 1781A Sweep Delay Generator

For detailed examination of complex signals or pulse trains. Permits viewing expanded waveform segment while still retaining presentation of earlier portions of the waveform. Delay time 1 μsec to 10 sec.; delaying sweep, 2 μsec/cm to 1 sec/cm. $375.00

hp 1782A Display Scanner

Provides output to duplicate on X-Y recorder any repetitive wave appearing on scope. Resolution with permanent records higher than CRT or photograph. (Available soon)

hp 1783A Time Mark Generator

Permits easy time measurements by providing intensity modulated time markers on scope trace. Range, 10 μsec, 1 μsec and 0.1 μsec intervals, ±0.5%. $130.00

SPECIFICATIONS hp 175A

Sweep Generator

Internal Sweep: 0.1 μsec/cm to 5 sec/cm, ±3%; vernier extends slowest speed to 15 sec/cm

Magnification: x1 and x10

Triggering: Internal, from vertical input signal causing 2 mm or more vertical deflection, or from power line. External, from signal 0.5 v p-p or more

Triggering Point: On positive or negative going signal; on external signal, level adjustable —10 to +10 v

Horizontal Amplifier

Bandpass: DC to 500 KC

Sensitivity: 0.1 and 1 v/cm

Vertical Amplifier

Bandpass: Main amplifier, dc to more than 50 MC

General

Power Requirements: 115/230 v ac ±10%, 50-60 cps. Maximum of 425 watts, depending on plug-ins used

Weight: Maximum of 70 lbs., depending on plug-ins used

Price: $1,325.00

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

HEWLETT-PACKARD COMPANY

1501 Page Mill Road, Palo Alto, California, Area Code 415, DA 6-7000
Sales and service representatives in all principal areas;
Europe, Hewlett-Packard S.A., 54-54bis Route des Acacias, Geneva;
Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand St., Montreal

JFD MAX-C

Sliding Piston Capacitors Specified For Precise Wide ΔC Tuning in Collins RF Phase Stability Analyzer

When circuit designs of an exclusive new RF Phase Stability Analyzer built for the U.S.A.S.R.D.L.* called for absolutely stable and linear frequency tuning with low noise and minimum microphonics, Collins Radio Company engineers turned to JFD Electronics.

To match the exacting requirements, JFD development engineers came up with the custom-designed VCJ496 and VCJ497 capacitors. One of the outstanding innovations of these capacitors was a sliding piston that was activated by compensated cams for straight line frequency tuning. Another was JFD's MAX-C construction that tripled the tuning range (5-180 pf. per unit) with no increase in size or weight. Use of special glass and invar for zero temperature coefficient provided the absolute stability necessary for exacting measurement.

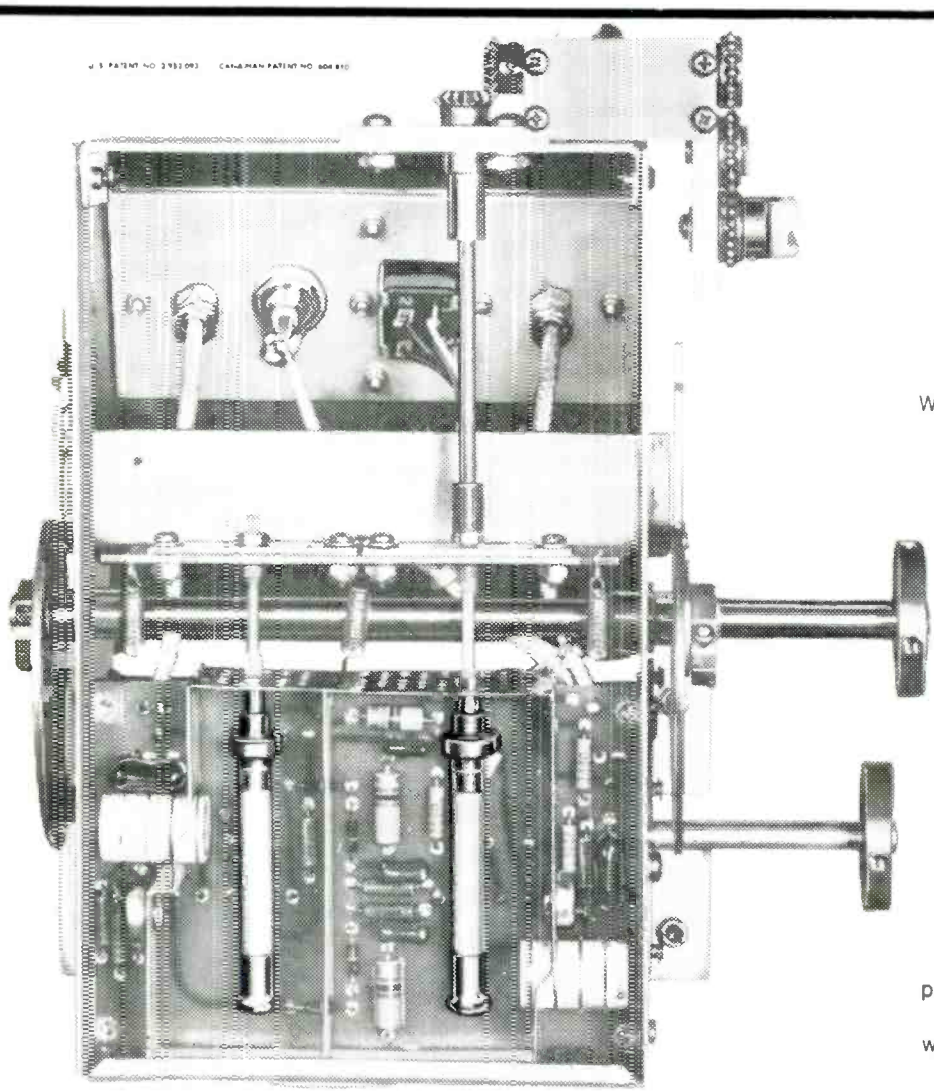
Today, the Collins Phase Stability Analyzer is performing measurements of instantaneous phase deviation on RF signal sources with a resolution which varies from 0.001 degrees at 1 mc. to 0.11 degrees at 110 mc.

This is one more example of how creative JFD variable capacitor technology added to your engineering team can meet and beat the toughest high frequency specifications.

This is one more reason why you can rely on the skills, the talent, and the resources of JFD for your special or standard trimmer capacitor needs.

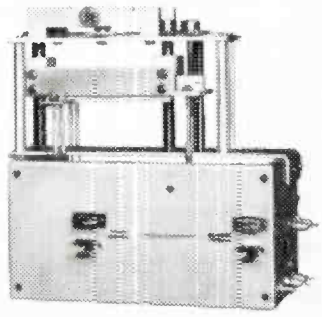
Call your local JFD Field Office or your nearest JFD franchised distributor for assistance.

*United States Army Signal Research and Development Laboratory



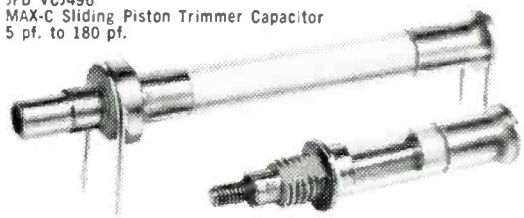
Two ganged cam-driven JFD MAX-C VCJ496 Sliding Piston Capacitors insure precise and stable linear tuning for 1-110 mc Tunable Phase Detector of Collins RF Analyzer.

COLLINS RF PHASE STABILITY ANALYZER



One VCJ497 Sliding Piston Trimmer (not shown) In 1-110 mc. Variable Crystal Reference Oscillator provides necessary frequency stability and accuracy in frequency tuning circuit.

4-Wire Printed Circuit Mounting
JFD VCJ496
MAX-C Sliding Piston Trimmer Capacitor
5 pf. to 180 pf.



actual size

Panel Mount
JFD VCJ497
MAX-C Sliding Piston Trimmer Capacitor
1 pf. to 50 pf.

See JFD Booths 708-709 at WESCON 1962

JFD

AT WORK IN THE NEW FRONTIERS OF ELECTRONICS

JFD ELECTRONICS CORPORATION

Components Division • 6101 16th Avenue, Brooklyn, New York • Phone DEwey 1-1000 • TWX-NY25040

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Van Nuys, Calif.	Skokie, Illinois	Marlboro, Mass.	Toronto, Ontario, Canada
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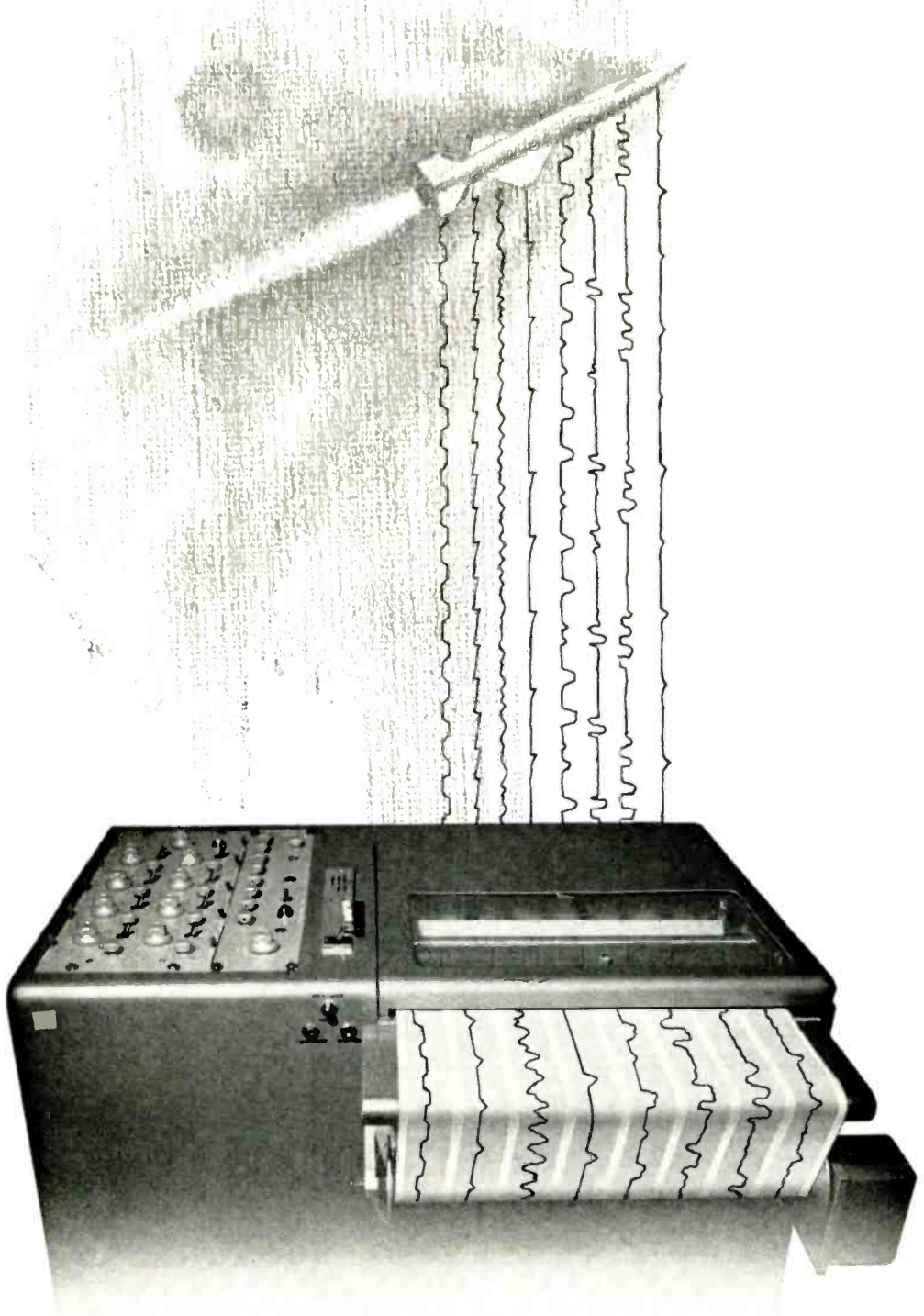
VARIABLE TRIMMER PISTON CAPACITORS • FIXED METALIZED INDUCTORS • LC TUNERS • FILTERS • DIPLEXERS
FIXED AND VARIABLE DISTRIBUTED AND LUMPED CONSTANT DELAY LINES • PULSE FORMING NETWORKS

Circle 94 on Inquiry Card

Offner Dynograph® Recorder / *for extreme stability and versatility in written recording of both physical and physiological data*



STABILITY, FROM RELIABLE TRANSISTOR CIRCUITRY • RECORD UP TO 24 CHANNELS ON ONE PIECE OF PAPER • MEDIUM SENSITIVITY, TYPE RC, (1mv/mm-5v/mm) FOR COMPUTER OR TELEMETRY WRITEOUT • MICROVOLT SENSITIVITY MODELS INCORPORATING PREAMPLIFIERS AND LOW COST INPUT COUPLERS ARE AVAILABLE • FREQUENCY RESPONSE, DC TO 200cps • MINIMUM DRIFT, MINIMUM RECALIBRATION • COMPACT, DESK SIZE • EDWARDS AFB TEST CENTER RECORDS *BOTH* AIRCRAFT AND PILOT DATA ON OFFNER EQUIPMENT (17 UNITS, 118 CHANNELS) • FOR DATA SEE YOUR OFFNER REPRESENTATIVE OR WRITE US.

Beckman® INSTRUMENTS, INC.

OFFNER DIVISION
Schiller Park, Illinois

062-782

Circle 95 on Inquiry Card

New Products

HALL-EFFECT DEVICES

Two devices offered: one for transverse, one for axial fields.

Transverse field "Hall-Pak," Model BH201, is less than 0.006 in. thick, for magnetic field measurements in extremely narrow gaps. The device uses semi-flexible construction to minimize danger of breakage. Active area is less than 0.030 x 0.060 in. Axial field device, Model BH204 measures almost 1/10 of an in. in dia. Axial fields in small TWT's and other devices with openings as small as 0.100 in. can be measured and plotted accurately. F. W. Bell, Inc., 1356 Norton Ave., Columbus 12, Ohio.

Circle 249 on Inquiry Card

HEADSET ASSEMBLY

Allows hand-free voice communications in noisy conditions.

The assembly, Model RHM-157(45) consists of Model RHE-158(45) headset and Model RBM-87(41) microphone. The headset contains 2 lightweight, sturdy, dynamic earphone elements. Freq. range of the earphone element is 100 to 5500 cps; impedance is 20Ω and sensitivity is 105db at 1000CPS ref. Odb 0.0002 dynes/cm² with input of lmw. Harmonic distortion is less than 3% with 100 mw applied. Microphone freq. range is 200-5000CPS; output impedance is 3.5Ω with harmonic distortion of less than 1% at normal voice levels. Roanwell Corp., 180 Varick St., New York 14, N. Y.

Circle 250 on Inquiry Card

vital link in Navy's newest ASW system

A unique Times cable assembly is the mechanical and electrical lifeline of the Bendix sonar detection system in the Sikorsky HSS-2 subhunter—one of the Navy's new ASW helicopters. Meeting demands for extreme reliability, Times manufactures this assembly to withstand the stress of being reeled and dereeled at high speeds. The cable, which directly supports the transducer, is rugged, extremely flexible and designed for indefinite use in seawater.

To insure the cable's perfect electrical performance, Times maintains the tightest quality control requirements on all components and processes from start to finish. This is the same exacting control which Times programs for all its cables and assemblies.

Other special-purpose Times cables are used in a variety of applications which require top reliability engineering—buoyant, and non-hosing coaxial cables for submarines, cables for electronic computers, GSE, and special cable assemblies for missiles and aircraft.

Times' years of cable experience can be applied to your system problems at any stage—from concept through production. Make Times your *first* choice when you have a cable or cable assembly problem. For information, wire or write Times' Sales Manager. Dept. 702

*A DuPont Trademark

TIMES WIRE AND CABLE

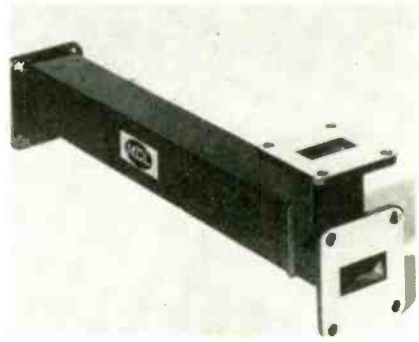
Division of The International Silver Company
Wallingford, Connecticut

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

New Products

DIRECTIONAL COUPLERS

These broadwall multihole units cover from 7.0 to 12.4GC.

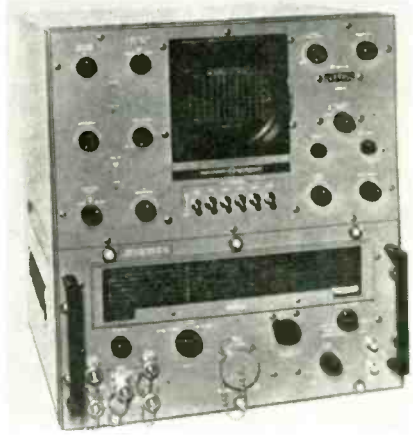


The series is available in EIA WR90 and WR112 waveguide sizes. The line offers 5 coupling ratios of 3, 6, 10, 20 and 30db in each of the 2 overlapping bands covering the freq. range of 7.0 to 12.4GC. New design has allowed a 2:1 reduction in length with little sacrifice in electrical performance. Each coupler is individually calibrated at 5 freqs. over its waveguide band. Microwave Development Laboratories, Inc., 19 Strathmore Rd., Natick Industrial Centre, Natick, Mass.

Circle 251 on Inquiry Card

SPECTRUM ANALYZER

Covers from 10MC to 43GC with one tuning head.



The Model SPA-10 offers 1% freq. accuracy, high sensitivity, single knob freq. tuning, internal waveguide and coaxial mixers, and non-contacting, klystron cavity shorts. Other features are: wide dispersion to 80MC; adjustable 1-80KC selectivity; and internal self-checking and calibration provisions. Accuracy of freq. scale is ±1% or ±1MC, whichever is larger. I-f attenuators cover 0-41db in 1db steps (smooth control, 0-20db) with an accuracy of 0.05db/db. Panoramic Electronics, Inc., 520 S. Fulton Ave., Mt. Vernon, N. Y.

Circle 252 on Inquiry Card

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

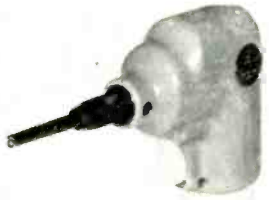
*Trademark Hughes Aircraft Company

Circle 100 on Inquiry Card

New Products

WIRE CONNECTOR

Offers cord-less portabilty, small size and light weight.

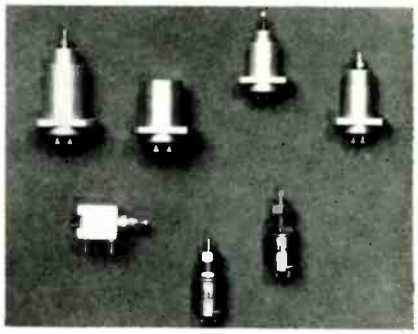


A variation of G-D's standard line of "Wire-Wrap" portable tools, Model 14R2 may be used in remote locations where air or electric power are unavailable or awkward to supply. A permanent magnet electric motor drives this compact tool and is powered by a 2.3a hr. rechargeable nickel-cadmium battery with a built-in charger. It may be equipped for wrapping all wire sizes between 22 and 32 gauge. Gardner-Denver Co., Gardner Expressway, Quincy, Ill.

Circle 253 on Inquiry Card

CAPSULE COIL ASSEMBLIES

For use as variable and fixed inductors under severe conditions.

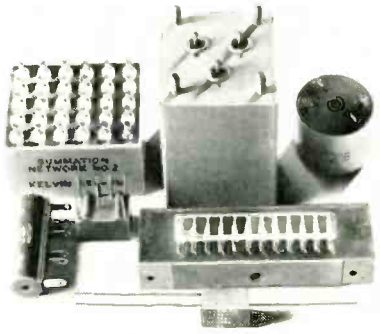


They are completely shielded against r-f radiation and designed for miniature and subminiature uses. The TEC assemblies, in a precision machined solid rod, meet all stability requirements over a temp. range from −40° to +105°C. Custom built for particular requirement in various freq. ranges from 200KC to 100MC. Sizes begin at ½ in. long and ⅜ in. dia. and are supplied with 2, 3 or 4 terminals. Teleradio Engineering Corp., 99 Wall St., New York, N. Y.

