

June 24, 1959

ELECTRONIC DESIGN

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AUG 10 1959



More $f(x)$ Per Dollar From Simple
Plug-In Generator p. 34

advanced PRECISION COMPUTING RESOLVERS for Cascaded Resolver Systems

SIZE 8 FEEDBACK WINDING RESOLVERS

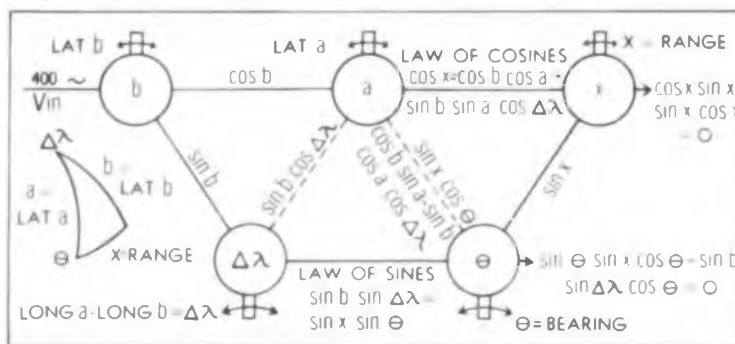


These resolvers are designed for use with transistorized amplifiers and permit the solution of spherical triangles in a size 8 cascaded resolver chain.

Functions of the spherical triangle which can be produced are indicated in the schematic below. More complex trigonometric functions, as well as systems involving coordinate axis transformation, can be generated with the use of these resolvers.

Accuracy: Functional error .1% or less; winding perp. $\pm 5'$. Electrical

characteristics: Input voltage 13.7v (compensator); Zro 234 + j596; Zso 244 + j548; Zcompensator 237 + j553; max. null voltage 1 mv/v.



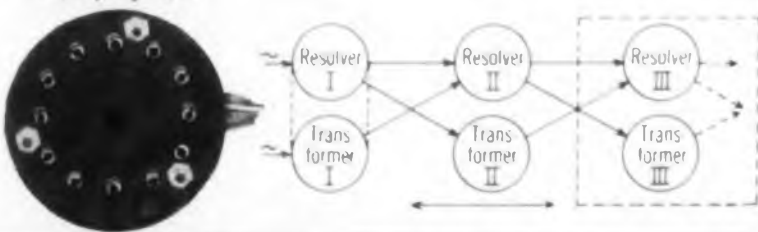
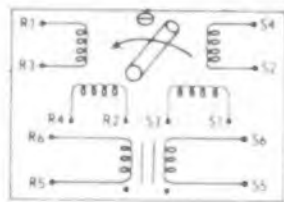
SIZE 11 AMPLIFIERLESS RESOLVER FOR ANGULAR DATA TRANSMISSION



These size 11 resolvers incorporate an integral transformer which simulates a resolver function at maximum coupling. They are used in the typical chain application indicated below for angular data transmission. In this particular application, the output information can be served at either end of the chain.

Quick disconnect allows ease in harnessing.

Accuracy: $\pm 5'$ of arc or less; winding perp. $\pm 5'$. Electrical characteristics: Input to EITHER rotor or stator. Input voltage 115v/1600~; output voltage 110v both stator and rotor as primary; phase shift (stator primary) 1.1°; phase shift (rotor primary) 1.9°; Zso (nom.) 990 + j13500; Zro (nom.) 1150 + j13500.



SIZE 11 RESOLVER TRIMMED FOR ZERO PHASE SHIFT CONTAINS ALL COMPENSATION IN 2 1/4" LENGTH



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These units have been trimmed to provide zero phase shift and compensated for transformation ratio stability, under temperature, when working into their iterative impedance.

Accuracy: Functional error .1% or less; winding perp. $\pm 5'$. Electrical characteristics: Input voltage (stator) 40v/900~; output voltage (rotor) 33.2v; phase shift 0; max. null voltage 1 mv/v.

Also ready for delivery is an equivalent, compatible pancake resolver. By its use, differential information from an inertial platform may be obtained and introduced into the system.

ENGINEERS — Join the leader in the rotating components field. Write David D. Brown, Director of Personnel, Dept. 57

cppe CLIFTON PRECISION PRODUCTS CO., INC.
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CIRCLE 1 ON READER-SERVICE CARD

HIGHLIGHTS OF ISSUE



Simple Generator Gives More F(x) Per Dollar (Cover) 34

A new plug-in component, the Quadratron, produces nonlinear functions cheaply and simply. The Douglas device costs about \$40, weighs only three ounces and occupies only 0.004 cubic feet.

Charts for Fast Checking of Guidance System Accuracy 22

Six basic motions affect the flight of a missile. Working charts are presented to enable the systems designer to determine the effect of component errors on missile flight.