Circle 254 on Inquiry Card

RESISTANCE NETWORKS

Hermetically sealed or encapsulated for missile and airborne use.



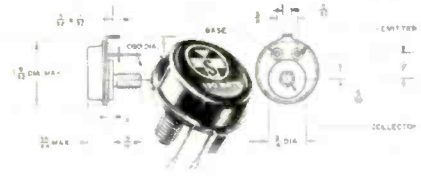
Precision wire-wound resistors are used throughout. Typical solutions to problems of special applications are those involving accuracy tolerance as close as 0.003%, long-term stability of 0.003%/year max. drift, temp. coefficient tracking to as close as 1ppm/°C, and low reactance to provide hi-speed operation. Designed for operation under conditions of severe shock, vibration and high humidity. Kelvin Electric Co., 4907 Noble Ave., Van Nuys, Calif.

Circle 255 on Inquiry Card

New Products

HIGH POWER TRANSISTORS

For use in power converters, regulators, and dc and servo amplifiers.

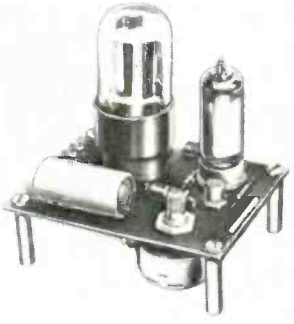


These silicon transistors, Types 2N1015C, 2N1015D, 2N1016C and 2N1016D are diffused junction, npn high power devices. They are 150w, single-end stud types with collector-emitter voltages of 150v for the "C" types and 200v for the "D" types. The 2N1015C and 2N1015D have a saturation resistance of 0.75Ω; the 2N1016C and 2N1016D have saturation resistance of 0.5Ω. Silicon Transistor Corp., Carle Place, N. Y.

Circle 256 on Inquiry Card

POWER SUPPLY MODULE

Combines high performance with small size, simplicity, and low cost.

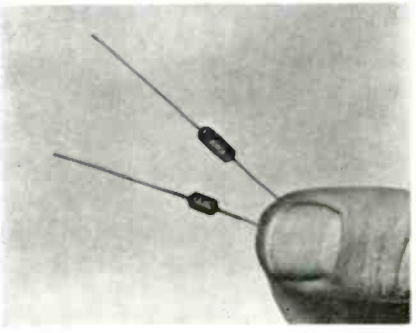


Model DCV-121 is a compactly designed, vacuum tube-transistor power supply. It is designed to provide regulated dc output from an unregulated dc input. The entire circuit is on a printed circuit board provided with threaded standoffs for mounting. It has a typical regulation of 0.02% for both line and load variation. It contains only one vacuum tube, one voltage reference tube, and one transistor. Production Electronics Inc., 525 Lehigh Ave., Union, N. J.

Circle 257 on Inquiry Card

SILICON RECTIFIERS

Line of 8 low cost units has PIV *ranging from 1500 to 10,000v.*



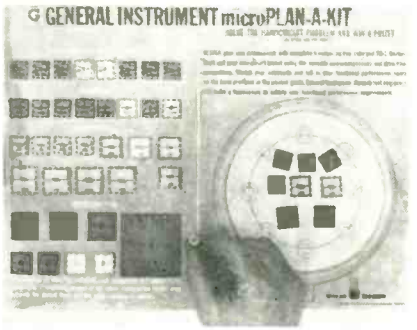
This line of subminiature high voltage silicon rectifiers offers rugged construction, both mechanically and electrically. They are hermetically sealed under pressure and feature high surge ratings. The silicon rectifiers are very reliable under high operating temperatures and require no heat sink. Standard package units are designed for low altitude applications. Semtech Corp., Newbury Park, Calif.

Circle 258 on Inquiry Card

New Products

MICROCIRCUIT KIT

Designed to aid engineers in laying-out microcircuits.

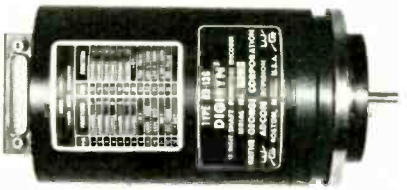


The General Instrument Micro Plan-A-Kit is a simulated microcircuitry breadboard. It permits the circuit designer to improvise a variety of high performance microcircuits, called Nanocircuits by GI, by using enlarged (to scale) silicon planar microtransistors, microdiodes, microresistors and microcapacitors on an enlarged TO-5 header. A selection of EIA equivalent type transistors and diodes, as well as suggested physical layouts and typical Nanocircuit schematics are included. Dept. MK, General Instrument Semiconductor Div., 65 Gouverneur St., Newark 4, N. J.

Circle 259 on Inquiry Card

SHAFT POSITION ENCODER

Designed for recording, computing and control purposes.



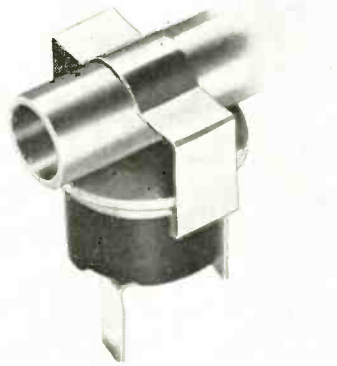
The DIGISYN®, Type RD-13G, gives electrical pulse outputs in parallel, cyclic binary code corresponding to the angular position of its shaft. It is a low friction (non-contacting) type optical shaft position unit with a glass disc coded with an array of opaque and transparent segments attached to the input shaft. Detector signals are amplified by a 13-channel transistor amplifier assembly to give high level outputs at low impedance. Accuracy is ±1 digit or approx. ±2.6 minutes of arc. Wayne-George Corp., Adcon Div., 322 Needham St., Newton 64, Mass.

Circle 260 on Inquiry Card

New Products

MOUNTINGS

Designed for all ¾ inch dia. disc type thermostats.



These clamp type mountings for all ¾ inch diameter disc type thermostats comprising the Stemco line are now available. Clamps for handling all tube diameters of ¼ through ½ inch are included, for both potted or regular style Stemco thermostats. Stemco model designations include Types GM, GY, N, GP, NP. Stevens Manufacturing Co., Inc., P.O. Box 1007, Mansfield, Ohio.

Circle 261 on Inquiry Card

PARABOLA ANTENNA

Offers high gain, field tuning and modular design at moderate cost.

Model C-1372 is available in 1, 2 or 4 bay designs, with each bay complete in itself with cylindrical parabola reflector and adjustable dipole feed. The bays are installed side-by-side. The current series is for operation in the 235 to 300MC range. The dipole feed may be tuned to the exact bandpass range required in the field. The feed system has a flat response over an 18MC bandwidth. Power handling capacity is limited by the type "N" connector normally employed. Technical Appliance Corp., Defense and Industrial Div., Sherburne, N. Y.

Circle 262 on Inquiry Card

New Products

FREQUENCY METERS

Seven waveguide direct reading units cover from 3.95 to 40.0GC.

These Direct Reading Frequency Meters give broadband measurement over the full waveguide freq. range to a high degree of accuracy, without the need for interpolation or charts. The direct reading feature makes these freq. meters ideal for use in both laboratory and production testing. The long effective scale length gives max. readability, resolution and accuracy. Overall accuracy ranges from 0.07% for the 398-DR to 0.12% for the 1098-DR. Waveline Inc., Caldwell, N. J.

Circle 271 on Inquiry Card

METER CALIBRATOR

The MC5400A is accurate within 0.2%, traceable to N.B.S.

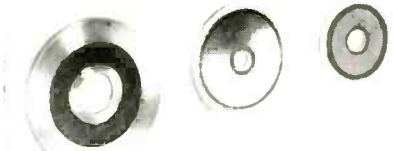
This portable Meter Calibrator supplies accurately metered ac and dc voltage and current for calibration of all kinds of panel and laboratory meters without loading errors. The 54 full-scale ranges cover 20μa to 10adc, 2v to 1000vdc, 20ma to 10a ac and 2mv to 1000vac. AC ranges are compensated and calibrated for 60 and 400 CPS; dc supplies are filtered to 0.5% or better. The controls of this instrument are fully interlocked for safety. Twinco Inc., 10 Cheney St., Boston 21, Mass.

Circle 272 on Inquiry Card

New Products

DISC RESISTOR

For all coaxial terminations, loads, "tee" or "pi" pads.



This line of unbreakable Fiberglass® Evaporated Metal Film Flexible Disc Resistors is made by the simultaneous deposition and fusing of a 150ppm/°C. temp. coefficient, pure metal film to a specially prepared and selected Fiberglass base. They are non-spiral, resistance-coated, on one or both sides to matched or differing resistance values in a range of from 1 to 600Ω standard. Rated power, from ¼ to 8w, is based upon 80°C. amb. Standard tolerance is ±2%, but tolerances of ±1% or ±5% can readily be supplied where required. Filmohm Corp., 48 W. 25th St., New York 10, N. Y.

Circle 263 on Inquiry Card

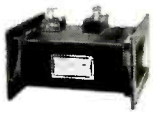
DC AMPLIFIER

Model 1503 "NUVAMP" delivers 15ma at ±100 to 50KC without distortion.

This compact, low-drift, chopper-stabilized dc amplifier, on a printed circuit card, is for analog computer systems, original equip., and control systems. The Model 1503 is designed with 5 nuvistors and solder terminal connections, and has a dc gain of over 50 million. Open-loop gain drops linearly from 160db at dc to 0db at 6MC, with noise down to 200 μv RMS. Small-signal bandwidth is over 300KC. Imput power is ±300vdc and 6.3vac. Embree Electronics Corp., 993 Farmington Ave., W. Hartford, Conn.

Circle 264 on Inquiry Card

DIRECTIONAL COUPLERS
RF LOAD RESISTORS
FILTERS/TUNERS
RF WATTMETERS
VSWR METERS

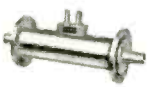


MicroGuide WAVEGUIDE DIRECTIONAL COUPLERS

Model No.	Frequency Range KMC	Coupling Attenuation db	Overall Length—Inches
WL30A	1.12 - 1.70	30	4¾
WS40A	2.60 - 3.95	40	3⅝
WC50A	3.95 - 5.85	50	3⅝
WX60A	8.20 - 12.40	60	1⅞

MicroMatch COAXIAL DIRECTIONAL COUPLERS DC OUTPUT

Model No.	Frequency Range Mcs.	Power Range Watts	RF Connectors
53663	2 - 30	0 - 1200	Type LC
576N	28 - 1000	0 - 400	Type N
402A8	28 - 1000	0 - 4000	1⅝" Flange
442A9	28 - 1000	0 - 12,000	3⅛" Flange

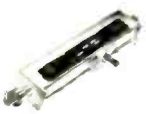


MicroMatch COAXIAL DIRECTIONAL COUPLERS RF OUTPUT

Model No.	Frequency Range Mcs.	Coupling Attenuation db	RF Connectors
308N2	500 - 1000	20	Type N
313N3	300 - 2000	30	Type N
362A7	30 - 1000	70	1⅝" Flange
382A6	120 - 1000	60	3⅛" Flange

COAXIAL FILTERS—LOW PASS

Model No.	Cutoff Freq. (Mcs.)	Power Rating (Watts)	RF Connectors
FLC41	700	1500	1⅝" Flange
FLC21	2200	100	N Type
FLC31	1200	200	⅞" Flange



COAXIAL LINE TUNERS

Model No.	Frequency Range Mcs.	Range of Correction	RF Connectors
151N	200 - 1000	Tunes residual mismatch to 1.000.	Type N
152N	500 - 4000		Type N

RF WATTMETERS Feedthru Type

Model No.	Frequency Range Mcs.	Power Range Watts	RF Connectors
711N	8 - 1000	0 - 30, 75, 300	Type N
712N	25 - 1000	0 - 2.5, 5, 10	Type N
706N	28 - 1000	0 - 400	Type N

RF WATTMETERS Absorption Type

Model No.	Frequency Range Mcs.	Power Range Watts	RF Connectors
621N	1 - 1000	0 - 120 mws	Type N
651N	25 - 1000	0 - 25, 100, 500	Type N
612A	44 - 1000	0 - 6000	3⅛" Flange

RF WATTMETERS Calorimetric Type

Model No.	Frequency Range Mcs.	Power Range (w)	RF Connectors
641N	0 - 3000	0 - 3, 10, 30, 100, 300	Type N

RF LOAD RESISTORS—50 AND 70 OHMS IMPEDANCE

Model No.	Frequency Range Mcs.	RF Power Dissipation (Watts)	RF Connectors
601N	0 - 3000	5	Type N
634N	0 - 3000	150	Type N
674N	0 - 3000	400	Type N, 70 Ohms
636N	0 - 3000	600	Type N
638A	0 - 2000	6000	3⅛" Flange

Equipment with type UHF, C, HN or other connectors can be supplied. Directional Couplers calibrated for 70 ohm use are also available.

MicroMatch® and MicroGuide® identify our coaxial and waveguide RF power and VSWR measuring instruments and associated microwave components designed to operate over 200 KC—12 KMC, at power levels from milliwatts to megawatts. ■ A patented* circuit in the directional couplers is designed to produce an output independent of frequency. ■ Although over 4500 different models have been produced, our "short order" departments add new models to meet requirements of industry and government. ■ Made in quantity to high Government standards, MicroMatch and MicroGuide combine high quality and low cost. ■ For more information, including a 68-page catalog, write M. C. Jones Electronics Co., Inc., Bristol, Connecticut.

*U.S. Letters Patent No. 2,588,390

M. C. Jones Electronics Co., Inc.

SUBSIDIARY OF THE Bendix CORPORATION

Circle 105 on Inquiry Card

New Products

COMPACTRON TUBE SOCKETS

Offered for both printed wiring and conventional wiring uses.

The dielectric material is optional, either black general purpose phenolic or mica filled low loss phenolic. For printed wiring, the 12 pin molded socket with external key mounts in a single round hole for either top or bottom panel dip soldering. For hand wiring, a 12 pin molded socket with molded in mounting saddle with holes on 1 5/16 in. centers is available. Methode Manufacturing Corp., 1700 Hicks Rd., Rolling Meadows, Ill.

Circle 265 on Inquiry Card

SSB TUBE

Typical operating efficiency is 80% at freqs. up to 30MC.

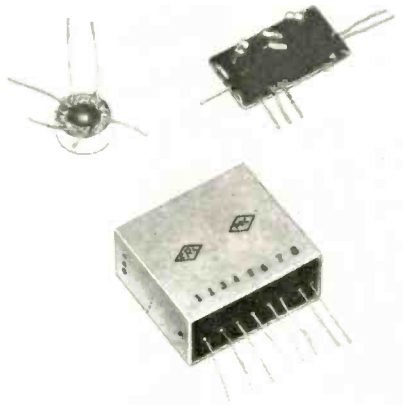
Type 8179, air-cooled tetrode, features a 3rd Order Intermodulation Distortion of 38db in grounded cathode operation and 45db in grounded grid operation, both without feedback. Plate dissipation is 800w. Heater voltage is 7.5v and current is 22.6a. Input capacitance is 48pf; while output capacitance is 9.5pf and plate to control grid capacitance is 0.1pf. Peak envelope plate power output, in grounded cathode operation, is 1145w; the grounded grid operation figure is 874w. Plate power output in typical r-f class C telegraphy operation is 2400w. Amperex Electronix Corp., Power Tube Div., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 266 on Inquiry Card

New Products

SEMICONDUCTOR AMPLIFIERS

Seven different 3-stage and 4-stage amplifiers available.

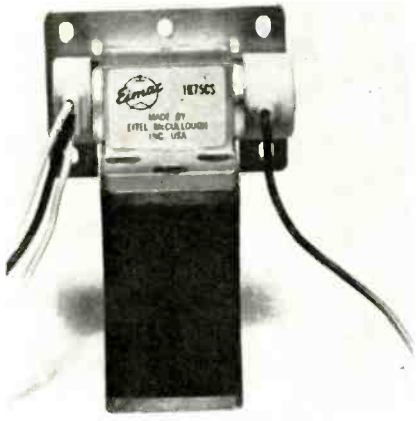


They are supplied in three basic sizes: a ½ inch diameter by ¼ inch high hermetically sealed case; a flat plate unit 1⅛ x ⅝ x ¼ inch; and an encapsulated block 1 7/16 x 1 1/8 x 19/32 in. The seven standard units cover a wide range of frequency response, gain and power output requirements. Centralab, The Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Circle 267 on Inquiry Card

MICROWAVE OSCILLATORS

For use in radar altimeters, parametric amplifiers and microwave relays.



The Iso-Klystron is a combination of reflex klystron oscillators and ferrite isolators in a unitized package. Savings are realized in improved freq. and power output stability in the presence of severe mismatches ranging from open to short circuit. Three Iso-Klystrons are available: a tunable X-band (1K20 series); a tunable, ruggedized C-band (X-1079) with a terminated 3-port circulator; and a fixed freq. C-band (1K75 CS, shown) for radio altimeter applications. Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif.

Circle 268 on Inquiry Card

New Products

POTENTIOMETER

Features linearity of ±0.25% from 25 to 200KΩ.

The 2200 Series Micropot is a 10-turn wirewound model, yet has a low price tag. Life expectancy exceeds 2 million revolutions. Ganging to 3 cups is possible. Power is rated at 5w at 40°C (still air) derated at 0 at 105°C. Operating temp. range is from −55° to 105°C. Capstan-type terminals replace the single-ear or double-ear terminals usually found on lower-priced potentiometers. Linearity accuracy to ±0.05% available. Borg Equipment Div., Amphenol-Borg Electronics Corp., Janesville, Wis.

Circle 269 on Inquiry Card

TIME DELAY MODULE

Features a 2μsec. "switch on" time and a 4μsec "switch off" time.

The Model 2825-50200 solid state Time Delay Module is a silicon semiconductor static switching relay. It is an inertialess device capable of over 1 million operations. Actuation time is 1μsec and decay time is 2μsec. It operates over a temp. range from −55° to +100°C. The timing cycle may be completely reset at any time simply by momentarily interrupting the input power. Complete epoxy encapsulation makes them immune to shock and vibration. Solid State Electronics Corp., 15321 Rayen St., Sepulveda, Calif.

Circle 270 on Inquiry Card

Systems and Circuits

RFI PROBLEMS are increasing with the increase in transmitter power. Prof. O. M. Salati, University of Pennsylvania, points out in his paper, "Recent Developments in RF Interference" that transmitter output and antenna size have increased by a factor of ten in the last decade. Similar increases are expected in the next five to ten years. His findings show that frequently transmitter spurious outputs are greater now than the desired outputs of transmitters a few years ago.

RELIABILITY and **MEDICAL ELECTRONICS** make a strange pair. What with all we've seen and heard about reliability in the electronic industry in the last few years, a reliability factor of 98% does not sound too impressive at all. But, this figure, mentioned in a recent report, is quite noteworthy. Because in this report it referred to pacemakers implanted in nearly 600 patients. So what about the other 2%? Let's remember, most of these people had little or no chance of normal life! They were all suffering from chronic heart conditions.

COMPUTER EXPORTS increased 194% during 1961 over 1960 according to a recent Commerce Dept. report. They were by far the leading category in all business machine exports. Closest competitor to computers was cash registers with a 44.6% increase over 1960.

Dollar volume of computer exports for nine months in 1961 was $79,615,539 or 34.8% of the total value of business machines shipped abroad. Punched card equipment with $44,497,494 shipped last year or 19.4% of the total, was second in line.

Imported computers accounted for only 4.7% of the total imports of business machines with a dollar value of slightly more than $3 million. Their increase over 1960 was 15.9%.

(*Continued on page* 162)

Systems and Circuits

(*Continued from page* 161)

EDP FIRE CODE was passed at the National Fire Protection Association convention held recently in Philadelphia. The first permanent code for computers and systems emerged after a stormy session. The computer manufacturers claimed that the cost of smaller systems might increase by 25% if the new code is completely followed. During the meeting it was pointed out that the real hazard is in the storage of paper and tape.

ULTRASONIC INSTRUMENT SENSITIVITY has been difficult to determine. Now a standard has been evolved. Vibrating a steel ball in water can be used to define a desired level of instrument sensitivity. A report, "A Primary Ultrasonic Standard," is available from OTS, U. S. Dept. of Commerce, Washington 25, D. C. Report AD 268 303 is priced at 50 cents.

ELECTRONIC FLASH APPROACH lighting system which has been operating for a number of years in 212 airports, will be installed in 38 more following a FAA contract award to Sylvania. The system has been well received by pilots landing under all-weather conditions. It employs a series of brilliant flashing lights which seem to provide a moving "fireball" to the pilot making his landing approach.

MICROMINIATURIZED CIRCUITS and systems for communications designed to withstand severe environmental conditions has been the subject of a government research project. The project was completed by Sylvania Electric Co. The findings are given in "Microminiaturization Techniques for Communication Equipment," AD 266 669, available from OTS, U. S. Dept. of Commerce, Washington 25, D. C., for $3.00.

Systems and Circuits

A HIGH SPEED MEMORY SYSTEM which can be used with existing general purpose computers will be designed and constructed by Scope, Inc., of Falls Church, Va., under a contract awarded by the U. S. Army Signal Corps. Termed Content Addressed Memory (CAM), the system is based on a 'dictionary philosophy' and the operational model will have a capacity of 1024 words. Allowing greater flexibility, CAM will also lessen computer programming effort by freeing the programmer from much of the tedious bookkeeping that is necessary with conventional computer memories.

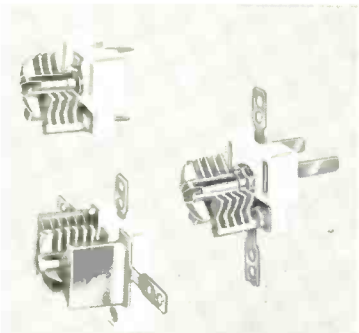
MORE GOVERNMENT BACKING OF R&D of thin-films and solid state integrated circuitry seems to be in the offing. A reliable source in the Dept. of Defense stated that our advanced space program's most promising technology, for meeting long range reliability and operating life-time, lies in thin-film and solid state integrated circuitry. The source was also of the opinion that the development and application of this new technology should not take a normal course, but be separately sponsored in a program not associated with any specific space program.

SPACE ELECTRONICS RELIABILITY development program is being considered by DOD. Areas to be considered include a reliability data collection and analysis activity. It would give complete information on spaceborne device performance from prediction and ground testing through space operation. Other areas include selection of the most advanced components and circuit techniques; the design, development, fabrication and ground testing of selected space devices; and an orbital test program to gather reliability, life and performance data on the design techniques used under actual space conditions.

* * *

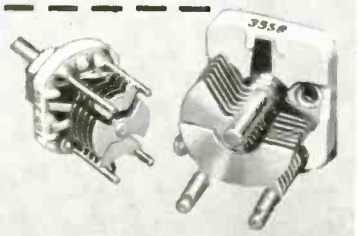
"M" AND "S" MINIATURES

Slightly larger than the "U" and "UB" Types, still excellent for use in compact equipment. Soldered plate construction, heavily anchored stator supports. DC-200 treated steatite insulators. Plates are nickel-plated brass. Available in Single Section, Butterfly and Differential types with straight, locking and screwdriver shafts. "S" also available in Dual type.



TYPE "M"—Requires only ⅝" x ¾" panel area. Peak voltage rating: 1250 volts on .017" spaced units; 850 volts on 160-130, spaced .013"; mounting bushing, ¼"-32.

TYPE "S"—Slightly larger than Type "M". Peak voltage rating: 850 volts—plate spacing .013", other spacings available on special order. Mounting studs tapped 4-40 on 17/32" centers.



SUB MINIATURE "U" AND "UB" TYPES

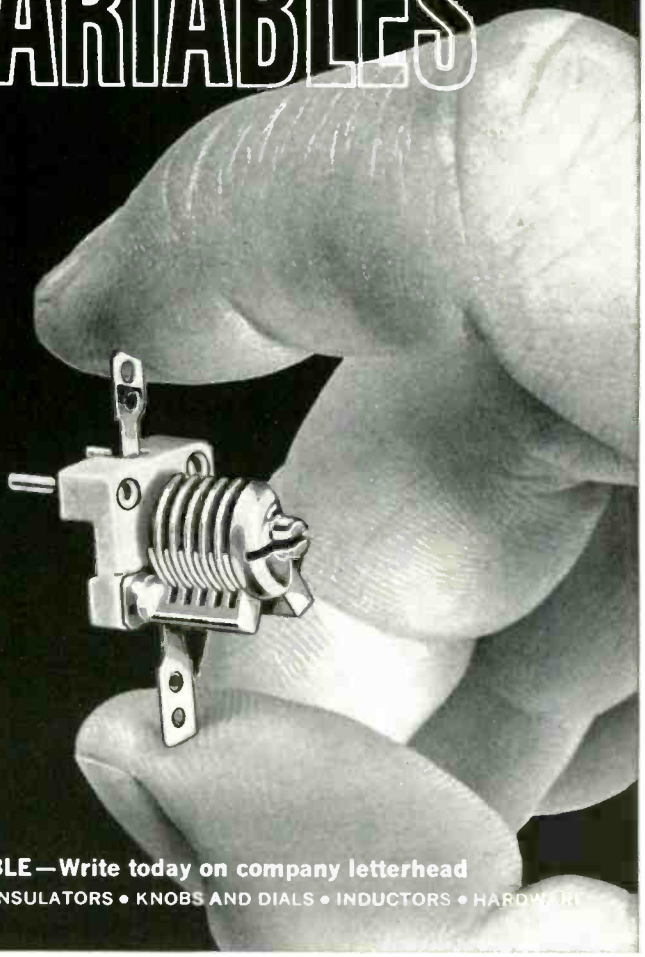
These tiny, sub-miniatures require less than 0.2 or 0.3 square inch mounting area, depending on type. Unique, precision machined design from one piece of solid brass delivers outstanding reliability, with exceptionally uniform delta C and voltage characteristics.

All metal parts silver-plated—ceramic is steatite Grade L-4 or better. Virtually impervious to shock and vibration damage—provides freedom from moisture entrapment found in trimmer capacitors of enclosed or solid dielectric type. Voltage breakdown ratings to 1,300 volts DC. Extra heavy rotor end plate is slotted for screwdriver adjustment. Choice of 3 fast, easy mounting types: "LocTab", Printed Circuit or 2-Hole.

E. F. JOHNSON COMPANY
3001 TENTH AVENUE S.W. • WASECA, MINNESOTA

- **Outstanding reliability—exceptional mechanical stability!**
- **High "Q"—greater than 1500 at 1 mc!**
- **High torque-to-mass ratio—2 to 7 inch ounces!**
- **Low temperature coefficient—approx. 35 PPM/°C positive!**

"U," "UB" AIR VARIABLES



Available in Butterfly, Differential, Dual and Single Section Types

DETAILED COMPONENTS CATALOG AVAILABLE—Write today on company letterhead

• CAPACITORS • TUBE SOCKETS • CONNECTORS • PILOT LIGHTS • INSULATORS • KNOBS AND DIALS • INDUCTORS • HARDWARE

Tele-Tech's
ELECTRONIC OPERATIONS

The System Engineering Section of ELECTRONIC INDUSTRIES · JULY 1962

SYSTEMS—WISE . . .

RADIO-COMMAND GUIDANCE SYSTEM FOR MANNED MERCURY-ATLAS LAUNCHES

Our manned orbital missions are tracked, during launch phase, by the big "ears" of a radar antenna like this one. The ground command guidance system, supplied by General Electric's Defense Systems Dept., Syracuse, N. Y., will guide the Atlas by radio commands till the precise velocity and flight path angle are reached. With the capsule at orbit injection point, the system sends a signal to cut-off the missile's engines.

▸ The police are testing UHF TV, in an experiment to see how TV might help in speedier law enforcement. New York City's Finest have had sets installed in Headquarters and key stations throughout the city. They will be used for receiving in-service training films, telecasts of line-ups (on specially modified sets) and other police programs.

▸ A complex of radar mapping test areas was completed in April of '61, and is already in limited use. The complex is made up of 3 areas, Willcox Dry Lake, in Arizona, and 2 sites in the east. The sites are providing careful pre-test calibration, realistic testing, and statistical evaluation and comparison of equipment and techniques of radar systems alleged to have a mapping capability. The sites are under the direction of the U. S. Army Engineer Research and Development Labs., Ft. Belvoir, Va.

▸ The Veterans Administration is automating its Dept. of Insurance. Using 4 Digitronics Dial-o-verter magnetic tape terminals and the Bell System Data-Phone subset 201B, approximately 4 million words of insurance information will be transmitted daily over telephone lines, at 3,000 words/minute, between Philadelphia, Denver and St. Paul. Digitronics Corp., Albertson, N. Y. is supplying the Dial-o-verter systems.

▸ The Coast Guard has awarded ITT Federal Laboratories at Nutley, N. J. a contract to furnish the complete radio transmitting equipment for 8 new stations of the Loran-C long range navigation system. Loran-C gives extremely accurate fixes over long distances, by means of low frequency signals that follow the earth's curvature.

▸ Hughes Aircraft Co's. Aerospace Group, Culver City, Calif. has been awarded a $4 million letter contract by the USAF to develop VATE (Versatile Automatic Test Equipment). The system, which will automatically check-out inertial guidance systems, will be located at the Heath Annex of the USAF's Depot, Middletown, Pa.

▸ Students learn at least as much from instructional TV as they do from conventional classroom teaching. Stanford University's Institute for Communication Research reported that 21% learned more from TV; 65% learned as much as in a classroom; and 14% learned less than in a classroom. Results were measured by the usual final exams or standardized tests.

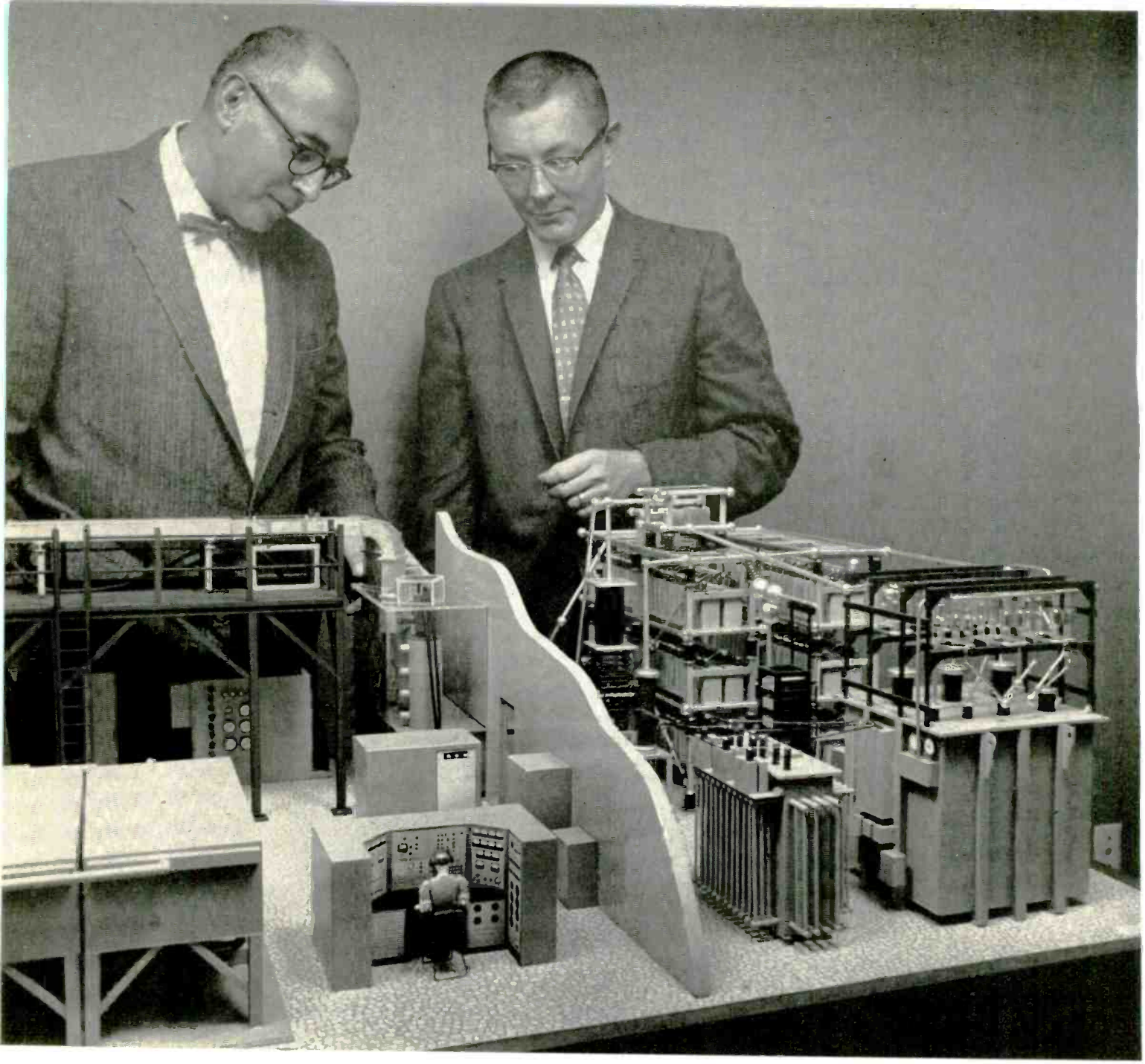
▸ Heart of 3 ground computer systems, for support of the Saturn vehicle program, will be the RCA 110 computer. Two of the systems will be delivered to Huntsville, Ala.; the other one goes to Complex 37 at the Cape. RCA is providing the systems under a $1,928,000 contract from NASA's Marshall Space Flight Center at Huntsville.

▸ A short-wave antenna, improving transoceanic communications has been developed by the U. S. Army Signal Corps and Avco Corp's. Electronics and Ordnance Div., Cincinnati, Ohio. ISCAN (inertialess sterrable communication antenna), which is electronically sterrable, does away with characteristic muffling and fading of overseas broadcasts. ISCAN consists of 24 simple vertical dipole antennas, a processing center to combine the signals through various length delay lines and underground cables connecting the antennas to the center.

▸ An altitude control system, allowing flight down to 50 feet and speeds, at that height approaching sound, has been announced by M. ten Bosch, Inc., Pleasantville, N. Y. Using a computer, radio altimeter and preset altitude, the aircraft can whiz along and be within one foot of desired altitude, even in a turn with bank angle of 70°.

FIELD TESTS OF EASILY TRANSPORTABLE 300 MILE RANGE TRANSMITTER-RECEIVER

Built for field use, the AN/TRC-77 weighs 26½ lbs. and has a 10w power output. Now undergoing field tests at Fort Monmouth, N. J. and Fort Huachuca, Ariz. the unit can be strapped to an infantryman's back, removed and set into operation quickly. The sets were built by the Electronic Defense Laboratories, Western Operation, Sylvania Electronic Systems, Mountain View, Calif.



MANY problems face the design engineer when he moves to the high voltage or high average power transmitter field. These are defined as 50 kv and/or 100 kw of average power consumption. There are good solutions to some of these problems and no really pleasant solutions to others. A discussion of a few of the salient problems and some of their possible solutions will at least forewarn the engineer who finds himself in this area for the first time.

Fig. 1 shows a model of a high power transmitter. This unit, now in final test, will provide 2.5 Mw peak and 150 kw avg power at 430 MC. This transmitter will drive Cornell University's 1000-ft diameter antenna located in Arecibo, Puerto Rico.

Problem areas associated with the design of large equipment can be divided as follows: problems due to large quantities of stored energy, both electrostatic and magnetic; higher line voltage; protection of low level components in high level circuitry; insulation; and grounding and monitoring.

Problems Due to Large Quantities of Stored Energy

Stored electrostatic energy: $E = \frac{1}{2} CV^2$

Many radars depend upon getting considerable power on the target. There being a limit to the peak power available with existing components, systems are going to longer pulse lengths. Pulses of 10 to 20 ms. duration are not unusual. This type of operation requires a large capacitor bank to minimize voltage droop. The typical bank shown in Fig. 2 is part of the Cornell transmitter and provides 7 Mw, 10 ms. beam pulses with an average power capability of 660 kw. There are three series groups of 55 kv capacitors with 88 capacitors in parallel on each level. This provides a bank of 20.5 μf at 165 kv, which can be reconnected for 46.2 μf at 110 kv. Stored energy capability is therefore $\frac{1}{2} CV^2 = 279{,}000$ joules.

The most economical capacitor case style, in the 55 kv range, is able to store about 1,000 joules. About 10,000 joules is enough to explode the case and/or make a projectile of the bushing. Clearly, if there

The engineer designing a high power transmitter for the first time faces many problems. Some of these problems are discussed and possible solutions given.

High Power Transmitter Design

By G. E. TALLMADGE

Senior Project Engineer
Radiation at Stanford
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are many parallel units each storing 1,000 joules, a dangerous situation will exist if one unit shorts and the others dump their energy into the fault. There are several ways to avoid this. One is to place a special high speed fuse on each capacitor. These are expensive and may add considerable inductance to the bank. Also, specification which will allow high peak bank discharge currents, and yet not cause thermal fatigue in the fuse, is difficult.

A better solution is to use 200 w wirewound resistors in series with each capacitor. In repeated tests 88,000 joules did not shatter these resistors. It only blistered them and usually opened the winding. The resistors also provide a way of visually finding the shorted capacitor. In 50 tests, no resistor shattered and no capacitor exploded. About one failure in ten cracked the capacitor bushing. The capacitors must be far enough apart to prevent the shorted bushing from arcing to the adjacent high voltage bushings, or the resistors will be useless.

Fig. 1 (left) A. J. Morris, President, Radiation at Stanford (l), and author G. E. Tallmadge, view a model of 2.5 Mw peak and 150 kw av. UHF radar transmitter for the 1,000 ft radio astronomy dish at Arecibo, P. R.

If the bank is also to be used for short pulses (0.1 μf or less), the inductance of the resistors and capacitors must be accounted for. If for this reason it is impractical to use resistors, another method can be used. Capacitors in the 50 kv range can be purchased which consist of three series sections per can. If one section fails, the remaining two have enough strength to hold for a short time. Included in the can is a pressure switch which activates due to the gas pressure generated by an arc. This switch is used to shut down the transmitter. Unfortunately, these capacitors are much higher in price than the simpler type.

Shorting bars for these large banks require current limiting. It is handy to know that 200 w wirewound resistors can stand 55 kv momentarily from end to end and that 100 k Ω units (the largest commonly available) can stand a discharge of at least 2,900 joules per resistor without damage. Some types of non-inductive wirewound resistors cannot be used due to the winding configuration which enhances turn-to-turn arcing at the ends of the resistor.

Specifying the capacitor itself can be a problem. One can usually obtain contractually a failure rate of 0.01% per 1,000 hours without incurring significant additional cost. One of the best indicators of capacitor quality is the dissipation factor. If this is not specified, the designer will probably receive units of 0.6% dissipation factor (at 1 KC). 0.5% can usually be obtained without additional charge. About the best that can be commonly obtained is 0.3%. This is a customary figure for power factor correction utility capacitors, which often see service for 30 years.

A more difficult parameter to specify is the ringing frequency, or internal inductance. The designer must determine his real need here because cost is usually related to lower inductance. Typically, a 55 kv unit rated at 0.7 μf may have a ringing frequency of about 150 KC, unless specified otherwise. Capacitors can, however, be built with reversing current paths to obtain flux cancellation, and with coaxial or thin disc-type bushings instead of the conventional petticoat insulators, thus providing lower effective internal inductance.

If really fast rates of current rise are needed, the designer will have to consider not only the component parts of the bank, but the overall geometry as well. The bank in Fig. 2 is about 16x12x14 ft. high and weighs 22 tons. Inductance of this device would be prohibitive for a very short pulse radar. For such extreme cases the bank might be constructed as a large distributed line to reduce inductance effects.