Wanted: Fewer Dreamers, More Doers in Engineering 54

Too much engineering talent is being wasted, says a young electronics executive, Bernard M. Gordon. And this, he believes, is creating the illusion of a shortage. He advises reorienting engineers from "systems" theorizing in "scientific" laboratories to traditional, practical design work.

Index to Articles, January 7 through June 24 98

Semi-annual index of *ELECTRONIC DESIGN* articles, appearing in this issue. All titles are annotated so that readers can appraise the probable interest of an article. Extensive cross-references are used.

Next Issue

1959 Transistor Data Chart

Next issue, complete listings of all commercially available transistors. Classification system first by category and then by increasing order of most important characteristics will make this list the most valuable published anywhere. Another *ELECTRONIC DESIGN* first.

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We Need a Radio to Export to Japan 21

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*Equations to determine performance R. C. Dorf*Wanted: Fewer Dreamers, More Doers in Engineering 54
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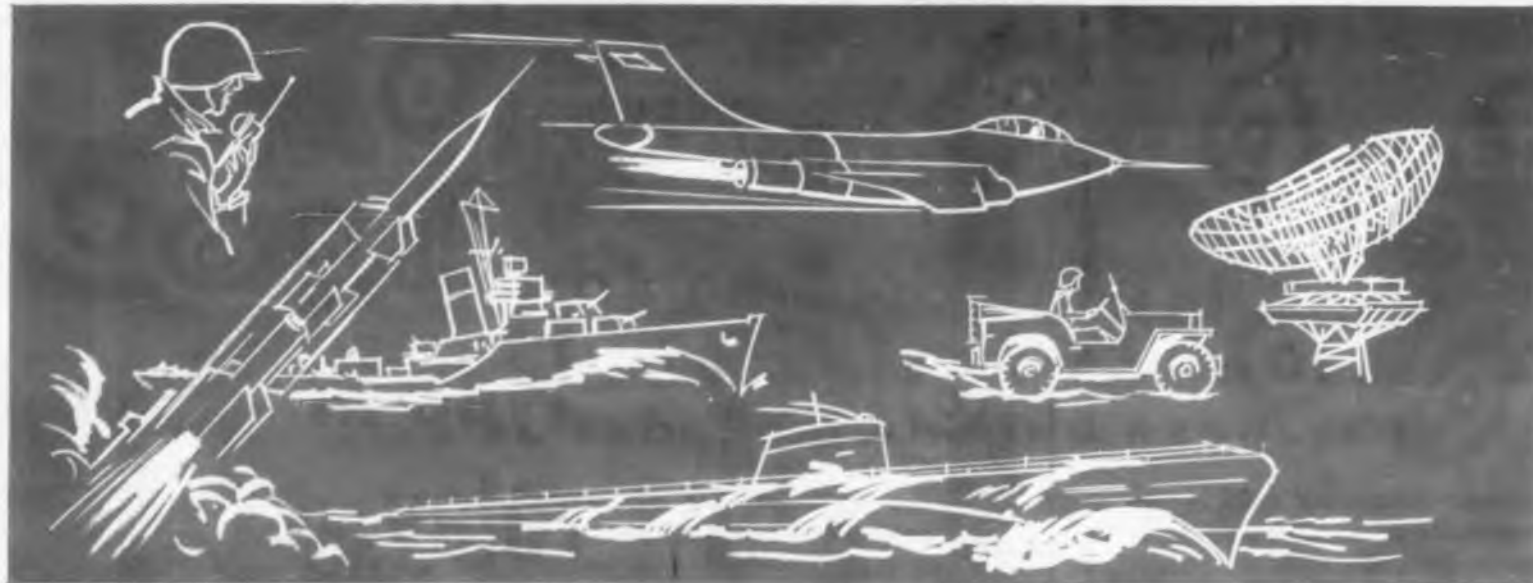
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| Stud Type | Specification MIL-E-1/ | Peak Operating Voltage -65°C to +135°C volts | Ave. Rectified Current 135°C Amps | | Reverse Current (Max.) at 25°C | |
|--------------|------------------------|--|---|-------------|-----------------------------------|----------|
| | | | 25°C mA | 150°C mA | μA | at volts |
| JAN 1N253 | 1024A | 95 | 1.0 | | 10 | 75 |
| JAN 1N254 | 989B | 190 | 0.4 | | 10 | 150 |
| JAN 1N255 | 990B | 380 | 0.4 | | 10 | 350 |
| JAN 1N256 | 991B | 570 | 0.2 | | 20 | 500 |
| Wire in Type | Specification MIL-E-1/ | Peak Operating Voltage -65°C to +165°C volts | Ave. Rectified Current | | Reverse Current (Max.) at 25°C | |
| JAN 1N538 | 1084A | 200 | 750 | 250 | 10 | 200 |
| JAN 1N540 | 1085A | 400 | 750 | 250 | 10 | 400 |
| JAN 1N547 | 1083A | 600 | 750 | 250 | 10 | 600 |