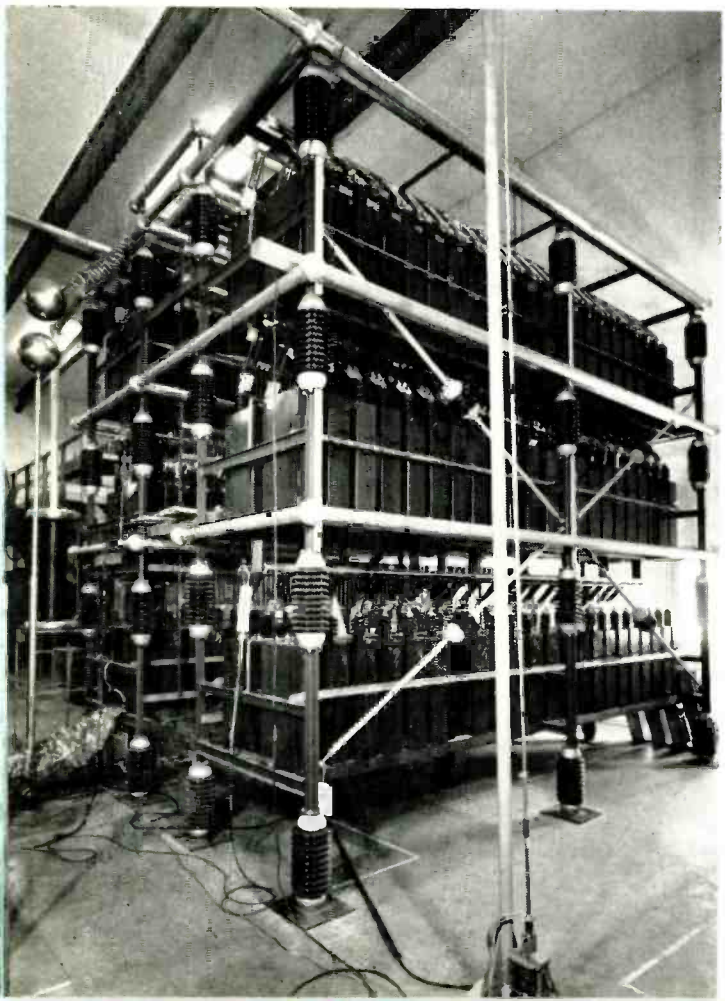
Transmitter Design *(Continued)*

For long life it is important to properly specify the current rating of the bank. One must calculate the RMS current due to the pulsing load and due to the filtering action of the bank on the ripple of the power supply. Another effect of load current is voltage sag. When the above bank is arranged for 46.2 μf @ 110 kv and a 10 ms 60 a. pulse is drawn, the voltage will fall from 110 kv to about 97 kv at the end of the pulse, a sag of 12%.

If the output tubes are klystrons, this implies a 17% drop in beam current and, therefore, a 25% drop in r-f output (neglecting loss of efficiency). One must be sure this is allowable. Concurrent with this sag, another effect occurs which may or may not be allowable. In electrically long tubes, such as klystrons, a lower beam voltage means a longer tube in terms of wave lengths. This implies that the phase of the r-f output will lag that of the signal source increasingly as the pulse persists. This lag can be deduced if the electrical length of the tube is known, coupled with the knowledge that the beam velocity is proportional to the square root of the beam voltage (excepting relatavistic effects over perhaps 50 kv). This also indicates that an equivalent FM displacement of the carrier can be deduced. Thus, capacitor bank size is very important, particularly in Doppler radars.

A further implication of large stored electrostatic energy is that when an arc occurs in the final amplifier, something must be done to prevent the tube receiving all of the stored energy. Banks for use with electron tubes are now in design or operation at levels above 500,000 joules. 500,000 joules is the equivalent of ¼ lb. of TNT. In view of this, perhaps the designer should be thinking about fault diverting equipment (commonly called crowbars).

Fig. 2. Capacitor bank can be arranged for 150 kv @ 20.5 uf or 110 kv @ 46.2 uf. Triggered ball gaps in air that act as a fault diverter are seen at top left.



A crowbar is a device which can sense a failure and very rapidly place a short circuit across the capacitor bank. Capacitors in the bank must, of course, be specified to take this type of repeated discharge. For small, low voltage banks, hydrogen thyratrons have been used, but generally they are not built for such rugged service. For large low voltage banks, ignitrons have been used successfully. For high voltage banks some experimental work is being done with trigitrons (triggered cold gaseous discharge devices). However, the best approach presently available seems to be triggered ball gaps in air (Fig. 2).

In the three-ball variety one ball is attached to each terminal of the capacitor bank. They are spaced so that they will not arc with maximum dc voltage on the bank. A third ball, the trigger ball, is placed near the bank high voltage ball. When a fault is sensed, the trigger ball rises in microseconds to between 200 kv and 800 kv, depending upon the system. This causes an arc between the trigger ball and the bank's high voltage ball. This in turn causes an arc between the two balls on the bank, shorting the bank. Discharge characteristic of the bank depends upon the capacitance, the resistors in series with each capacitor and the various inductances of the circuit. Discharge currents of 15,000 a. are not uncommon. Even so, a really large bank would take several hundred μsec. to empty itself. However, with proper circuit configuration the voltage at the tube is removed in a few μsec.

By inserting a small limiting resistor in series with the final amplifier cathodes (5 to 100 Ω) the short circuit path of the crowbar is a much better one than the tube fault path. Hence, the name "crowbar" is something of a misnomer; it ought to be called a fault diverter.

To illustrate the effectiveness of the crowbar of Fig. 2, a short circuit was imposed without a crowbar through a 24 kw 75 Ω resistor weighing perhaps 30 lbs. The resistor was totally destroyed, throwing bits and pieces over a 75-ft. radius. However, with the crowbar operating normally, the resistor didn't even get warm to the touch. Furthermore, the resultant 1,600 a. arc was struck to a piece of solder. The only effect was a tiny nick where the arc struck.

Stored Magnetic Energy: $E = \frac{1}{2} LI^2$

Until the advent of semiconductors, most electronic engineers didn't worry much about stored magnetic energy. This was because the stored energy in small magnetic parts was not enough to destroy thermionic and passive parts. With the advent of large transformers weighing 20 tons or more (Fig. 3), even previously immune equipment has become susceptible. This is particularly true since high speed disconnect devices such as vacuum switches are finding common usage in these circuits, especially silicon diode-type power supplies. Therefore, the designer must now estimate this energy and do something about it.

There are a number of easy solutions. Points that

should be suspected are the inputs and outputs of all magnetic devices in which current can be interrupted quickly. This includes plate transformers, autotransformers, filter chokes, large magnets, etc. Properly spaced ball gaps may be placed on the legs of 3 ϕ devices, or across chokes to prevent breakdown of insulation. However, the magnetic component manufacturer must know about this use of arc gaps so he can surge wind the ends of his coils. This must be done because the rapid rising wavefront is still present and is only limited to perhaps 1½ times normal. This is the most economical method for high voltage units. Another method is to use Thyrites, lightning arrestors, or Autovalves. These are resistors which decrease in resistance as voltage is increased; some are coupled with arc-gap devices. Another method which is suitable at lower ac voltages—say to 10 kv or so—is to use ac transient suppressing capacitors sold for the purpose by several heavy electrical equipment manufacturers. In this case, the voltage peak to be expected can be found by equating the electrostatic energy equation with the magnetic equation and solving for voltage $\left(E = I\sqrt{\frac{L}{C}}\right)$. When using capacitors it may be desirable to limit inrush current with a small resistor. Use of capacitors has the incidental advantage, if they are large enough, that they may serve to enhance power factor.

Power factor can become a problem because as voltages become very high, insulation thickness of the transformer windings causes the leakage inductance to become very large. In a 150 kv 600 kw transformer this may be two or more henries per leg. For small transmitters in the 10 to 20 kw range a pf of 0.8 is reasonable; however, in big units a pf of 0.6 may be encountered. This is in no way enhanced by the 10 to 50 hp induction motors required for fans and coolant pumps. In addition to this, transformer leakage reactance is often specified artificially high (up to 25%) in silicon diode power supplies to help limit short circuit diode current.

High Line Voltage Problems

The principal problem facing the electronic engineer who works for the first time at line voltages over 600 v. is one of lack of familiarity with what equipment is available. It would be worthwhile to obtain one or two switchgear catalogues from any of the principal manufacturers (Westinghouse, G. E., etc.) and peruse them. One can fine out about boric acid fuses, fuse coordinating, oil-air and air blast circuit breakers, inverse time fault relays, potential and current transformers, load interrupting switches, and a host of other vital items, many of which were being developed before electronics left its infancy.

Specifically, there are two things many electronics engineers are more or less unaware of. One is called offset. When a short circuit occurs and it is rapidly interrupted, the peak fault current may exceed that which would be anticipated merely by dividing the line voltage by the source impedance. Offset may require fault current ratings as high as 75% over the value indicated by the source impedance. This is so important that most high-power circuit breaker manufacturers include the offset current in their ratings.

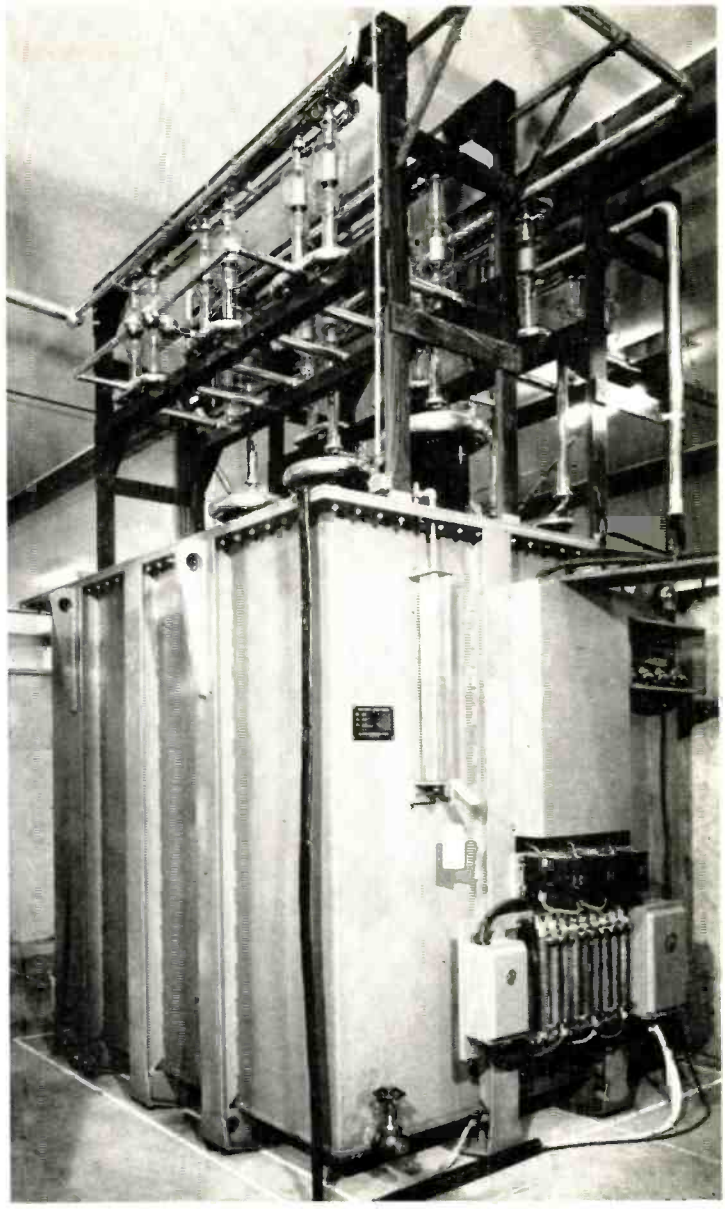


Fig. 3. 22-ton transformer for 150 kv 4.4 amp power supply.

A common error in designing higher voltage systems is that of not specifying BIL ratings and using instead electronic voltage ratings on equipment attached directly to the line (potential transformers, etc.). If it is desired to monitor line voltage on a 4160/2400v three-phase line, the designer may go to an electronic transformer manufacturer and simply stipulate 5 kv insulation. He will probably get a 10 lb. transformer about 4" on a side with ceramic bushings ⅜" in diameter about ⅝" high, and it will be very economical, at first.

Sometime in the next year he will probably be called upon to remove about 10 lbs. of charred metal. Had he used a utility-type potential transformer, it would have been about 50 lbs., 14x11x8" with bushings 2" high and probably would have included high voltage fuses. The difference lies in the fact that the latter device has at least a 60 kv BIL rating attached to it. BIL refers to "basic impulse insulation level" and implies a test with a wavefront rising in 1.5 μs and falling in 40 μs which will not destroy the item. The obvious point here is that the designer is now working directly on the mains, or at best, removed by one large transformer. Hence, he is heir to transients of large magnitude about which he has little knowledge.

Another problem in large radars, particularly in long pulse interplanetary radars, is that line flicker

may be caused by the pulsing. Power companies take a dim view of this and it may effect contractual matters if someone has to service several miles of powerline or insert a motor generator with a large flywheel. Furthermore, it may be necessary for the electronics engineer to brush up on per unit calculations before he can converse with the power company on this and related subjects.

Protection of Low Level Components for High Level Circuitry

This problem is brought about because all parts do not scale up with the power level of the transmitter. Transistors, diodes, meters, zeners, relays, lights, etc., are just the same in any transmitter, yet fault currents may be 25,000 a., and pulse voltages may be 700 kv. The most common problem seems to be with meters which for the most part have 50 mv movements and 300 v insulation from movement to case. The best solution seems to be to bypass these meters with capacitors and to run capacitors from the movement directly to the panel in which the meter is placed. Large silicon diodes capable of short bursts of 1,000 a. are advisable as additional bypass elements. At a forward voltage of 50 mv they conduct only a few microamps and thus do not seriously shunt the meter movement until a heavy overload appears. It is possible by these means to place a 100 ma meter in a circuit which conducts 2,000 a. during a fault, and also to place a 100 mv meter three feet from a 400 kv pulsed crowbar, without losing the meters.

A paramount requirement is that the engineer trace all of the possible paths that fault currents might be expected to take due to the failure of high voltage components. This will quickly show which parts will be overstressed. If the circuit is in air, one may use a needle or ball gap to bypass the current. If it is under oil, a sealed arc gap can be used. These can be obtained with flashover ratings from about 750 v. to about 50 kv and some can carry upwards of 5,000 a. Needle gaps are recommended only for low current noncritical circuits, as the tips tend to erode. Furthermore, they can't be expected to work with repeatable results at arc-over spacings less than 400 v. Large glow tubes would be better for low voltage cases but they can handle only a few joules. Where better high voltage calibration is required, balls should be used where the spacing is not more than one-third the ball diameter. Stainless balls can handle thousands of amps hundreds of times without affecting the firing point.

Approximate spacings in air for ball gaps can be deduced from the following:

$$l = \frac{0.9Vd}{75000d - 0.9V}$$

Where l is the separation in inches
d is the ball diameter in inches
V is the desired peak arc-over voltage

Insulation Problems

Oil is the most commonly used insulation for high voltage systems. Pertinent questions regarding oil are: What are its properties? What can it be expected to do? How does one maintain it?

There are a great many types of oil; however, the majority of applications involve ordinary transformer insulating oil. Shell Diala, Wemco C, and Chevron Insulating Oil are common names for roughly equivalent oils.

The reason for using oil is its dielectric strength. Where air breaks down at about 7.5 kv/0.1", oil will stand about 30 kv/0.1". The latter figure is variable, depending upon purity of the oil, with particular regard to the water that has been taken up by the oil. Newly processed oil may be as good as 45 kv/0.1", but if it is left exposed to air for several days, it may absorb enough moisture to fall to 10 kv/0.1". If it is necessary to leave a large surface area exposed for prolonged periods, it may be worth while installing thermostatically-controlled oil heaters. If the oil is kept 10 or 20°F above room temperature, even 10,000 gals. with 50 sq. ft. of exposed surface will go weeks without falling appreciably. Care must be taken not to scorch the oil by using heaters designed to emit too many watts/unit area as water heating elements do.

Maintenance of oil is necessary due to water absorption and to contamination that may be caused by dissolving of immersed materials or the introduction of foreign matter, usually as the result of a component failure or an arc. In large installations a clean, dry storage tank in which to put the oil during reprocessing, is essential. Reprocessing is best done with a filter press. These units filter, heat, and centrifuge the oil. Typical units will process 100 to 500 gals./hr. Dielectric strength can be tested in a flash cup test set.

The second desirable aspect of oil is its ability to conduct away heat. As an example, a Machlett DP11 triode designed for oil immersion has a 2.7 kw filament. In air the seals overheat with just the filament turned on.

Table of Maximum Gradients

Parallel Planes	$E = \frac{V}{l}$
Sphere and Plane	$E = \frac{0.9V}{l}\left(1 + \frac{l}{2/r}\right)$
Two Spheres	$E = \frac{0.9V}{l}\left(1 + \frac{l}{2r}\right)$
Two Coaxial Cylinders	$E = \frac{V}{r\ln\left(1 + \frac{l}{r}\right)}$
Cylinder Parallel to Plane	$E = \frac{0.9V}{r\ln\left(1 + \frac{l}{r}\right)}$
Two Parallel or orthogonal Cylinders	$E = \frac{0.45V}{r\left(1 + \frac{l}{2r}\right)}$

When E is maximum gradient in volts/unit length
V is voltage between elements
l is shortest distance between elements
r is radius of sphere or cylinder—(inner cylinder in coax case)

A REPRINT
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

In free convection oil, the plate dissipation rating is 6 kw, and with forced oil flow, it is rated at 30 kw.

Corona in oil must be avoided just as in air. A reasonable design basis is to start with 35 kv/0.1" oil and plan on letting it fall to 25 kv/0.1". If one then plans on stresses no greater than 12.5 kv/0.1", no trouble should be encountered. The following table may help estimate radii and spacings necessary to prevent corona.

Grounding and Monitoring

Grounding and monitoring clutter often present problems in large systems. There is no ideal solution for grounding problems. Obviously, all major units must be grounded for equipment and personnel safety reasons. When large transient currents with high rates of rise are involved, ordinary wire is not the best connector because of its relatively large inductance. One should use wide, thin strips of copper. Strips 40" x 0.010" are not unreasonable. It is often wise to choose the circuit with the most severe current problems and make this the central ground point for the entire system, taking care to have radial ground connections to the peripheral equipment. Closed ground loops are to be avoided if possible because hundreds of amps can be induced in them. Also, thousands of volts can be developed across even a five-foot piece of copper 24" wide. The latter is the main reason for having only a single ground point which preferably should be attached to rods sunk into the earth. Coax shields are often the cause of multiple ground loops. It is not always necessary or advisable to ground both ends of the shields.

No matter how substantial ground connections are between units which may be spread over large areas, there will be some 60 cps voltage difference between the units. As much as two or three volts may be more or less unavoidable. Finding the exact source can be an impractical prospect due to the hundreds or even thousands of wires that thread through the equipment. Hence, it is advisable to keep oscilloscope waveforms over 20 or 30 v. where possible.

Detected r-f waveforms present a problem because they usually can't be greater than one to three volts. In this case one can use an "inside-outside dc block." This is a high pass filter in both the center conductor and shield of the coaxial block.

These pass only r-f signals, thus blocking 60 cps transmission. A quarter wave length shorted stub can be used to establish a dc return for the crystal.

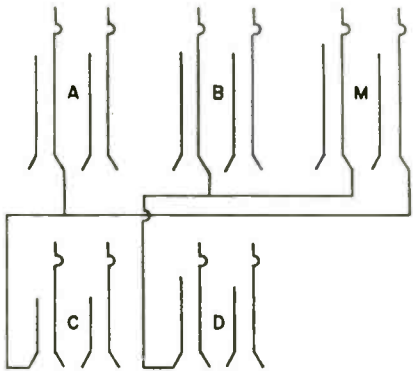
The conclusion to be drawn from these comments is that few new principles are involved in putting together higher power transmitters. However, much more care must be directed at what used to be secondary effects and there is room for considerable ingenuity in circumventing them.

CUES for Broadcasters

Patch Cord Tester

GEORGE W. SHARPE, Ch. Eng.
WEAN, Providence 2, R. I.

To test patch cord conductivity and shielding quickly, connect single circuit jacks as shown in diagram. Observing cord polarity, plug cord into jacks "A" and "B". An ohmmeter or other conductivity indicating device is plugged into jacks "M". Reverse cord in jacks "A" and "B" to check other conductor. Insert cord into jacks "C" and "D" to observe shielding continuity.



Wiring diagram for the patch cord tester. An ohmmeter is connected at "M."

Editor's Note: The addition of a small battery and a bulb to this tester would serve as a visual continuity indicator.

Video Plug Modification

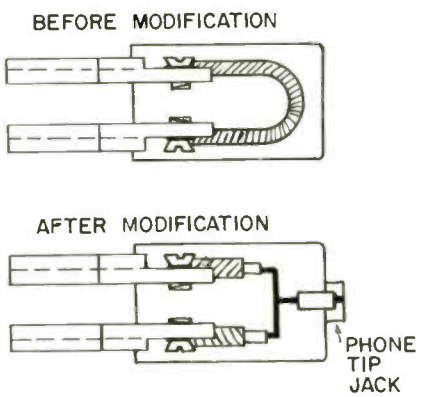
STEPHEN J. STANLEY, Studio Sup'v.
WAST TV, Albany 4, N. Y.

The following modification was made on a number of our RCA video normal plugs. We did this to provide pick-off points on the video patch panel for waveform observation. This makes it possible to set levels and troubleshoot from one location.