RAYTHEON PNP GERMANIUM TRANSISTORS

| Type | Service | Specification MIL-T-19500/ | V _{CE} max. volts | I _{PKT} ave. | f _{0.1} min MC |
|------------------|-------------|----------------------------|----------------------------|-----------------------|-------------------------|
| USAF 2N404 | Computer | 20 (USAF) | -24* | 30 | 4.0 |
| U. S. Army 2N425 | Computer | 41A (Sig. C.) | -30* | 30 | 2.5 |
| U. S. Army 2N426 | Computer | 42A (Sig. C.) | -25* | 40 | 3.0 |
| U. S. Army 2N427 | Computer | 43A (Sig. C.) | -20* | 55 | 5.0 |
| U. S. Army 2N428 | Computer | 44A (Sig. C.) | -15* | 80 | 10.0 |
| U. S. Army 2N416 | R.F., G.P. | 56A (Sig. C.) | -12 | 60 | 5.0 |
| U. S. Army 2N417 | R.F., G.P. | 57A (Sig. C.) | -12 | 80 | 15.0 |
| U. S. Army 2N464 | Audio, G.P. | 49B (Sig. C.) | -40 | 22 | 0.4 |
| U. S. Army 2N465 | Audio, G.P. | 50A (Sig. C.) | -40 | 45 | 0.5 |
| U. S. Army 2N466 | Audio, G.P. | 51A (Sig. C.) | -35 | 90 | 0.5 |
| U. S. Army 2N467 | Audio, G.P. | 52B (Sig. C.) | -35 | 180 | 0.6 |

*Min. Punch Through Voltage I_B = 1mA, V_{CE} = 0.25V I_E = 1mA, V_{EB} = 6V, f = 1000 cps.

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CIRCLE 7 ON READER-SERVICE CARD



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Variety of products at the Japanese Electronics Show in New York point up Japan's interest in the U.S. market, where Japanese transistor radios are already entrenched.



Japanese Electronic Imports Challenge American Designers

THE JAPANESE Electronics Show held two weeks ago in New York raises a pointed question: How will steadily rising electronic imports from Japan affect American designers?

Some industry observations can be summarized this way:

First, so many new parts and products are now available from Japan (and other countries) that designers must follow new-part specs with minute care to make sure that competitors are not the first to incorporate them in cheaper products.

Then, designers in some fields, like low-priced consumer products, can expect an increasing flow of ideas from Japanese engineers. Considerable design attention in Japan is concentrated on products tailored for the U.S. market, and the growing number of Japanese designers could easily become a major source of design know-how.

Observers report that many of Japan's engineering facilities are equal to the best in the U.S. Some companies in Japan employ hundreds of engineers and scientists in electronics R & D. In optical design, Japanese engineers and scientists have already become important sources of design developments.

Also, rising Japanese imports add pressure to

the need to innovate. As the lag between new products and copies or improved versions of them narrows, American management will lean more heavily on new-product engineers to stay ahead of Japanese competition. Some electronic companies may soon operate in the "innovate or die" climate facing segments of the Swiss watch and novelty industry.

Still another effect has already involved some American electronics engineers: their companies are closely working with Japanese concerns. Some of the largest U.S. manufacturers—General Electric, Western Electric, Motorola, Radio Corporation of America and others—have working agreements with major and minor Japanese companies. Some American manufacturers buy components for assembly here under a "Made in the U.S.A." tag.

Others now import finished units and do no more manufacturing. Still others exchange technical information, buy specially designed parts or work with the Japanese under licensing agreements. In 1956 Japan paid over \$5 million to U.S. companies for patent rights and technical assistance.

Most Japanese companies, preferring to avoid

U.S. resistance to their exports, are seeking tie-ins with American manufacturers. And more and more U.S. companies are trying to establish some working arrangement with suppliers of electronics in Japan.

Eventually U.S. engineers who design for export may be as harried by Japanese advances as are German photo-equipment designers, now fighting to stay abreast of the Japanese in a field Germany once dominated. Japan seems bent on playing a major role in the world's electronic market.

U.S. Not Main Target

The U.S. can absorb a fair amount of imports from Japan—mainly cheaply shipped finished products requiring much hand labor—and last year did buy about half of Japan's electronic exports. But the less-developed nations of the world are Japan's main market. These countries in Asia, Africa and Latin America are the targets of our own export-minded companies.