The modification is made as follows: First disassemble the plug and remove the connectors. Bolt together the two bakelite halves and drill a ¼ in. hole in the end opposite the connectors. Be sure to clamp in a vise to prevent breakage while drilling.

Next cut the coax connecting the connectors at ex-

(*Continued on page* 174)



Modification of video plug permits observing waveforms of the video signal.

WASHINGTON News Letter

MICROWAVE USE INQUIRY—The FCC has launched a detailed inquiry into the use of the microwave portion of the radio-frequency spectrum by common carrier and private organizations. The inquiry will include hearings and solicitation of written statements. Aimed at improvement of frequency utilization, it will emphasize protection to service channels in microwave systems and the necessity for using broadband channels in the systems for order wire and alarm circuits. The rules to be issued by the Commission as the result of the inquiry will have the aim of carrying out in detail microwave policy decisions made by the FCC in 1960.

2,000 MC BAND TO EDUCATIONAL TV—Along the lines of rulemaking in the microwave area, the FCC is preparing to open up the 2,000 mc. band to educational TV. Com. Robert E. Lee said transmitting equipment in this band can be produced at a fraction of the cost of broadcast band equipment. He predicted that the microwave band proposal could make available more than five additional TV channels to every community.

ALL-CHANNEL TV SETS—The manufacture of UHF TV receivers is expected to be stimulated by passage of the all-channel bill now before Congress. TV manufacturers through the EIA plan to approach the FCC to request participation in setting up a definition of "adequate" UHF performance. The EIA also wants to participte in establishing standards for receiver reception and sensitivity.

IMPORTANCE OF COMPONENTS—AT&T Vice President Claude M. Blair, in an address before the Society of Military Engineers, expressed the Bell System's confidence in its Telstar satellite, particularly its design and proved construction of small parts for trouble-free service. He detailed specifications, saying it will contain 2,528 semiconductor devices—1,064 transistors and 1,464 diodes.

SATELLITE COMMUNICATIONS BILL—Procedure slowed up final action on the satellite communications bill after it was reported out by the Senate Commerce Committee by a 15-2 vote. Because the two dissenting Senators were given ten days to file their views, action was delayed for several weeks. Proponents of government ownership, a small segment of the Senate body, opposed the bill also.

The bill reported out by the Senate Commerce Committee followed the broad outlines of the satellite communications bill passed overwhelmingly by the House by a 354-9 vote and the bill endorsed by the Senate Aeronautical & Space Sciences Committee. The legislation's supporters feel the several points of major difference in the Senate and House versions can be resolved speedily in a joint conference. The Senate Commerce Committee bill strengthens the role of the FCC in administering the act and gives the Commission more flexibility in determining ownership of ground stations to be used in the system. The Senate committee measure also brings in the Small Business Admin. as an adviser to the FCC on procurement matters.

National Press Building
Washington 4
ROLAND C. DAVIES

FIVE YEAR U. S. PROCUREMENT PLAN—Of major importance to electronics and other defense manufacturers is the 5-year procurement plan the Defense Department is making up on military supply and research needs to help business, workers and communities gear their economic policies. It was announced at the final session of the President's Conference on National Economic Issues by Defense Secretary McNamara. He said the advance plans will be laid out by industries and areas. Saying that total defense spending will be in excess of $50 billion annually for the next five years, McNamara added: "Such information would be extremely valuable in planning measures to soften the impact of inevitable changes in development and production programs."

NEW R&D CONTRACT PLAN—The Pentagon is considering a "reverse pyramid" procedure for awarding R&D contracts. Under this system, a multiple competitive approach to technology would result in fewer approaches to systems development and still fewer production items for a given use. The first response of a defense agency needing a certain system would no longer be toward a development contract. The agency would, instead, first study alternative weapon characteristics and capabilities of companies. Companies would then perform short-term study work (30-180 days) on methods to accomplish alternative specifications.

LUNAR-ORBIT CONCEPT—Some NASA officials are reportedly leaning toward a lunar-orbit rendezvous, instead of an Earth-orbit mission, for the first American landing on the Moon. Space agency officials have been reticent to comment on the change because the mission would be considerably cheaper than the Earth orbit flight. The House has already approved a $3.6 million authorization bill for Project Apollo on the basis of undertaking the Earth-orbit flight. Some elements of NASA oppose changing to the lunar-orbit concept. Others favor it. Top officials are keeping mum.

CUES for Broadcasters

(*Continued from page* 168)

actly the center. Cut back the rubber insulation allowing about ¼ in. to remain beyond the back end of connectors. Unbraid the shield and twist together on each connector. These are later soldered together to form a continuous shield. Next, cut inner conductor insulation, leaving about ⅛ in. of conductor exposed. Lay the two connectors in one half of the shell and solder the shields together. Then solder the two inner conductors together with a jumper. Finally solder the tip jack to the jumper so that the test end protrudes from the end of the shell. Reassemble the normal plug.

After this modification was made, a Telechrome multiburst test signal was fed through the patch panel. The signal was observed at the source, at the tip jack, and at the sink. There was no loss or degradation observed.

Automatic Plotting at UHF of Filter Frequency Response

At a recent exhibit a system for automatically plotting the frequency-response characteristics of filters and other networks at high frequencies was demonstrated. In the demonstration, the frequency characteristics of a 500MC low-pass coaxial filter were plotted

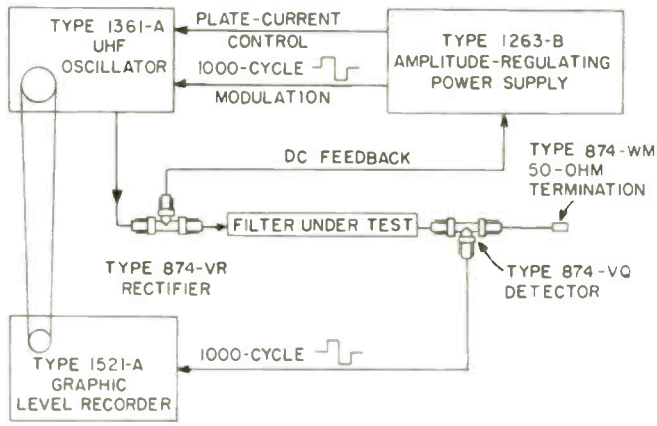


Fig. 1: Block diagram of automatic plotting set up.

Fig. 2: Amplitude regulating power supply, uhf oscillator and graphic level recorder used to plot frequency response characteristics of filters and other networks at high frequencies.

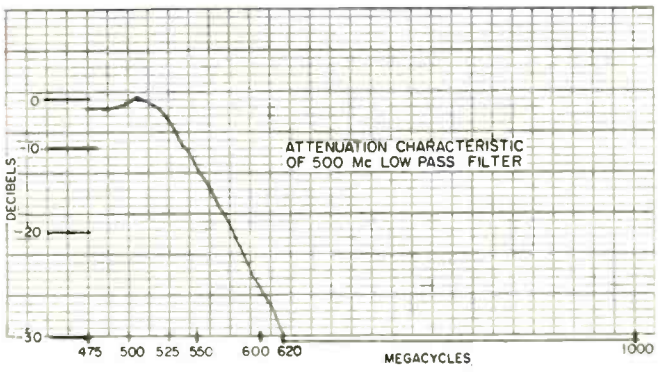


Fig. 3: Typical attenuation characteristic reading obtained with automatic plot system.

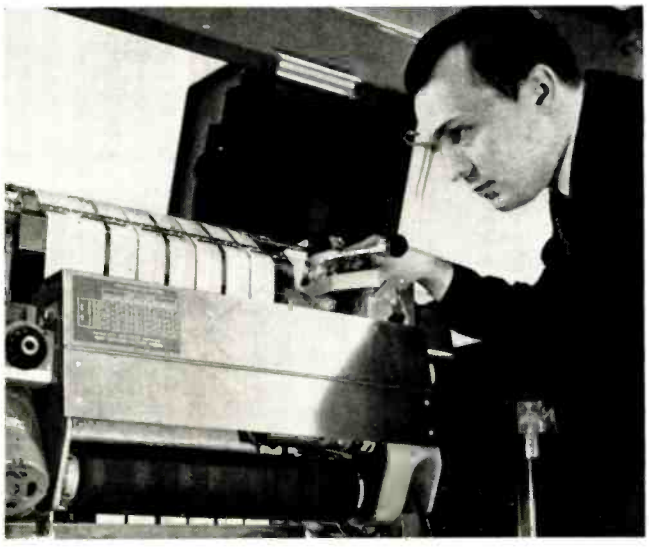
on a General Radio Type 1521-A Graphic Level Recorder.

In operation, the oscillator frequency-control dial is driven through a chain coupling by the recorder motor. The oscillator output level is held constant by an amplitude regulating power supply, which also modulates the oscillator with 1000CPS square waves. Amplitude control is by feedback of the rectified oscillator output to the power supply, which automatically controls the oscillator plate current to maintain constant amplitude of oscillation. A second rectifier demodulates the r-f output of the filter under measurement, and the 1000CPS output is applied to the recorder.

The amplitude regulating power supply, which acts as both amplitude controller and modulator, makes it possible to extend this automatic plotting technique to r-f; heretofore, the method has been widely used only in the a-f range. The use of square-wave modulation avoids the incidental frequency modulation that accompanies sine-wave amplitude modulation and which could be a serious source of error in the measurement.

BANK AID

New tape listing feature for IBM 1403 printer permits banks to speed up sending groups of checks to banks on which they were drawn. Feature enables IBM printer to produce separate tape listings of electronically sorted groups of checks. Banks can thus complete many transit sending operations by passing documents once through IBM MICR system.



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AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
El Tech. Electronic Technology
GEC J. General Electric Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Bull. Fr. El Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
El. et Auto. Electronique et Automatisme
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Uebertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
Nach. Z. Nachrichtentechnische Zeitschrift
Rt. Regelungstechnik
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechnizne

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radioteknika i Elektranika
Rad i Elek. Radioteknika I Elecktranika
Iz. Acad. Bulletin of Academy of Sciences, USSR.

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ANTENNAS, PROPAGATION

Influence of the Earth in Transhorizon Radio Links. F. Du Castel. "Onde." Jan. 1962. 19 pp. The author studies the influence of the diffraction phenomena on the earth in the radio waves propagation beyond horizon. This study presents, particularly, the works of V. Flock, in the University of Leningrad, using the complex integral method which have not yet been published in French. Results of the study of the propagation phenomena are applied essentially to the ultra short waves. (France)

Progress in the Construction of Common Aerials Using Novel Components. Heinz Licht. "Rundfunk." Feb. 1962. 5 pp. Communal aerial installations are expected to feed to those sharing them, via a distribution circuit, the TV signals in Bands I, III, IV and V. Signal-to-noise ratio existing at the aerials may not be noticeably reduced. Remarkable progress may be achieved in this respect with new components that are particularly favorable, in Bands IV and V, regarding the insertion loss, matching and decoupling. Author describes the method of operation, the practical design and the possibilities of application for two of these components. (Germany)

Wind-Pressure on Aerial Masts and Towers at Great Heights Above Sea-Level. Fritz Staiger. "Rundfunk." Feb. 1962. 3 pp. The author gives an example of calculation for an aerial tower whose altitude at the base is 1000 m above sea-level. (Germany)

Impedance Measurements on Rhombic Aerials and Associated Transmission Lines. R. C. Barton and K. F. Ferres. "Proc. AIRE." Jan. 1962. 9 pp. Impedance/frequency characteristics of two 2-tier HF rhombic aerials and a 4-wire transmission line for a radio receiving station are investigated. Basic design and constructional features are briefly discussed. (Australia)

The Effect of Several Reflection Points in Antenna Feeders of FM Radio Relay Systems. U. v. Kienlin and A. Kurzl. "Freq." Feb. 1962. 10 pp. Paper discusses the influence of several reflection points in long antenna feeders on the transmission quality of frequency-modulated radio relay systems. Frequency response of the reflection coefficient at the input of such feeders and the envelope delay distortion due to such points of reflection are determined. (Germany)

Design of Tchebyscheff-Type Directional Couplers With Weak Coupling. A. L. Feldstein and E. S. Zhavoronkova. "Radiotek" 17, No. 1, 1962. 11 pp. A method is offered which can be used in the synthesis of multi-element directional couplers having optimal properties. Typical problems are tabulated for the number of elements ranging from two to eleven. Examples are given to illustrate the design technique. (U.S.S.R.)

A Waveguide with a Parallelogram Cross-Section. E. G. Solovyeff. "Radiotek" 17, No. 8, 1962. 2 pp. An approximate theory of electromagnetic wave propagation in a waveguide with parallelogramic cross-section is presented. An equation is derived for the phase constant of type Hmo waves. Design calculations are compared with experimental results. (U.S.S.R.)

AUDIO

Artificial Reverberation. H. Kuttruff. "Freq." March 1962. 6 pp. After a brief review of the principal characteristics of natural reverberation, the paper describes first the principle of increasing the reverberation time of rooms. The principal point is the method by which the required additional reverberation is produced, i.e., how a given electrical signal is "reverberation-conditioned." (Germany)

Is 1 Neper = 8.6858db and is it Permissible to Add Appendage to db? W. Reichard. "Freq." March 1962. 6 pp. The question posed in the title as to whether 1 Np = 8.6858db and whether affixes may be attached to decibel units, was answered in the affirmative on both counts in a lecture held before 1961's NTG-Convention at Frankfort "100 Years of Electroacoustics," i.e., it is recommended to make such an agreement. (Germany)

CIRCUITS

Reduction of Time in the Analysis of Discrete Radio Signal Spectra by the Method of the "Active" Analysis. I. M. Zhlobinsky and L. G. Sodin. "Radiotek" 17, No. 2, 1962. 10 pp. Basic relationships among the parameters of an "active" spectrum analyzer are investigated. A more effective circuit for the realization of the device in question, which provides an increased saving in the analysis time, is offered. Parameters are selected for the device, retaining the sensitivity and the resolution, and the amount of time saving in the analysis through the use of this circuit is determined. (U.S.S.R.)

Delay Lines with Distributed Constants as used in Nano-Second Band Pulse Circuits. V. A. Solovyev. "Radiotek" 17, No. 1, 1962. 10 pp. Delay lines with distributed constants are analyzed to determine possibilities for designing small size delay lines for high frequency circuits. A design method based on time relationships is given. Formulae for the build-up time of the distributed capacitance of a spiral line are derived. Designs of delay lines with a multilead flat spiral and a double reverse lead are analyzed. (U.S.S.R.)

Bistable Multivibrator. S. Lacaux. "El et Auto." Feb. 1962. 2 pp. This paper presents a non-saturated bistable multi-vibrator using two 2N337 transistors, two Zener

diodes and five ordinary diodes. It can operate at frequencies up to 1mc. (France)

Amplifiers of High Amplitude with Tunnel Diodes. J. Markowski. "Roz. Elek." Vol. 7, #4. 23 pp. An equivalent diagram of a diode is given and its characteristic parameters are discussed. Article also gives the analysis of a circuit with a negative resistance and the conditions of stabile work of such a circuit are also given. A few sets of amplifiers with a tunnel diode are analyzed from the point of view of a maximum amplification of power and from the point of view of maximum bandwidth and a minimum coefficient. (Poland)

Applications of Micrologic Elements. H. Rotceig. "El. et Auto." Feb. 1962. 4 pp. Paper describes several practical designs based on micrologic elements. They are a clock pulse generator, a six-input gate, a complementary flip-flop, a binary counter with carry gate, a parallel decade, a decimal conversion matrix, a shift register, a two's complementer and a serial full adder. (France)

Pulse Generation by Parabolic Lines. O. N. Litvinenko. "Radiotek" 17, No. 2, 1962. 9 pp. Two pulse-generating circuits with parabolic lines are analyzed. The first circuit, employing a parabolic line as a forming two-terminal circuit, lowers the charge potential on the line proper. The second circuit, having the property of forming and transforming pulses, contains two parabolic lines, one determining the duration of the generated pulse, the other the coefficient of transformation. (U.S.S.R.)

Reduction of a Multi-Pole Circuit to an Equivalent Four-Pole Circuit. A. A. Tiutin. "Radiotek" 17, No. 3, 1962. 10 pp. A method to reduce a multi-pole network to an equivalent four-pole network is analyzed. Method is based on separating a group of coordinates, provided that the components of the master vector, corresponding to the unseparable branches of the circuit, are equal to zero. (U.S.S.R.)

Design and Investigation of Voltage—Doubling Rectifying Circuits. E. A. Karpoff. "Radiotek" 17, No. 3, 1962. 7 pp. A design method for complex electrical circuits with rectifier elements is offered. Expressions, relating circuit parameters to harmonic components of the current flowing through the rectifier are derived. Operation of symmetrical and unsymmetrical rectifier circuits with voltage doubling are investigated. (U.S.S.R.)

COMMUNICATIONS

Ideal Reception and Prediction of Phase Telegraphy Signals with Fading. V. S. Melinkoff. "Radiotek" 17, No. 1, 1962. 10 pp. Noise-proof features of an ideal receiver with prediction are analyzed for reception of phase telegraphy signals. An evaluation of the expected probability of an erroneous phase telegraphy signal reception, with fading present, is given on the basis of the observed autocorrelation magnitude of shortwave signals. (U.S.S.R.)

The Transmitter Characteristics of the Stereophonic FCC Multiplex System for VHF-VM Broadcasting. A. Ruhrmann. "Nach. Z." March 1962. 6 pp. Required values and tolerances for all operations data of the stereophonic FCC Multiplex System are quoted and their effects and relationship between each other are investigated. (Germany)

The Experimental Determination of Non-Linear Distortion in a Discriminator for Frequency Modulation. J. Marique. "Onde." Jan. 1962. 11 pp. It is recalled first that the rate of production of harmonics due to non-linear distortion can, with advantage, be determined experimentally. It is shown that if one uses a frequency scanning device it is possible under certain conditions to replace the derivative dv/df by dv/dt with reference to time which such a device makes it possible to obtain automatically. (France)

The Octuple Layer Cable, a New Constructional Element for Symmetrical Communication Cables. G. Demmel. "Nach. Z." March 1962. 6 pp. Eight conductors twisted around a core of insulating material and systematically transposed at regular intervals can be used as a new symmetrical design element requiring less cross-sectional area per cable pair than a multiple twin quad—or a star quad. (Germany)

Telemetering Equipment for a Survival-at-Sea Trial. H. S. Wolff. "Brit. C.&E." March 1962. 5 pp. The inflatable life raft has been provided with signalling equipment of a number of types, including radio, to attract potential rescuers. Article describes telemetering equipment used in survival-at-sea trials of such life rafts. (England)

Standard Frequencies in Test Fields for Long Distance Communication Systems. K. Brennecks. "Freq." Feb. 1962. 3 pp. Certain tests on communications transmission systems call for voltages at standard frequencies. Concepts are explained, the principal transmitters of standard frequencies are enumerated and some typical measuring accuracies are stated. (Germany)

Reduction of Mutual Interference Between Radio Communication Channels in the Transmission of Random Sequenced Signals. M. S. Gourevitch. "Radiotek" 17, No. 3, 1962. 7 pp. A possible approach to the study of mutual interferences is analyzed. It is shown that the analysis of real communication properties is simplified if these properties are represented in the form of a sequence of functions displaced with time. (U.S.S.R.)

COMPUTERS

Some Methods of Designing "Voltage-Code" Converters. M. G. Reinberg. "Avto. i Tel." Vol. 23, #2. 11 pp. New methods of converting voltage into binary code are considered which are varieties of the dynamic compensation principle. (U.S.S.R.)

Fail-Safe Logic Using Multi-Aperture Ferrite Cores. D. H. Hardy. "Brit. C.&E." March 1962. 5 pp. Requirements for a "fail-safe" logic system are stated, and the means are described by which safety may be achieved. A multi-aperture magnetic device, which is readable and inherently "fail-safe" has been chosen to form the basis of a complete logical switching system. (England)

The Use of Analog Computer Elements in VLF Measuring Technique. G. Meyer-Brotz. "Freq." Jan. 1962. 7 pp. Measurement of the real and imaginary parts of the complex frequency response can be reduced to simple elementary operations such as addition, integration, and multiplication. For performing these operations the electronic analog computers present computing elements of high accuracy whose frequency range is also specially adapted to the problems of measuring applications at lowest frequencies. (Germany)

Magnetic Tape Generator of Random Pulse Successions. M. G. Kalachev. "Avto. i Tel." Vol. 23, #2. 4 pp. Generator of random pulse successions is considered which permits reproduction of the same realization of the random pulse process. This realization can be used for statistical analysis of sampled-data control systems by means of analog computers. (U.S.S.R.)