American manufacturers concede that in general Japanese electronic exports are made with

(Continued on next page)

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reset time for 3PDT depends upon delay period
Hermetically sealed, potted leads optional.



TYPE M-101 and M-102, 2PDT
Magnetic latch or Standard.
Crystal case size.
Voltage . . . 28 VDC Standard;
other voltages on request.
Contact Load at 29 VDC-2 Amp. Res.
Temperature . . . to 125°C.
Terminals and mounting optional.
Hermetically sealed.



NEWS

Products Made By Exhibitors at Japanese Electronic Show.

Airborne DF—45
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 Portable—10
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good workmanship and good materials and are well-designed, whether with American or Japanese ideas. These products are solid competition for any country's designers. Backed by low prices and good sales service, they could mean major changes for export designers here.

What is available from Japan? Showing their wares at the Electronics Show were 45 of the roughly 100 electronics companies that export from Japan. The 45 account for about 80 per cent of that country's electronic exports—mainly transistor radios and tubes. The accompanying table shows what the exhibitors are offering U.S. buyers.

Not all products may be immediately available—many of the concerns exhibiting were interested mainly in testing the U.S. market.

For design highlights of the show see pp. 106-9 of this issue of ELECTRONIC DESIGN. ■ ■

◀ CIRCLE 4 ON READER-SERVICE CARD

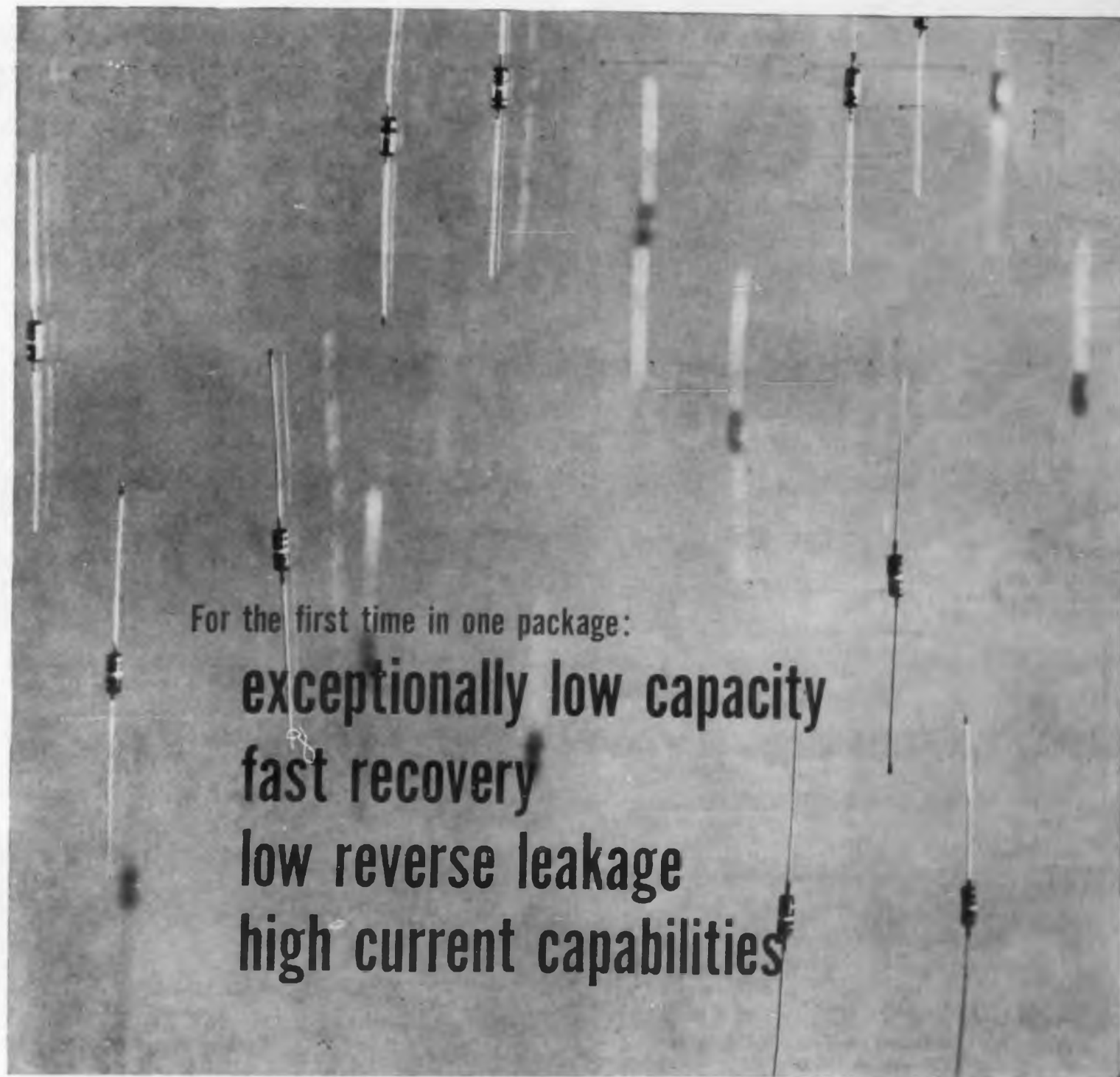
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Exhibitors at Japanese Electronic Show.