Methods for Solution of Linear Algebraic Equation Systems by Means of Electronic Computers. M. V. Rybachov. "Avto. i Tel." Vol. 23, #2. 8 pp. Different methods of solution of linear algebraic equations by means of an electronic computer are compared. The gradient method is shown to be the most universal one. (U.S.S.R.)

Determination of Frequency Characteristic with the Help of Computing Unit of Electronic Model. L. N. Darovskikh. "Avto. i Tel." Vol. 23, #2. 4 pp. The way of the experimental determination of the phase-amplitude characteristic points by means of the computing units of the electronic models is described. (U.S.S.R.)

A Critical Appreciation and Comparison of AC and DC Servo Systems. F. Walker. "Brit. C.&E." March 1962. 6 pp. In this article the emphasis is on remote position control (r.p.c.) systems especially those in the high-power range, although the remarks made will apply equally well to velocity control systems. A comparison is made between dc systems and amplitude-modulated ac systems, and certain lines of future development are suggested. (England)

Supervisory Remote Control Manchester-Liverpool-Crewe Railway Electrification. A. O. Davies and O. Jones. "ATE Jour." Jan. 1962. 17 pp. This supervisory and remote control system is concerned with the power feed to railway tracks and a brief description is first given of power feed arrangements and methods of railway working. (England)

Remote Indication and Control Equipment Application to Lighthouses. H. V. Paris and D. H. J. Taylor. "ATE Jour." Oct. 1961. 13 pp. A system is described which was developed primarily for the remote control and monitoring of lighthouses from a base station using a line or a radio link. A description is given of the "base" and "outstation" equipments and their functions, followed by the pulse transmitting/receiving principles of the system. Fuller details are then given of the transmitting/receiving units. (England.)

To Problem of Synthesis of Optimum Controller in Time-Delay Systems. Chang Jen-Vay. "Avto. i Tel." Vol. 23, #2. 5 pp. Based on the dynamic programming principle an approximate method of the synthesis of an optimum controller in the time-delay systems is described. (U.S.S.R.)

Synthesis of Automatic Control Systems with Random Actions. I. N. I. Sokolov. "Avto. i Tel." Vol. 23, #2. 10 pp. A method is suggested for the determination of the desired transfer function of the automatic control system with the astatism of the set order and with random stationary actions. (U.S.S.R.)

Concerning Mechanical Synthesis of Compensation of Devices by Means of Self-Adjusting Systems. O. A. Charkviani and V. K. Chichinadze. "Avto. i Tel." Vol. 23, #2. 10 pp. Results of mechanization of the synthesis of some automatic control devices by means of self-adjusting systems are described. The self-adjusting system realizes the search of the synthesized device structure and parameters. (U.S.S.R.)

To Problem of Realization of Compensator Parameters Control in Disturbance Control Systems. A. A. Belenky. "Avto. i Tel." Vol. 23, #2. 5 pp. Invariance problems in the

Sources

disturbance control systems are considered for the case of stationary random functions. (U.S.S.R.)

GENERAL

Estimate of Combinative Frequency Level and of Permissible Fluctuation of Levels of Frequency Code Telemechanics Signals Sent Simultaneously, V. L. Inosov and B. K. Skirta. "Avto. i Tel." Vol. 23, #2. 8 pp. Analytical way of the estimation of the combinative component level according to the form of the oscillation envelope of two frequencies after their passing through the non-linear element is considered. (U.S.S.R.)

Noiseproof Features of a Receiver Summing Autocorrelation Function Registers. N. F. Vollerner, N. G. Gatkin, M. I. Karnovsky. "Radiotek" 17, No. 2, 1962. 7 pp. Noiseproof features of a correlation receiver of pulse signals are analyzed for the case where the output signal is formed by the sum of the passing autocorrelation function registers, taken with definite weighting factors. Values of weighting factors providing maximum noise-proofing are determined. (U.S.S.R.)

Random Process Probability Distribution Density Analyzer. I. N. Bocharov and R. I. Stakhovsky. "Avto. i Tel." Vol. 23, #2. 7 pp. A model of a probability distribution density analyzer is described which is destined to analyze processes with frequency from fractions of Hz up to 8 kHz. (U.S.S.R.)

Analysis of the Locking Operation in a Tracking Auto-Selector. S. V. Pervatchoff. "Radiotek" 17, No. 2, 1962. 5 pp. Locking operation of a tracking auto-selector is analyzed. Based on the mathematical generality approach which describes the action of the auto-selector and the automatic phase control systems for continuous signals, it is determined how the lock-in band of the auto-selector with an integrating filter depends on the system parameters. (U.S.S.R.)

Input Impedance of Stepped Transitions. L. R. Yavitch. "Radiotek" 17, No. 3, 1962. 4 pp. A solution is presented for the problem of determining the input impedance of stepped transitions. Advantages of transitions with maximally flat frequency characteristics over Tchebysheff-type transitions are shown relative to constancy of the active component and the smallness of the reactive components. (U.S.S.R.)

Advantages of Introducing Cancellation Intervals. L. F. Borodin and I. I. Grushko. "Radiotek" 17, No. 3, 1962. 11 pp. Possibilities of increasing the probability of correct reception of correcting code combination at the expense of introducing cancellation intervals are investigated. Necessary and sufficient conditions for advantageous introduction of the cancellation interval are formulated. Simple evaluations of the cancellation intervals, which maximize the probability of correct reception and minimize the probability of errors, are obtained. Increase in the probability of correct reception is determined. (U.S.S.R.)

Calculation of Optimum Parameters of Ferrite Systems, Operating According to Farraday's Effect. A. M. Starodubtzeff. "Radiotek" 17, No. 1, 1962. 8 pp. Optimum operating conditions of a ferrite sinusoidal and squarewave modulator are derived. The influence of insufficient load matching of the ferrite rectifier on the magnitude of reverse attenuation is determined. An evaluation is carried out of the influence of spatial and time assymmetry in the operation of the modulator on the magnitude of a parasitic signal in the case where the ferrite modulator is used in a modulation radiometer. (U.S.S.R.)

On Effect of "Catch" of Code Rings, G. I. Panov. "Avto. i Tel." Vol. 23, #2. 7 pp. Method of coding continuous values using code rings is considered. (U.S.S.R.)

Controlled Non-Linear Resistance Multiplier, O. M. Kudrjavtzev and R. A. Lipman. "Avto. i Tel." Vol. 23, #2. 6 pp. A multiplier is considered which is based on the controlled transfer coefficient principle. Circuit main element is a non-linear controlled resistance with three pairs of electrodes located in three inter-perpendicular planes. Basic correlations characterizing the circuit operation and the experimental results are proposed. (U.S.S.R.)

Comparative Investigations with Various Methods of Contact Wetting, L. Borchert and K. L. Rau. "Nach. Z." March 1962. 6 pp. Various methods of contact wetting by dc impact, high-frequency and pulses are compared with one another, in respect of contact resistances, fading, unbalance cross-talk and noise in telephone circuits. (Germany)

Construction and Purpose of the Information Converter, Anton M. Springer. "Freq." Feb. 1962. 3 pp. Relationships given by the information storage units are explained and some typical applications are given. (Germany)

The Planning of an Electronic Telephone Switching Center, with Special Consideration Given to the Possibility of Interference, Part I. The Structure of the Experimental System, Winfried Becker. "Freq." March 1962. 9 pp. Part I describes the layout of a small experimental system operating on the path-multiplex principle which was constructed for the connection of six telephone stations of conventional design. (Germany)

Remagnetization of Toroids from Rectangular Ferrite, W. Hilberg. "Freq." Jan. 1962. 8 pp. First the fundamental problems are delineated which are encountered with the analytical treatment of remagnetization phenomena. Besides the problems of remagnetization time, time functions of voltage and current, and energy conditions, the paper investigates the transformer characteristics of rectangular cores with given source and termination impedances. (Germany)

The Influence of Sidetone Level on Pitch and Volume of Speech, P. Riedel. "Freq." Feb. 1962. 6 pp. Statistical investigations reveal that the mean pitch, to which a human speaker adjusts himself without any conscious effort, is related to the mean volume. Variations in the sidetone level give rise to a measurable, if slight, variation of the pitch relative to the volume. Results found suggest that no considerable physiological influence on the timbre of the human voice need be anticipated by the activation of the artificial sidetone path in telephony. (Germany)

Continuous Formation of the Median with Passive Networks, H. L. Langer. "Freq." Jan. 1962. 10 pp. Paper reports on an electric method that is suitable for the continuous formation, over a fixed time interval T, of the arithmetic mean of an arbitrary time function. (Germany)

The Helitran, A Continuously-Variable Ratio Transformer for R-F Bridges, C. G. Mayo and R. V. Harvey. "El. Tech." March 1962. 5 pp. It is difficult to provide an accurately-calibrated standard of conductance for an admittance bridge working over a wide range of radio frequencies. Difficulties encountered with various existing methods are discussed and the advantages of a variable-ratio transformer are shown. (England)

(*Continued on page* 181)

Sources

Logic Circuits, R. Duchamp. "El. et Auto." Feb. 1962. 3 pp. Paper deals with the use of transistors in logic circuits. (France)

TELEVISION

On the Influence of the Magnetic Tape on the Quality of Television Tape Recording. O. Schmidbauer and K. Altmann. "Rundfunk." Feb. 1962. 8 pp. Values for the magnetic flux and the signal-to-noise ratio of sound tapes are compared with those of TV tape recordings. The cause of tape noise lies in the structure of the active layer. It is distinguished between two forms. For FM recording, however, the only one of importance is the modulation noise as a consequence of the external field for the orientated Weiss domains, and beyond this the modulation defects due to inhomogenities of the layer. When these are of larger size, they manifest themselves as "drop-outs." The authors illustrate the reasons for their existence and describe a device for indicating them. (Germany)

Film Recording by the "Negative" Method. Jakob Buhler. "Rundfunk." Feb. 1962. 6 pp. In TV, much importance is attached to the storage of the TV signals. A possibility of doing this is offered by film recording. In the so-called "negative" method, a negative picture is displayed on the screen of the tube and thence photographed on negative film. After developing the film, a positive film is obtained. System involves the use of the suppressed-frame method with either 35 mm or 16 mm film. (Germany)

Deep Fringe Television Reception Problems. I. R. Morphett. "Proc. AIRE." Jan. 1962. 10 pp. During the last year increasing attention has been paid by TV receiver manufacturers to the design of receivers suitable for operation in fringe areas. In this paper, the required sensitivity of the signal amplifiers is discussed and means of protecting the last stage from overload are presented. An AGC amplifier which operates with a constant dc potential derived from the horizontal output stage, and which relies on noise-gating for noise immunity is described. (Australia)

Some New Developments in BBC Television Technique. D. C. Birkinshaw. "Rundfunk." Feb. 1962. 5 pp. Author reviews some projects and developments of recent years. After a description of the present state of construction of the Television Center in London, he discusses the problem of operating television cameras. (Germany)

$$\Delta G = \Delta G / \epsilon n_i \mu_p \ell$$

THEORY

Comparison of Discrete Signal Reception Methods. B. A. Varshaver. "Radiotek" 17, No. 2, 1962. 5 pp. Based on the potential noise rejection theory and information theory, information transmission speed in a communication channel is comparatively evaluated for the cases where code combinations are received in the "whole" and elementwise by an ideal Kotelnikoff-type receiver. (U.S.S.R.)

Predistortion and Filtration in a Channel with Varying Parameters. V. I. Koulya. "Radiotek" 17, No. 2, 1962. 7 pp. A formula is derived for the mean-square error which is caused by a signal with noise passing through a channel with incidental variation of parameters. (U.S.S.R.)

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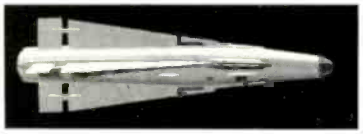
Solid State Computers



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Educational TV Due for Growth

The educational TV field may be due for a great expansion soon with the signing into law of a bill appropriating $32 million in U. S. funds for equipping educational stations and with the pending adaption by Congress of a bill requiring TV set manufacturers to design new sets to receive UHF channels.

NAEB Administrative Vice President Harold E. Hill said a survey among potential backers of educational TV stations recently taken shows as many as 1,000 more channels may be needed in a decade. He said the $32 million appropriation should help get 150 more stations on the air, most within two years.

There is room for 2,200 channels in the country under present FCC standards. There are 62 educational stations in the country at present. The FCC has allocated 273 channels for educational use.

NSF Grants Offer Research Opportunities

College and secondary school science teachers will be encouraged to participate in scientific research. This comes as a result of two groups of National Science Foundation grants.

Grants totaling about $850,000 were made to 48 educational institutions to provide research participation programs for college science teachers. A total of about $735,000 was granted 47 institutions for programs for 370 high school teachers.

Both programs will enable teachers to help carry out research projects of a university or college department and to work directly with the researchers in charge.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient resume form, page 145.

HUMAN ENGINEER

"How far is an arm's length?" Dr. Joseph W. Wissel is getting the answer with help of a mock-up of a section of a Polaris submarine launching tube. As a "human engineer," Dr. Wissel and his assistants at Lockheed Missiles and Space Co., prime contractor for the Polaris missile system, try to make it impossible for Navy technicians maintaining the missiles to make a mistake.

Tech Students Choose Other Careers in College

Interest in engineering, mathematics and science tends to decrease between freshman and senior years among college students, and interest in teaching and business careers grows correspondingly, according to a survey recently made of 5,471 Northwestern University undergraduates.

The survey, taken by Dr. Frank S. Endicott, Placement Director, showed that 25% of the freshmen, but only 15% of the seniors, listed their vocational choices in the engineering, math and science fields.

Endicott said business and teaching seem to attract students after their freshman years. Approximately 7% of freshmen and 13% of the seniors want business careers. The teaching percentage increased from 24 to 42%. Most choosing teaching are women.

Employment Outlook Good for College Grads

The employment picture for the college graduate this Summer was better than last year, especially in the science and engineering fields, reported the U. S. Department of Labor's Bureau of Labor Statistics after a survey of college placement directors.

The survey of Middle Atlantic Region colleges showed that more than two-thirds expected jobs to be more plentiful this year, based on the amount of recruiting going on at their schools.

Leading recruiters were electronic, missile, aircraft, accounting and data processing companies, along with all levels of government, the directors reported. They said technically trained graduates such as electrical, chemical and mechanical engineers, mathematicians, chemists and physicists continued to be in greatest demand.

Salary offers in nearly all areas of science and engineering were expected to range 3-5% higher. Expected salaries quoted for engineers averaged $6,800 a year, ranging from about $6,500 for civil engineers to $7,000 for electrical engineers. Salary offers to physics, math and chemistry graduates were said to average about $6,000.

College Faculty Wages Up in '61-'62

The salary of the average full-time faculty member in a 4-year undergraduate college last year was $7,680. This is 4.8% more than the 1960-61 average ($7,330), and 12.3% higher than the 1959-60 figure ($6,840), according to the United States Office of Education.

The Office reported that the average faculty salary in 4-year public colleges is $7,910, while that in similar private institutions is $7,290. Increases over previous years' salaries about paralleled the overall increases listed above.

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

Managements are playing follow-the-leader in developing and marketing new products in the hopes of reaping high profits.
This article shows how latecomers can wind up with substantial losses; even though they entered the market at a time when demand is still increasing and profit margins are high.

How Late is 'Too Late' In A Competitive Market?

By EDWIN B. BERLIN
Sperry Semiconductor, Div. of Sperry Rand Corp. Norwalk, Conn.

IN a competitive market, a number of companies usually are developing a new or improved product simultaneously. One manufacturer will win the "development" race and begin marketing his product first. Not too much later, similar competitive items begin appearing in the marketplace.

If the demand for the product continues to rise, other producers enter the field, looking to reap profits from lucrative markets.

Eventually, supply satisfies market demand, profit levels become marginal, and the stable market volume can no longer support all suppliers. Those producers with stronger market positions remain with the "matured" product until it gradually becomes obsoleted by another new or improved item.

The late-comers want to assure themselves that a late market entry will not leave them with a heavy capital investment and infinitesimal profit margins.

Excluding the use of prophets hired on retainer, how can the late-entering manufacturer minimize his risks?

Estimates Are The Key

The writer has developed a general procedure for timing market entry which requires the market planner to make five estimates or assumptions. The resultant adequacy of this procedure is in proportion to the accuracy of these estimates:

1. Estimate the length of time the new product will be saleable from its introduction by the first manufacturer to the point when profit margins will not support all existing competitors.

2. Estimate the number of competitors entering the market, when they enter, and their respective market shares for each time period plotted.

3. Estimate the average price range and price trend over the established time scale.

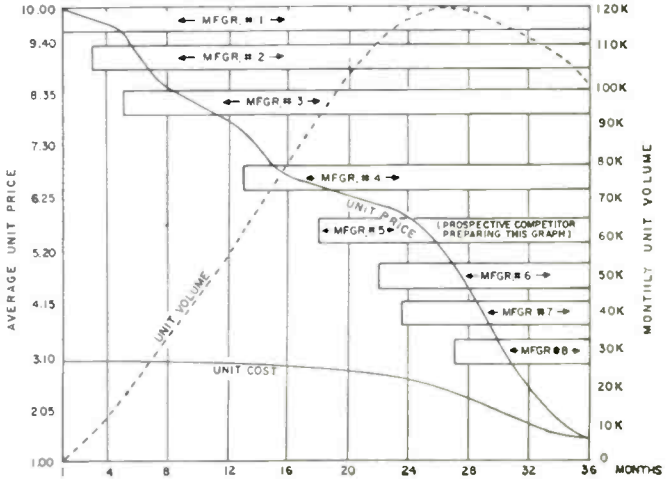
4. Estimate the unit volume range and unit volume trend over the established time scale.

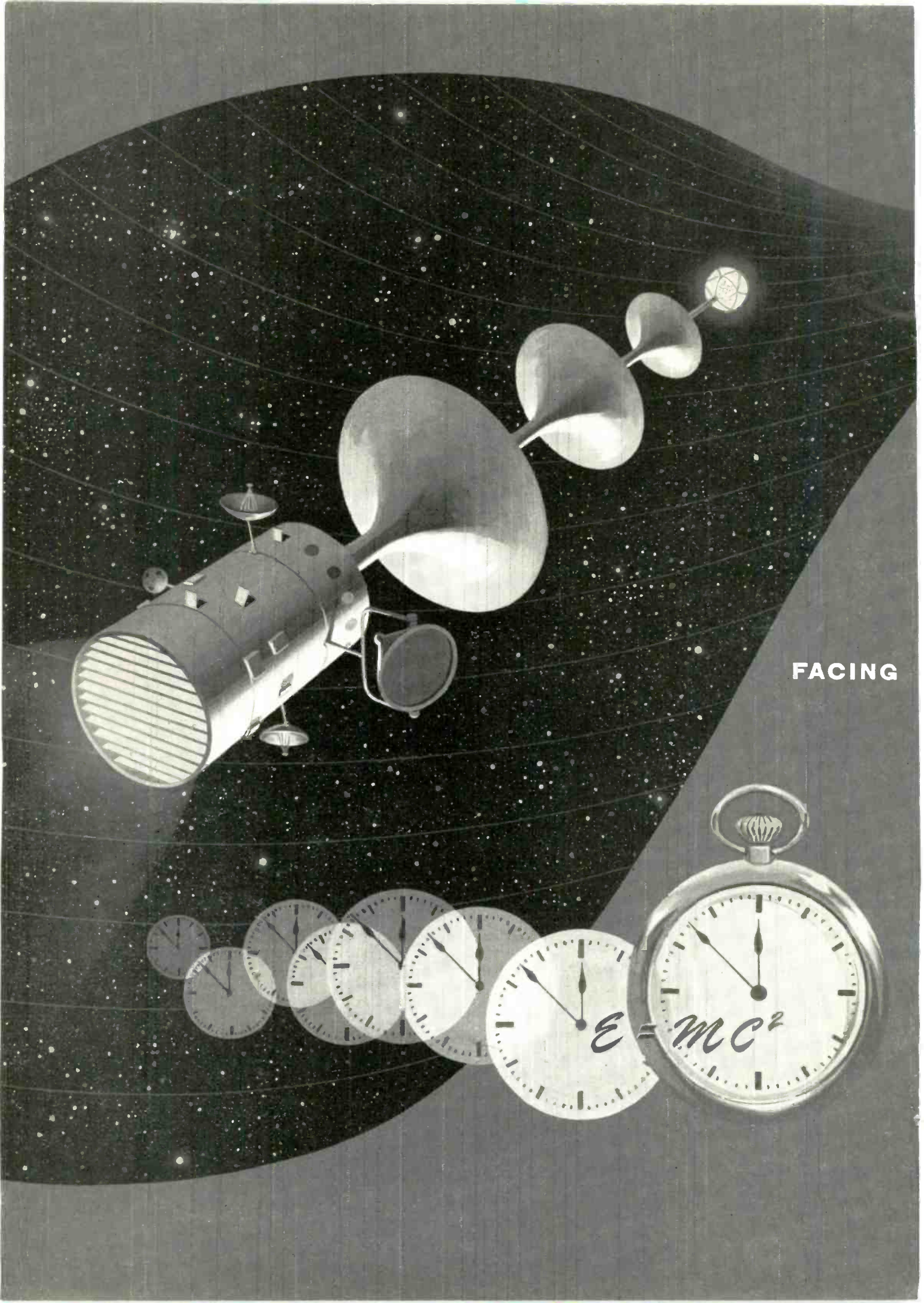
5. Estimate the total unit cost (direct cost plus sales, general and administrative expenses) range and cost trend over the established time scale.

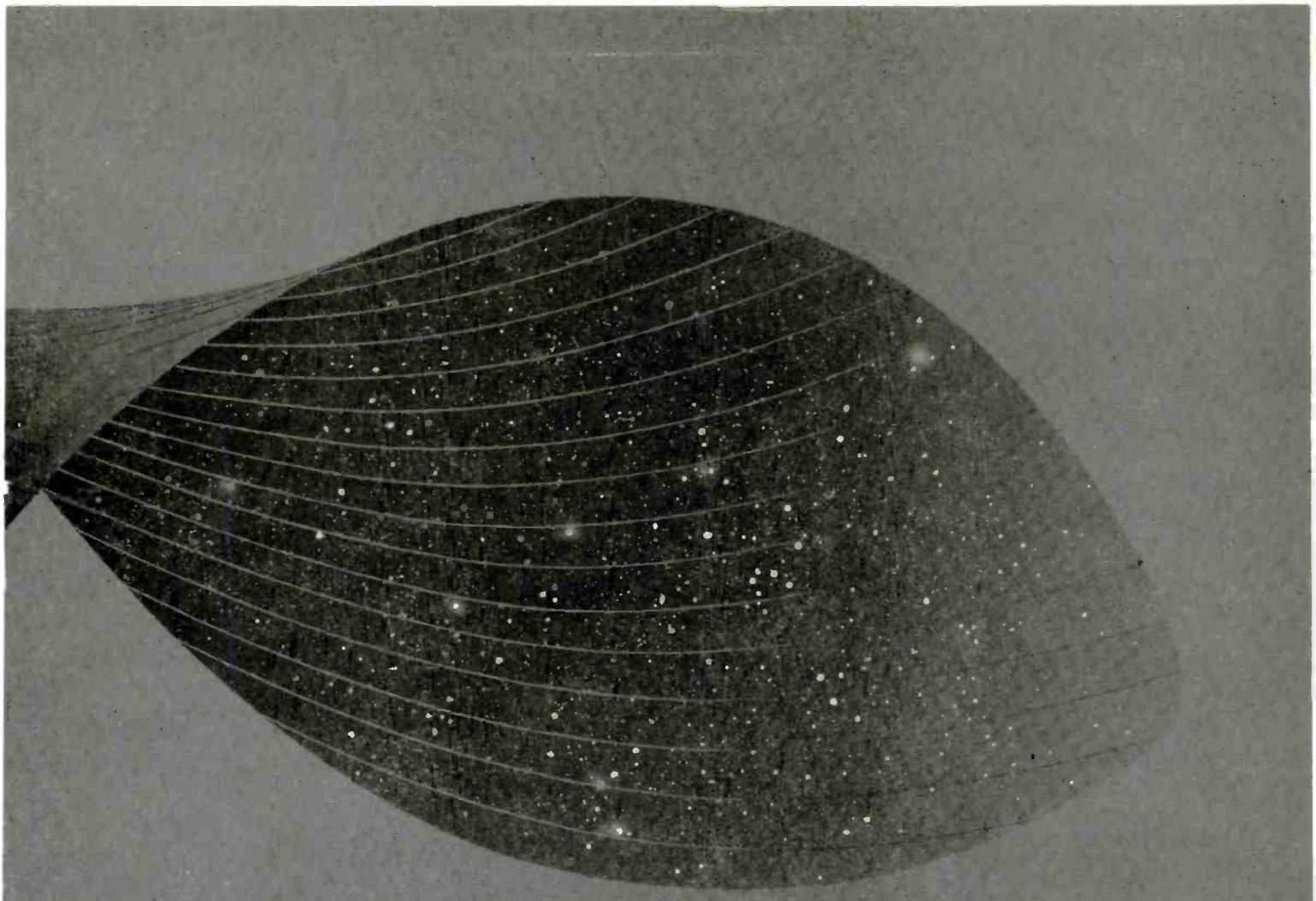
There may be difficulty in arriving at fairly accurate estimates for products which had not yet been marketed, but much of this information can be determined if the product already has been sold. Therefore, a manufacturer considering a belated market entry will have less difficulty with these estimates, especially if similar products previously marketed can be analyzed and used as a guideline.

(*Continued on page* 184)

Fig. 1: When the late manufacturers enter the market, the average selling price still provides acceptable profits for all.




FACING
E = MC²



THE FOURTH DIMENSION IN PROPULSION DEVELOPMENT

Whether the universe has a "saddle shape," or any shape at all, is a matter of interesting conjecture. The matter of space trave , however, s the subject of intense experimentation. A nuclear/thermionic/ionic propulsion system, currently being studied at Lockheed Missiles & Space Company, might well become the power source for space vehicles.

Its design incorporates a nuclear reactor only one foot in diameter, generating heat at a temperature of 1850°K. This is transmitted to banks of thermioric generators, converting the heat directly into electrical energy for the ion beam motor which uses cesium vapor as a fuel. The entire system is designed without any moving parts, minimizing the possibility of failure.

Lockheed's investigation of propulsion covers a number of potential systems. They include: plasma, ionic, nuclear, unique concepts in chemical systems involving high-energy solid and liquid propellents, combined solid-liquid chemica systems. The fundamentals of magnetohydrodynamics, as they might eventually apply to propulsion systems, are also being examined. Just as thoroughly, Lockheed probes all missile and space disciplines in depth. The extensive facilities of the research and development laboratories—together with the opportunity of working with men who are acknowledged leaders in their fields—make association with Lockheed truly rewarding and satisfying.

Lockheed Missiles and Space Company in Sunnyvale and Palo Alto, on the beautiful San Francisco Peninsula, is an exciting and challenging place to work. For further information, write Research and Development Staff, Department M-24A, 599 North Mathilda Avenue, Sunnyvale, California. An Equal Opportunity Employer.

LOCKHEED MISSILES & SPACE COMPANY

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

Systems Manager for the Navy POLARIS FBM and the AGENA vehicle in various Air Force Satellite programs. Other current projects include such NASA programs as the OGO, ECHO, and NIMBUS.

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The Competitive Market *(Continued)*

One graph and two charts are prepared. Using a hypothetical example, the writer will illustrate the steps in the procedure.

The product selected is a non-patentable, small signal, silicon transistor which has some electrical features which are superior to previously manufactured devices. It is assumed that the product has been on the market for six months and that at this time three producers are supplying similar items. Thus, the first six months of this product's history is assumed to be known.

It is also assumed that it will take twelve months from the time of market analysis for a particular manufacturer to bring out a competitive product. He will be Manufacturer Number 5 and will enter the market eighteen months after Manufacturer Number 1. (See Fig. 1.)

Notice in Figure 1 that, when the late manufacturers enter the market, the average price still results in acceptable profit margins and unit volume is still rising. These producers undoubtedly set out with an optimistic picture of future business, only to find that their rosy view has soon wilted. Remember, these suppliers have a *competitive*, not a significantly *superior* product, and they expect to increase their sales not only by taking business away from competition but also as a natural outgrowth of increased market demand.

The following estimates have been developed for this transistor:

1. The time span from market inception to the point at which it is no longer profitable for all existing competitors is thirty-six months.

2. There will be eight competitors in the market and their estimated dates of market entry are plotted on the graph (Figure 1). Their respective market shares are listed in Figure 3.

3. The average unit price range is estimated to be from $10.00 to $1.50, and the price trend is plotted in Figure 1. It is assumed that sharper price declines will occur as more competitors enter the market and as the pressure mounts to reduce inventories.

4. The unit volume range is estimated to be from 500 units to 120,000 units per month, and the unit volume trend is plotted in Figure 1. A gradual volume decline will occur as other improved products are offered for sale.

5. The total unit cost (direct cost plus overhead) range is estimated to be from $3.00 to $1.50, and the cost trend is plotted in Figure 1. Cost declines will result from improved manufacturing techniques, automatic test equipment, and increased volume.

After the price-cost-volume chart is prepared, calculations are made from this chart to develop the schedule shown in Fig. 2. We find that in the 36-month period until the transistor is no longer profitable, more than 2,750,000 units will have been sold for a total of over $14,000,000. The next question to be answered is: "How much of this profitable $14 million market will each competitor receive and how much net profit will accrue to each?"

Fig. 2: Profits diminish with increasing competition.

MONTH	(A) AV. PRICE	(B) AV. COST	(A–B) NET PROFIT PER UNIT	(C) INDUSTRY UNIT VOLUME	(C x A) INDUSTRY DOLLAR VOLUME
1	$10.00	$3.00	$7.00	500	$ 5,000
2	9.92	3.00	6.92	4,000	39,680
3	9.83	3.00	6.83	8,000	78,640
4	9.70	2.99	6.71	12,000	116,400
5	9.55	2.99	6.56	16,000	152,800
6	9.10	2.98	6.12	22,000	200,200
7	8.65	2.98	5.67	28,000	242,200
8	8.42	2.97	5.45	33,000	277,860
9	8.25	2.97	5.28	38,000	313,500
10	8.10	2.96	5.14	44,000	356,400
11	7.90	2.96	4.94	48,000	379,200
12	7.75	2.95	4.80	54,000	418,500
13	7.52	2.94	4.58	60,000	451,200
14	7.17	2.93	4.24	66,000	473,220
15	6.85	2.91	3.94	73,000	500,050
16	6.67	2.89	3.78	78,000	520,260
17	6.52	2.87	3.65	84,000	547,680
18	6.42	2.85	3.57	90,000	577,800
19	6.38	2.83	3.55	96,000	612,480
20	6.27	2.80	3.47	102,000	639,540
21	6.22	2.77	3.45	106,000	659,320
22	6.10	2.73	3.37	111,000	677,100
23	5.96	2.69	3.27	115,000	685,400
24	5.82	2.65	3.17	117,000	680,940
25	5.64	2.54	3.10	119,000	671,160
26	5.28	2.43	2.85	119,000	628,320
27	4.90	2.38	2.52	119,000	583,100
28	4.45	2.32	2.13	120,000	534,000
29	3.85	2.09	1.76	119,000	458,150
30	3.40	2.02	1.38	116,000	394,400
31	2.83	1.88	.95	114,000	322,620
32	2.48	1.75	.73	112,000	277,760
33	2.16	1.60	.56	110,000	237,600
34	1.80	1.56	.24	107,000	192,600
35	1.60	1.53	.07	104,000	166,400
36	1.50	1.50	–	100,000	150,000
			TOTAL UNIT VOLUME		2,764,500
			TOTAL DOLLAR VOLUME		$14,221,480
			AVERAGE PRICE		$5.11

Fig. 3: (far right) Share of the market acquired by each manufacturer.

MFR.	Units Sold	% of Mkt.	$ Sold	% of Mkt.	$ Cost	Net Profit	% of Sales	No. of Profit Months	Avg. Price
#1	895,830	32	$5,162,534	36	$2,285,321	$2,877,213	56	36	$5.76
#2	785,470	28	4,502,623	32	2,059,501	2,443,122	54	34	5.73
#3	474,040	17	2,488,584	17	1,195,272	1,293,312	48	32	5.25
#4	293,050	11	1,173,273	8	631,816	541,457	46	24	4.00
#5	211,720	8	735,815	5	426,271	309,544	42	19	3.47
#6, 7, & 8	104,390	4	158,651	2	—	—	—	15-10	1.52
Totals	2,764,500	100%	$14,221,480	100%	—	—	—	36	$5.11

To determine this, the schedule shown in Fig. 3 is computed from Fig. 2 and estimated market shares for each competitor are entered. In order to remain in harmony with Manufacturer Number Five's probably optimistic view, the writer has permitted each of the first five suppliers to retain a 19% market share by the thirty-sixth month. In addition, only the combined market percentage figure is prepared for Manufacturers 6, 7, and 8, since it is assumed that their individual market shares will not measurably influence the sales of the remaining competitors.

From Fig. 3 we arrive at the following summary data:

Let us assume that all manufacturers have plants producing related items, so that the costs of bringing out this transistor include only engineering development time, capital equipment expenditures, and burden; and that this research and development cost is:

$700,000 for Manufacturer No. 1
$650,000 for Manufacturer No. 2
$600,000 for Manufacturer No. 3
$500,000 for Manufacturer No. 4
$450,000 for Manufacturer No. 5
$400,000 for Manufacturer No. 6
$350,000 for Manufacturer No. 7
$300,000 for Manufacturer No. 8

Since later market entrants will have some knowledge of production techniques as a result of hiring experienced scientists away from prior market entrants, their engineering costs will be lower.

Analysis

Below is listed the net profit or loss to each manufacturer after R&D costs have been deducted:

Manufacturer No. 1—$2,177,213 Profit
Manufacturer No. 2—$1,793,122 Profit
Manufacturer No. 3— $693,312 Profit
Manufacturer No. 4— $41,457 Profit
Manufacturer No. 5— $140,456 Loss

Obviously, Manufacturers 6, 7, and 8 suffer substantial losses.

(*Continued on page* 186)

MONTH	MANUFACTURER #1				MANUFACTURER #2				MANUFACTURER #3				MANUFACTURER #4				MANUFACTURER #5				MFGRS. 6-7-8
	% OF MKT.	UNITS SOLD	$ SOLD	$ COST	% OF MKT.	UNITS SOLD	$ SOLD	$ COST	% OF MKT.	UNITS SOLD	$ SOLD	$ COST	% OF MKT.	UNITS SOLD	$ SOLD	$ COST	% OF MKT.	UNITS SOLD	$ SOLD	$ COST	AGGREGATE MARKET SHARE
1	100	500	5,000	1,500	–				–				–				–				–
2	100	4,000	39,680	12,000	–				–				–				–				–
3	95	7,600	74,708	22,800	5	400	3,932	1,200	–				–				–				–
4	84	10,080	97,776	30,139	16	1,920	18,624	5,760	–				–				–				–
5	69	11,040	105,432	33,010	29	4,640	44,312	13,874	2	320	3,056	957	–				–				–
6	64	14,080	128,128	41,958	32	7,040	64,064	21,050	4	880	8,008	2,622	–				–				–
7	59	16,520	142,898	49,230	35	11,550	84,770	34,419	6	1,680	14,532	5,006	–				–				–
8	53	17,490	147,266	51,945	37	12,210	102,808	36,264	10	3,300	27,786	9,801	–				–				–
9	50	19,000	156,750	56,430	38	14,440	119,130	42,887	12	4,560	37,620	13,543	–				–				–
10	48	21,120	171,072	62,515	38	16,720	135,432	49,491	14	6,160	49,896	18,234	–				–				–
11	46	22,080	174,432	65,357	39	18,720	147,888	55,411	15	7,200	56,880	21,312	–				–				–
12	44	23,760	184,140	70,092	40	21,600	167,400	63,720	16	8,640	66,960	25,488	–				–				–
13	42	25,200	189,504	74,088	40	24,000	180,480	70,560	16	9,600	72,192	28,224	2	1,200	9,024	3,528	–				–
14	41	27,060	194,020	79,286	39	25,740	184,556	75,418	17	11,220	80,447	32,875	3	1,980	14,197	5,801	–				–
15	40	29,000	200,020	84,972	38	27,740	190,019	80,723	18	13,140	90,009	38,237	4	2,920	20,002	8,497	–				–
16	39	30,420	202,901	87,914	37	28,860	192,496	83,405	19	14,820	98,849	42,830	5	3,900	26,013	11,271	–				–
17	38	31,920	208,118	91,610	37	31,080	202,642	89,200	20	16,800	109,536	48,216	5	4,200	27,384	12,054	–				–
18	37	33,300	213,786	94,905	35	31,500	202,230	89,775	21	18,900	121,338	53,865	6	5,400	34,668	15,390	1	900	5,778	2,565	–
19	36	34,560	220,493	97,805	34	32,640	208,243	92,371	21	20,160	128,621	57,053	7	6,720	42,874	19,018	2	1,920	12,250	5,434	–
20	35	35,700	223,839	99,960	33	33,660	211,048	94,248	21	21,420	134,303	59,976	8	8,160	51,163	22,848	3	3,060	19,186	8,568	–
21	34	36,040	224,169	99,831	33	34,980	217,576	96,895	20	21,200	131,864	58,724	9	9,540	59,339	26,426	4	4,240	26,373	11,745	–
22	33	36,630	223,443	100,000	32	35,520	216,672	96,970	20	22,200	135,420	60,606	9	9,990	60,939	27,273	5	5,550	33,855	15,152	1
23	32	36,800	219,328	98,992	31	35,650	212,474	95,899	20	23,000	137,080	61,870	10	11,500	68,540	30,935	6	6,900	41,124	18,561	1
24	31	36,270	211,091	96,116	30	35,100	204,282	93,015	20	23,400	136,188	62,010	11	12,870	74,903	34,106	7	8,190	47,666	21,704	1
25	30	35,700	201,348	90,678	29	34,510	194,636	87,655	19	22,610	127,520	57,429	12	14,280	80,539	36,271	8	9,520	53,693	24,181	2
26	29	34,510	182,213	83,859	28	33,320	175,930	80,968	19	22,610	119,381	54,942	13	15,470	81,682	37,592	9	10,710	56,549	26,025	2
27	28	33,320	163,268	79,302	28	33,320	163,268	79,302	19	22,610	110,789	53,812	13	15,470	75,803	36,819	10	11,900	58,310	28,322	2
28	27	32,400	144,180	75,168	27	32,400	144,180	75,168	18	21,600	96,120	50,112	14	16,800	74,760	38,976	11	13,200	58,740	30,624	3
29	26	30,940	119,119	64,665	26	30,940	119,119	64,665	18	21,420	82,467	44,768	15	17,850	68,723	37,307	12	14,280	54,978	29,845	3
30	25	29,000	98,600	58,580	25	29,000	98,600	58,580	18	20,880	70,992	42,178	16	18,560	63,104	37,491	13	15,080	51,272	30,462	3
31	24	27,360	77,429	51,437	24	27,360	77,429	51,437	17	19,380	54,845	36,434	17	19,380	54,845	36,434	14	15,960	45,167	30,005	4
32	23	25,760	63,885	45,080	23	25,760	63,885	45,080	18	20,160	49,997	35,280	17	19,040	47,219	33,320	15	16,800	41,664	29,400	4
33	22	24,200	52,272	38,720	22	24,200	52,272	38,720	18	19,800	42,768	31,680	18	19,800	42,768	31,680	16	17,600	38,016	28,160	4
34	21	22,470	40,446	35,053	21	22,470	40,446	35,053	18	19,260	34,668	30,046	18	19,260	34,668	30,046	17	18,190	32,742	28,376	5
35	20	20,800	33,280	31,824	20	20,800	33,280	31,824	18	18,720	29,952	28,642	19	19,760	31,616	30,233	18	18,720	29,952	28,642	5
36	19	19,000	28,500	28,500	19	19,000	28,500	28,500	19	19,000	28,500	28,500	19	19,000	28,500	28,500	19	19,000	28,500	28,500	5
	TOTALS	895,830	$5,162,534	$2,285,321		785,470	$4,502,623	$2,059,501		474,040	$2,488,584	$1,195,272		293,050	$1,173,273	$631,816		211,720	$735,815	$426,271	

The Competitive Market

(Concluded)

Clearly, Manufacturers 1, 2, and 3 will do quite well in this market. Manufacturer No. 4 must ask himself if his profit return is worth the investment of working capital and management time, which perhaps could have been put to more profitable use. Manufacturer No. 5 now realizes that he had best turn his talents to more profitable tasks.