Numbers refer to table above.

- 1 Aiko Electric Co., Ltd., 4, Motosakuma-cho, Kanda Chiyoda-ku, Tokyo
- 2 Asahi Radio Co., Ltd., 38 Suehiro-cho, Kanda Chiyoda-ku, Tokyo
- 3 Ashida Sound Co., Ltd., 217.3-chome, Higashi-osaki, Shinagawa-ku, Tokyo
- 4 Foster Electric Co., Ltd., 384 Shimorenjaku, Mitakashi, Tokyo
- 5 Fuji High Frequency Radio Laboratory Co., Ltd., 387 Shibasaki-cho, Chofu-city, Tokyo
- 6 Fuji Seisakusho Co., Ltd., 5.1-chome, Mita, Shiba, Minato-ku, Tokyo
- 7 Fukuin Electric Works, Ltd., 5 Otowa-cho 6 chome, Bunkyo-ku, Tokyo
- 8 Fukuyo Sound Co. Ltd., 2-25-3 Horifuneco, Kitaku, Tokyo
- 9 Global Mfg., Co., Ltd., 13, Shiba Sakaecho, Minato-ku, Tokyo
- 10 Hayakawa Electric Co., Ltd., 232, 1-chome, Nishitanabe, Abeno-ku, Osaka
- 11 Hitachi, Ltd., 4, 1-chome, Marunouchi, Chiyoda-ku, Tokyo
- 12 Hokusai Denki Kogyo Co., Ltd., 6-1300 Kamimeguro, Meguro-ku, Tokyo
- 13 Kansai Works Co., Ltd., Nishinoin Shijo, Nakagyo-ku, Kyoto
- 14 Kataoka Electric Co., Ltd., 247, Yukigaya-cho, Otaku, Tokyo
- 15 Kawasata Sales Co., Ltd., c/o Hirasawa Bldg., 7 Kanda kamakura-cho, Chiyoda-ku, Tokyo



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Syracuse, 224 Harrison Street; Syracuse 2, N. Y.; GRanite 1-0163

Chicago, 6120 West North Ave.; Chicago 39, Ill.; NAtional 2-0283
 Philadelphia, 1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365
 Los Angeles, 690 N. Sepulveda; El Segundo, Calif.; OR 8-6125

Or write, Hughes Products, Marketing Department,
 SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.

| Type | Min. Forward Current @ 25°C | | Max. Reverse Current (μ A) @ 25°C | | Reverse Resistance (R) (ohms) | Reverse Recovery* Maximum Recovery Time (μ sec) |
|--------|-----------------------------|-----------|--|-----------|-------------------------------|--|
| | (@ 100 μ A) | (@ +1.0V) | @ 25°C | @ 100°C | | |
| 1N840 | 50 | 150 | 0.1 @ 40V | 15 @ 40V | 400 K | 0.3 |
| 1N837A | 100 | 150 | 0.1 @ 80V | 15 @ 80V | 400 K | 0.3 |
| 1N841 | 150 | 150 | 0.1 @ 120V | 15 @ 120V | 400 K | 0.3 |
| 1N843 | 250 | 150 | 0.1 @ 200V | 15 @ 200V | 400 K | 0.3 |
| 1N844 | 100 | 200 | 0.1 @ 80V | 15 @ 80V | 400 K | 0.5 |
| 1N845 | 200 | 200 | 0.1 @ 160V | 15 @ 160V | 400 K | 0.5 |

*Measured in JAN test circuit and switched from 30mA forward current to -35V.
 TYPICAL CAPACITANCE: C₋₁₀=2.2 μ mf C_{-1.5}=4.4 μ mf C_{-0.5}=9.0 μ mf
 Operating Temp. Range: -65°C to +150°C Storage Temp. Range: -65°C to +200°C

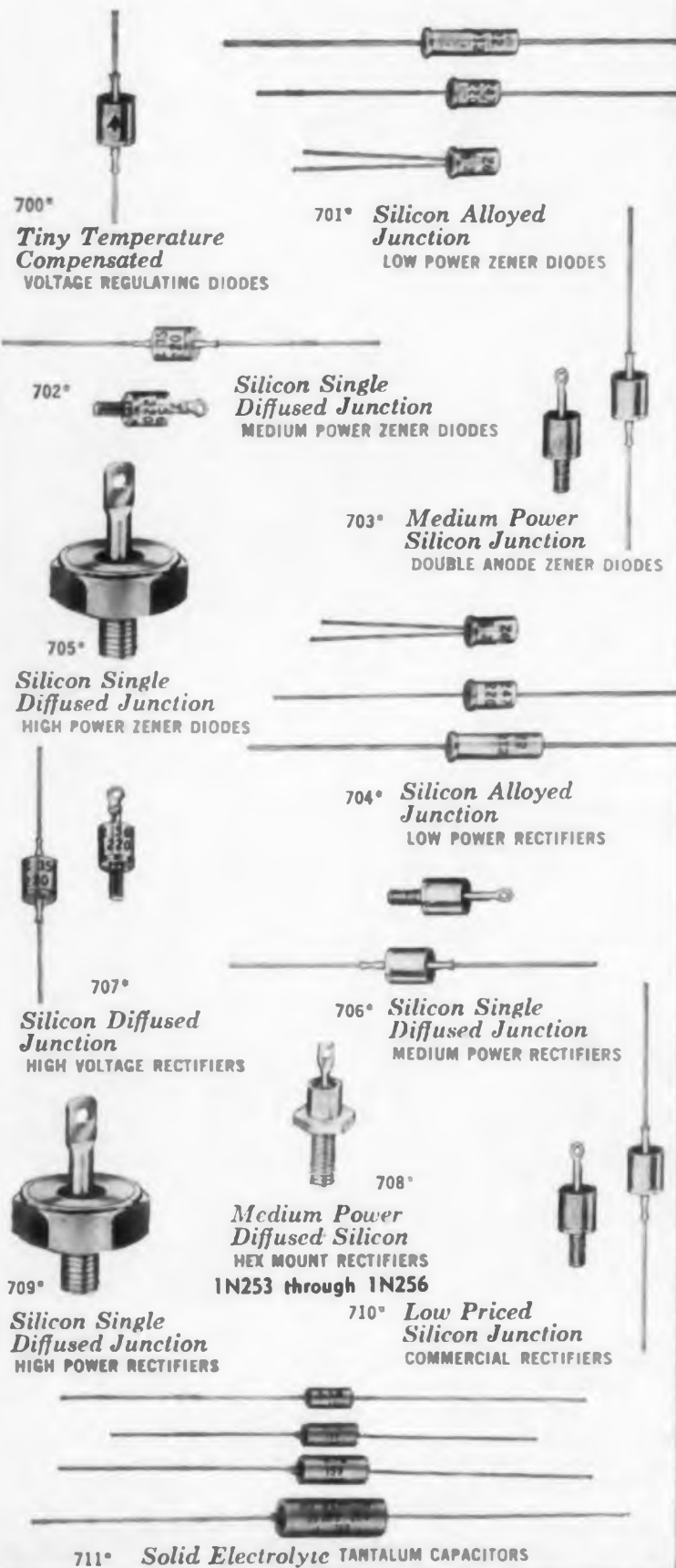
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- 16 Koda Kogyo Corp., 5, Wadayama-dori, 1-chome, Hyogo-ku, Kobe
- 17 Matsushita Electric Industrial Co., Ltd., Kadoma, Osaka, Pref.
- 18 Mitsubishi Electric Mfg. Co., 3, 2-chome, Marunouchi, Chiyoda-ku, Tokyo
- 19 Mitsuoka Electric Mfg. Co., Ltd., 8, 1-chome Kanaya-cho, Kita-ku, Osaka
- 20 Murata Manufacturing Co., Ltd., Hino-oka, Yamashina, Higashiyama-ku, Kyoto
- 21 Nanao Radio Co., Ltd., 1054, 4-chome, Shimomeguro, Meguro-ku, Tokyo
- 22 Nippon Alpha Electric Co., Ltd., 6, Azabu-Fujimicho, Minato-ku, Tokyo
- 23 Nippon Chemical Condenser Co., Ltd., 1306, 2-chome, Yutaka-cho, Shinagawa-ku, Tokyo
- 24 Nippon Communication Industrial Co., Ltd., 260, Kitamikata Kawasaki City, Kanagawa Pref.
- 25 Nippon Electric Co. Ltd., 2, Shiba-Mita-Shikokumachi, Minato-ku, Tokyo
- 26 Ohmatsu Electric Co., Ltd., 2596, 5-chome Kamimeguro, Meguro-ku Tokyo
- 27 Riken Dengu Seizo Co., Ltd., 4-6, Azusawa, Itabashi-ku, Tokyo
- 28 Sanritsu Electric Machine Co., Ltd., 91, Kamiakatsuka, Itabashi-ku, Tokyo
- 29 Sansui Electric Co., Ltd., 460, Izumi-cho, Suginami-ku, Tokyo
- 30 Sanwa Electric Instrument Works, Ltd., 1069, Koigakubo, Kokubunji-machi, Kitatama-gun, Tokyo
- 31 Shizuki Electric Works Co., Ltd., 233, Nagai-cho, Imazu Nishinomiya
- 32 Showa Musen Kogyo Co., Ltd., 24, 5-chome, Higashitogoshi, Shinagawa-ku, Tokyo
- 33 Sony Corp., 351, Kitashinagawa-6 Shinagawa-ku, Tokyo
- 34 Soshin Electric Co., Ltd., 2, Nishi-Magomemachi 4-chome, Ohta-ku, Tokyo
- 35 Standard Radio Corp., 53, Mukoyama-machi, Shibuya-ku, Tokyo
- 36 Taiyo Yuden Co., Ltd., 1, Kanda Kamezumi-cho, Chiyoda-ku, Tokyo
- 37 Tamura Seisakusho Ltd., 689, 4-chome, Kashiwagi, Shinjuku-ku, Tokyo
- 38 Teikoku Tsushin Kogyo Co., Ltd., 335, Nishinakamachi, Kariyado, Kawasaki
- 39 Tokyo Denki Co., Ltd., 2, Kanda Kaji-cho, 1-chome, Chiyoda-ku, Tokyo
- 40 Tokyo Optical & Radio Mfg. Co., Ltd., 407, Nukui-cho, Nerima-ku, Tokyo
- 41 Tokyo Shibaura Electric Co., Ltd., 2 Ginza Nishi 5-chome, Chuo-ku, Tokyo
- 42 Victor Co. of Japan, Ltd., 1-1, 4-chome, Nihonbashi-Honcho, Chuo-ku, Tokyo
- 43 Yamada Electric Industrial Co., Ltd., 3, 6-chome, Shiba-Shimbashi, Minato-ku, Tokyo
- 44 Yamamaka Electric Co., Ltd., 198, 2-chome, Omori, Ota-ku, Tokyo
- 45 Yaou Electric Co. Ltd., 2776, Ooi, Sakashita-cho, Shingawa-ku, Tokyo