If Manufacturer No. 5 had not attempted to determine the net profitability of his product in advance, he would have begun development in the sixth competitive month with market information which was highly misleading and difficult to argue against, for these were the facts at the time:

1. Current monthly unit volume for the industry was 22,000 units and rising rapidly.
2. Current monthly dollar sales volume for the industry was $200,000 and accelerating as though it were going out of orbit.
3. The average selling price that month was $9.10, while the total cost was only $2.98.
4. There were only three competitors in the market, and all were operating very successfully.

The facts are just as misleading twelve months later when Manufacturer No. 5 enters the market:

1. A current monthly unit volume for the industry of 90,000 units and still climbing.
2. A current monthly dollar sales volume for the industry of $578,000 and rising.
3. An average selling price of $6.42 with costs down to $2.85.
4. Only four other competitors in the market.

Conclusions

What did Manufacturer No. 5 overlook?

1. In free competition it doesn't take long before a number of vendors begin their assault on a lucrative market, and competitive pricing eventually reduces handsome profits.
2. Many products enjoy a relatively short period of success before something better comes along, which prevents a continuing rising market demand.
3. Prospective industrial suppliers often assume that they can take the market away from competitors by an aggressive marketing job. However, customers are not likely to change vendors unless the quality, price, delivery, or service of the late-comer are superior. If the original market entrants are performing effectively, they will retain much of their market share.

Thus, it behooves a prospective competitor to examine all the facts and not to be guided only by what appears on the surface.

Once these facts are uncovered Management must decide whether or not it wishes to compete. Despite the possibility of losses, some companies may feel that the need to establish themselves in this *general* market area is a more important consideration. Whatever the decision, now at least, Management will know what to expect and disappointments, if not corporate losses, will be kept to a minimum.

NEW Openings for EEs & MEs in Product Design and Development

Delco Radio's continuous search for new and improved electronic products provides challenging opportunities—in several areas—for capable engineers; specifically:

MOBILE COMMUNICATIONS (Automobile Radiotelephone) **EQUIPMENT**—

EEs—3-5 yrs. Exper—for design of and production assistance with 150 and 450 mc receiver transmitters; transistorization, packaging, duplex operation and dial mobile. Desire experience or interest in mobile communications equipment, private system or telephone link.

Project Engineers—work includes supervising type tests and FCC qualification testing of automotive radiotelephone equipment. Must audit designs for field reliability.

SUBMINIATURE MILITARY COMMUNICATIONS EQUIPMENT—

EE or ME—for assignment to development group designing all-transistor portable transmitters and receivers, operating in 2-100 mc range. FM—AM—FSK—CW—SSB modulation.

AUTOMOTIVE RADIO DESIGN AND DEVELOPMENT—

EE—to work with Senior Engineer on advanced development of auto radios and other entertainment devices, including FM-AM, miniaturized circuitry and components.

ME—for design of small electronic mechanisms, including FM-AM, Signal Seeking and push-button tuners, and components modules.

EE or ME—for packaging of auto radios and associated tuners, solenoids, etc. Required to make some engineering contacts with automobile manufacturers.

DIGITAL CIRCUITS AND SYSTEMS—includes card, module and digital systems design, and production liaison involving components and special purpose systems operating from 200 kc to 10 mc.

Project Engineer—to direct efforts of design engineers and technicians in designing and releasing digital circuits for production. Supervisory experience highly desirable.

EEs—for design and development testing and packaging of transistorized digital switching circuits from 200 kc to 10 mc.

RELIABILITY ASSURANCE—

Project Engineer—to handle tests and evaluations of transistorized systems and components, both power and small signal type. Must evaluate results and associated statistical data. Also includes failure analysis work with suppliers and production.

EE—for design and development work on test equipment for semiconductors and special products, such as radiotelephone.

AUTOMOTIVE ELECTRONICS—non-entertainment automotive electronic development including radio control for Garage Door Operators; other transistor applications in automobile, usually involving electromechanical transducers—

ME—for advanced development work in electromechanical systems used in automotive field.

EE—for design and development of transistorized automobile equipment.

EE or ME—with electromechanical interests for development of electronic equipment for the automotive service market.

● If your interests and experience fall in the above areas and if you're looking for an opportunity to fully exercise your personal competence . . . among men of like talent . . . in unmatched facilities . . . then let's talk. Send your resume today to the attention of Mr. Carl Longshore, Supervisor Salaried Employment.

An equal opportunity employer

solid state electronics ●

DELCO RADIO DIVISION OF GENERAL MOTORS

KOKOMO, INDIANA

Industry News

Richard F. Kirchberger—appointed New England District Sales Manager, Microwave Associates, Inc., Burlington, Mass.

R. F. Kirchberger

W. B. Helms

Walter B. Helms — elected Vice President of Giannini Controls Corp., Duarte, Calif. He will continue as General Manager of Firm's Transducer Div., Pasadena, Calif.

Roger Lewis — elected President, General Dynamics Corp., New York, N. Y.

Radio Corp. of America, New York, N. Y., announces the following Vice Presidential appointments: George A. Fadler—Staff Vice President, Purchases; and Eugene E. Beyer, Jr.—Staff Vice President and General Attorney, Corporate Affairs.

Robert Schramm—appointed Sales Manager, Data Systems Div., Harman-Kardon, Inc., Plainview, N. Y.

Arthur B. Shesser — appointed to the newly created post of Marketing Manager, Electronic Components Div., Burroughs Corp., Plainfield, N. J.

Terry Halpern—appointed Marketing Manager, Control Components Div., International Resistance Co., Philadelphia, Pa.

Minnesota Mining and Mfg. Co., St. Paul, Minn., announces the following appointments: Lloyd A. Hatch—Vice President, Long Range Planning; Dr. C. W. Walton — Vice President for Research and Development; and J. W. Selden—Division Vice President, New Products Commercial Development.

SPECIAL AWARD

Conference

Happy winner shown above is Leon Podolsky, Technical Assistant to the President, Sprague Electric Co., just after receiving the first Special Contributions Award of PGCP during Electronics Components Conference in Washington, D. C. Left to right are: Virgil Graham, Co-Director, EIA Engineering Dept.; Floyd Wenger, PGCP Chairman; Podolsky, and Gustave Shapiro, Awards Committee Chairman.

Thomas C. Pridmore—named to the new position of General Manager, Semiconductor Products, ITT Components Div., International Telephone and Telegraph Corp., Clifton, N. J.

James P. Buckley—appointed to the position of Western Corporate Representative, the Bendix Corp., Burbank, Calif.

E. C. Titcomb—appointed Marketing Director, Computer Measurements Co., San Fernando, Calif.

C. G. Grant—named Vice President, Marketing, Ampex Corp., Redwood City, Calif.

Anaconda Wire & Cable Co., Hastings-on-Hudson, N. Y., announces three new Vice Presidents. They are: **Frank B. Dickey**—named Vice President, Magnet Wire Div.; **Robert E. McIlvane**—named Vice President, Communications Products Div.; and **R. Bruce Van Wagner**—named Vice President, Market Planning and Development.

Stuart R. Hyans—named Eastern Sales Manager, new Metro Div., Ortronix, Inc., Detroit, Mich. He will continue also as Eastern Sales Manager, Electronics Div.

S. R. Hyans

R. S. Saichek

Robert S. Saichek—named National Marketing Manager, Diodes, Inc., Canoga Park, Calif.

Howard S. Roberts — appointed Sales Manager, J. Bishop & Co. Platinum Works, Malvern, Pa.

Thomas L. Paganelli—named General Manager, Heavy Military Electronics Dept., General Electric Co., Syracuse, N. Y.

George A. Franco—appointed General Manager, Advanced Communications Center, Sanders Associates, Inc., Nashua, N. H.

Raymond A. Costello, Jr. — named Sales Manager, Advanced Systems, Communications Systems Div., Philco Corp., Ft. Washington, Pa.

Telemet Corp., Amityville, L. I., N. Y., announces the following appointments: **G. Richard Tingley**—appointed Vice President and Assistant to President; and **Jack Horowitz** — named Vice President, Operations.

John E. Ebert—appointed Vice President, Research, Development and Engineering, Weinschel Engineering Co., Inc., Kensington, Md.

News of Mfrs' Representatives

ERA Names Morgan New Executive Director

Robert J. Morgan has been named Executive Director of the Electronic Representatives Association. He was formerly the Association's Director of Education. He succeeds William C. Weber, Jr., who has resigned to enter private business. Association headquarters is in Chicago, Illinois.

Representatives Wanted

Manufacturer of low frequency filters, pulse transformers, specialty transformers and delay lines wants representatives in the following areas: the Southeastern states, Pennsylvania, Maryland, Southern New Jersey, Northern California, Southern California. Box 7-1, Editor, ELECTRONIC INDUSTRIES.

Ten year old manufacturer of comfort cushioning now in protective cushioning field fabricating molded polyurethane, polyethylene, expanded polystyrene, foam rubber, rubberized hair and heavy-density bonded foam products needs representatives to call on electronic and electronic instrument companies. Box 7-2, Editor, ELECTRONIC INDUSTRIES.

Manufacturer of low frequency oscillators, frequency standards and inverters, wishes representative in all states except the following: Southeastern Coastal states, New York, Connecticut, Northern New Jersey, California, Wisconsin, Minnesota, Iowa, Michigan, Indiana and Illinois. Box 7-3, Editor, ELECTRONIC INDUSTRIES.

Edward Magnuson Co., Chicago, Ill., has been appointed representative by G. B. Components, Inc., Van Nuys, Calif., to cover Illinois, Indiana, Minnesota and Wisconsin.

Graybar Electric Co., Boston, Mass., has been named New England representative by California Chassis Co., Lynwood, Calif.

Frank C. Nickerson Co., Inc., Decatur, Ga., has been appointed representative in the Southeast by Semiconductor Div., the Bendix Corp., Long Branch, N.J., to cover Florida, Georgia, Alabama, North and South Carolina, and Eastern Tennessee.

Malcolm Ross and Co., Los Angeles, Calif. — named representatives for Computer Diode Corp., Lodi, N. J., in Southern California and Arizona.

Chafin Enterprises, Cupertino, Calif., — named representatives for Auto Data, San Diego, Calif., to cover Northern California.

(*Continued on page* 196)

ELECTRONIC INDUSTRIES Advertisers—July 1962

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News of Mfrs' Representatives

(continued from page 194)

Omnitronics, Inc., Philadelphia, Pa., announces the following representative appointments: **Eustis Co.**, Kirkland, Wash., to cover Washington and Oregon; and **Southwest Engineering Sales Co.**, Dallas, Tex., to cover Texas, Oklahoma, Arkansas, and Louisiana.

Spectran Electronics Corp., Maynard, Mass., announced the following representative appointments: **M. J. Fein & Co.**, Scarsdale, N. Y., to cover New York State, and Northern New Jersey; and **Components Sales Corp.**, North Miami Beach and St. Petersburg, Fla., to cover Florida and the U. S. Possessions in the Caribbean.

Associates Industries, Seattle, Wash. — named representatives for Transicoil Div. of Daystrom, Inc., Worcester, Pa., to cover Oregon and Washington.

Raytheon Co., Industrial Operations, announces the following representative appointments for their Sorensen line: **Arnold Barnes Co.**, Dallas, Tex., to cover Texas, Louisiana, Arkansas, and Oklahoma; and **Gawler-Knoop Co.**, Roseland, N. J., to cover metropolitan New York, Long Island, New York counties of Westchester and Rockland, and Northern New Jersey.

General Instruments Corp., Magnehead Div., announces the following representative appointments; **Jack Logan & Assoc.**, San Francisco, Calif., to cover Northern California and Northern Nevada; **Lightner & Assoc.**, Chicago, Ill., for Minnesota, Iowa, Wisconsin, Illinois, Indiana, Southern Michigan, and Western Ohio; and **General Corp.**, Orlando, Fla., for Florida.

EMPLOYMENT OPPORTUNITIES

HELP WANTED

ELECTRONIC ENGINEERS for permanent positions with Federal Communications Commission, Washington, D. C., GS-12, $8,955 to GS-13 $10,-635. Must be graduate engineers with good knowledge of problems involved in the area of space communications. Government will pay expenses for transportation of employee, his family, and household goods to Washington. Attractive fringe benefits include retirement, life and health insurance, automatic pay increases. Good opportunity to enter government career service.

Reply to PERSONNEL OFFICER
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON 25, D. C.

EQUIPMENT, MATERIALS, PARTS & COMPONENTS

From (G-V), the most experienced Time Delay engineers:

Dependability and tolerances guaranteed in low cost RED/LINE thermal timing relay

Time Delays from ½ Second to 3 Minutes and Energizing Voltages from 6.3 to 230 AC or DC

Today, with the increased performance demands of commercial applications, G-V Red/Line thermal timing relays are in widespread use in air conditioning, electronic equipment, heating equipment, communications equipment and industrial control. For excellent reasons. Foremost is the Red/Line's long life and dependability, both previously unavailable except in much higher priced units. The Red/Line relay features a high degree of timing accuracy and a relay mechanism of stainless steel (differential expansion type). No glass is used so there is no danger of cracking or breakage in handling and use. The heating element is designed to ensure long heater life even when the relay is continuously energized. Moreover, a dust-tight metal shell completely encloses the relay mechanism and contacts, providing dust-free protection for the structure. All the time delay intervals are preset at the factory so there is no chance of tampering in the field which might endanger associated equipment. And all Red/Line relays are directly and easily interchangeable with all other octal-size relays in the field. Among the many current applications for Red/Line relays are elevators, dry cleaning machines, automatic doors, flow control equipment, conveyor systems, photo copy equipment and heater controls.

Available rapidly from local distributors

Red/Line relays are produced in both normally open and normally closed types, in the standard heater voltages and delay intervals listed below. All standard types are available from local G-V distributors.

6.3 volts	26.5 volts	48 volts	115 volts	230 volts
0.5 sec.	0.5 sec.	—	—	—
1.0 sec.	1.0 sec.	—	—	—
1.5 sec.	1.5 sec.	—	—	—
2.0 sec.	2.0 sec.	2.0 sec.	2.0 sec.	—
5.0 sec.	5.0 sec.	5.0 sec.	5.0 sec.	—
10.0 sec.	10.0 sec.	10.0 sec.	10.0 sec.	10.0 sec.
20.0 sec.	20.0 sec.	20.0 sec.	20.0 sec.	20.0 sec.
30.0 sec.	30.0 sec.	30.0 sec.	30.0 sec.	30.0 sec.
45.0 sec.	45.0 sec.	45.0 sec.	45.0 sec.	45.0 sec.
60.0 sec.	60.0 sec.	60.0 sec.	60.0 sec.	60.0 sec.
90.0 sec.	90.0 sec.	90.0 sec.	90.0 sec.	90.0 sec.
120.0 sec.	120.0 sec.	120.0 sec.	120.0 sec.	120.0 sec.
180.0 sec.	180.0 sec.	180.0 sec.	180.0 sec.	180.0 sec.

SPECIFICATIONS

Contact arrangement: Single pole, single throw, either normally open or normally closed.

Contact rating:
AC-Non-Inductive: 5 amps to 125 volts and 3 amps to 250 volts.
AC-Inductive: 1 amp to 250 volts.
DC-Non-Inductive: 1 amp to 32 volts.
DC-Inductive: ⅛ amp to 32 volts.
For heavier loads, consult the factory.

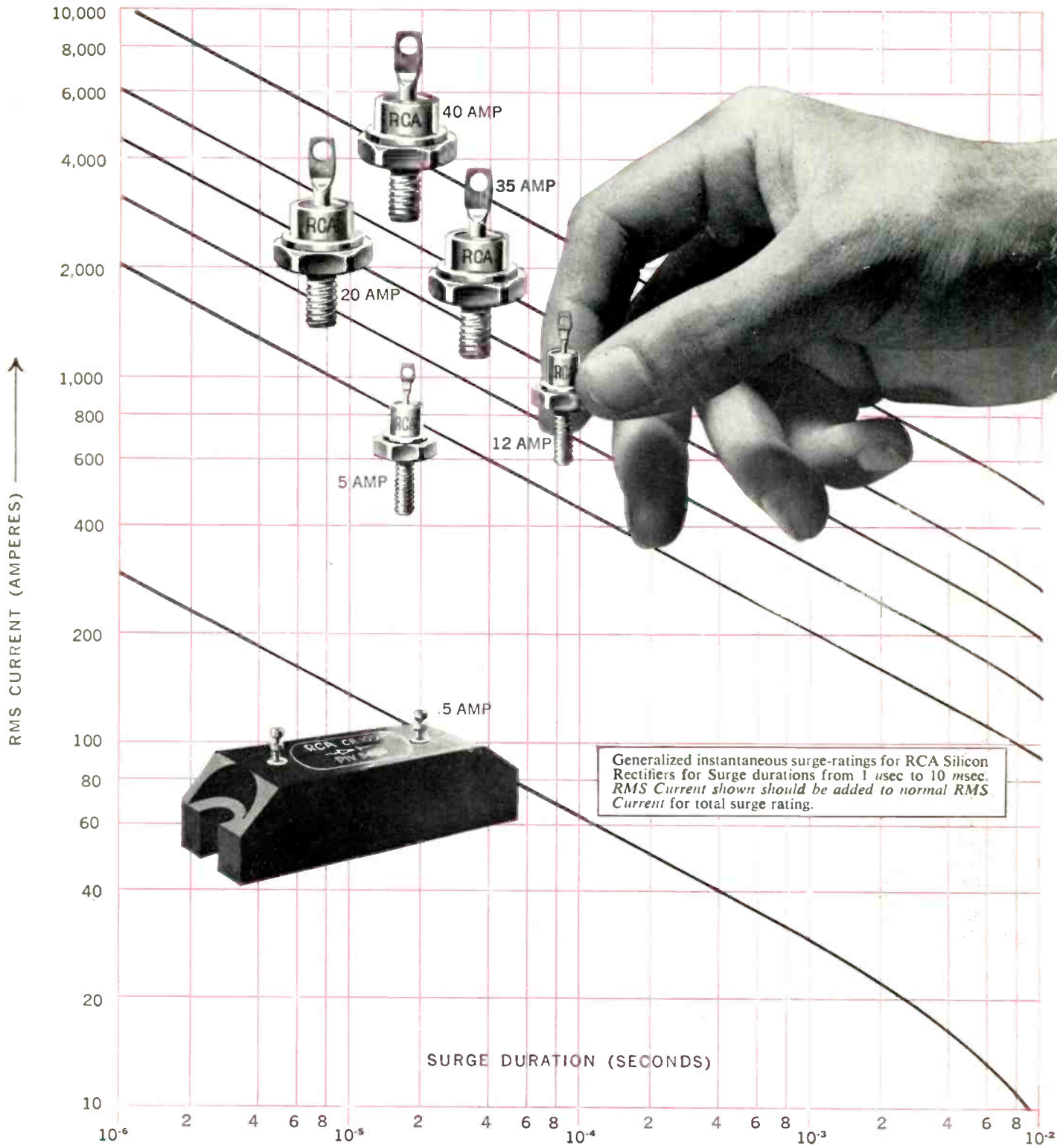
Contact life: Over 100,000 makes and breaks at full rated load.

Operating conditions: Suitable for operation at ambient temperatures up to 185°F. Relay design compensates for the effect of ambient temperatures over a wide range. Operates in any position.

G-V Regional Field Engineers throughout the United States are available for consultation on time delay problems. For complete literature and/or assistance, write to **G-V Controls Inc., Okner Parkway, Livingston, N. J.,** or call **992-6200** (Area code 201), **Mr. George Compton.**

G-V®

Circle 131 on Inquiry Card



Here's New Assurance of Extra Performance... in Every RCA Silicon Rectifier You Specify

Now you can design rectifier circuits with much greater assurance with RCA Silicon Diffused-Junction Rectifiers, because you have *complete* surge information. Check the surge value for the conditions you must meet and you'll find the right RCA rectifier for the job.

RCA Silicon Rectifiers can withstand temporary current overloads hundreds of times higher than average current rating.

Here are some of the features of RCA Silicon Rectifiers that make this quality possible:

- Diffused Junction Process...extremely tight characteristics limits
- Each package designed to meet the stringent environmental and mechanical requirements of today's military and industrial power equipment
- Extra-high-strength zirconium-alloy mounting stud
- Unique internal heat sink assures union of pellet and contact to eliminate high-current hot spots
- Thermal fatigue cycling tests – the best assurance for long and dependable service
- Every unit is dynamically tested prior to shipment

Call your RCA Representative for complete information. For your copy of the RCA Application Note, SMA-4, write to RCA Semiconductor and Materials Division, Commercial Engineering, Section IJ 7, Somerville, N. J.

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