Radar Mapping System Studied

An advanced radar mapping system is being developed for the Army by Goodyear Aircraft Corp. at Litchfield Park, Ariz. Airborne radar sensing and data-reduction procedures are being studied to establish design parameters for integrated, military topographic mapping.



Available from stock... **MICROWAVE GENERATORS**

Now available for immediate delivery are several high-performance Hughes microwave tubes... including the Model LOU-2 pictured above. This Ku band backward oscillator is completely ready for insertion into a system. The prepackaged LOU-2 tube gives you power output of from 10 to 60 milliwatts over the band... and tunes the frequency range of 12.4 to 18.0 kmc/sec.

Since the tube is housed in a self-contained permanent magnetic focusing package, no separate power supply for a focusing electromagnet is necessary. Result: you get a lighter and more compact package.

Reliability has been engineered into the tube—and has been proven in more than 2 years of life tests. The package is completely sealed and magnetic structures are potted in epoxy resin.

Developed by the famed Hughes Research & Development Laboratories, the LOU-2 helps solve your problems associated with microwave signal generators, panoramic receivers and spectrum analyzers, frequency scan radars, navigational radars, microwave links, and countermeasures.

Hughes also offers you from stock these other high performance microwave tubes:

| | | | | | |
|--|---|--|--|--|--|
| | <p>S-band traveling wave amplifier—Periodically focused, the type MAS-1A has a peak power output of one kilowatt over a band of 2-4 kmc at duties up to 0.005. The tube has a gain of 30 to 33 db, giving an excess of one kilowatt over most of the band.</p> | | <p>S-band backward wave amplifier—Type PAS-2, a voltage-tuned amplifier, features: frequency range 2.4-3.5 kmc, tube noise figures of less than 5 db, crystal protection, spurious input signal elimination, cold isolation greater than 80 db and image rejection.</p> | | <p>X-band backward wave amplifier—Featuring a noise figure of 4.5 db, the PAX-1 tube, also offers a 12 MC bandwidth which is electronically tunable over the X-band spectrum.</p> |
|--|---|--|--|--|--|

For additional information please write: Hughes Products, Electron Tube Sales, International Airport Station, Los Angeles 45, California. For export write: Hughes International, Culver City, California.

Creating a new world with **ELECTRONICS** **HUGHES PRODUCTS**

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SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS
CIRCLE 6 ON READER-SERVICE CARD



Enlarged photograph of raw crystal



BULOVA CRYSTAL CONTROLLED ULTRA-STABLE SHIFT OSCILLATORS

Bulova shift oscillators are all that any electronics engineer could ask for in miniature crystal controlled packages!

Consider this new Bulova custom designed 18.5mc shift oscillator. Here's an assembly of two oscillators operating at 18.5mc. One is fixed, with a $1 \text{ pp } 10^7$ stability. The other is a variable with equal stability, $1 \text{ pp } 10^7$. The shift is accomplished by means of a variable air capacitor. How-

Department A-1361, Electronics Division, Bulova, 40-06 62nd Street, Woodside 77, New York

ever, the same shift, at the same frequency, can be affected with a varicap.

This new ultra-stable shift oscillator is only one of many recent advances made by Bulova Electronics. For information on these specific units, or on how Bulova experience, in mastering component and system reliability, can help your program, write—

CIRCLE 7 ON READER-SERVICE CARD

NEWS

Space-Probe Telemetry System Designed for 25,000 Samples/Sec

A proposed system for very-long-range telemetry involves use of advanced coding techniques and digital mechanization to meet outer-space communication problems of high-signal-to-noise ratios and ranges of over 100 million miles.

Space Electronics Corp. expects its proposed Digilock system to transmit data at rates varying from 100 samples per second to a maximum of 25,000. The system will be designed to trade off between transmitting power and the amount and accuracy of the data to be transmitted. This is to cut down power requirements, estimated to be on the order of three to five watts.

The company reports that a new method of modulation plus phase lock at the receiver will also be used to cut power requirements.

Communication efficiency is expected to closely approach the best value possible, according to information theory, the company claims.

Electricity to Be Sought in Strontium 90 Decay

Conversion to electricity of the heat of decay of Strontium 90 will be investigated by the Martin Co. of Baltimore under a contract from the Atomic Energy Commission.

Studies will be made of the properties of strontium compounds and the fabrication of reliable, corrosion-resistant strontium heat elements. The project aims to develop compact devices capable of turning out 100 electrical watts.

Designs will be sought of land and sea applications, such as ocean buoys, emergency markers and remote weather telemetering equipment.

Sputnik Radio Logs 8000 Hours

A radio transmitter aboard Sputnik III has been operating continuously for more than 8000 hours, the Soviet Union has reported.

Solar batteries have powered the unit for more than 6000 hours, chemical power for the remainder of the time.

The transmitter was described as consisting of two units: a main and a reserve transmitter and a commutating device and power source. Provisions have been made for switching over to the reserve transmitter in case of failure, but for this has not been necessary, the Soviet Union said.

When the solar batteries are lighted by their voltage exceeds that of the chemical source, conserving chemical power for when solar cells are in the shadow.

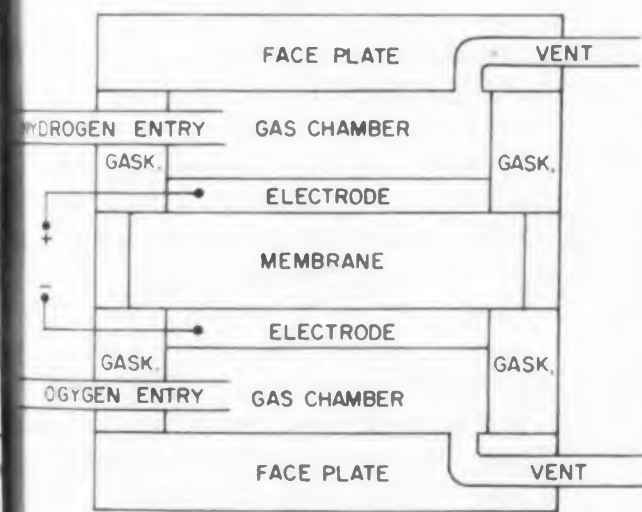
Design Details Released On 2 More Power Sources

From the Air Research and Development Command comes word of a Westinghouse thermo-electric generator described as the most powerful ever built.

The 40-pound unit generates 100 watts, using a propane flame burning at 850 F, and can be modified to permit the use of gasoline and kerosene. It is being developed in an advanced version that would be fired by a radioactive isotope.

At the same time additional details have been released on General Electric's hydrogen-oxygen fuel cell.

In this suggested power source, with a predicted potential of 2 kw per cu ft, hydrogen ions carry charge through an ion-exchange membrane that acts as an electrolyte. Use of the membrane and vents solve problems of ion leakage, electrolyte dilution and collection of water at the fuel electrode. Water can be disposed of by evaporation. GE states that more than 60 per cent of heat released by combustion is converted to electricity and that some tests have been conducted at densities of 30 ma per cu cm.

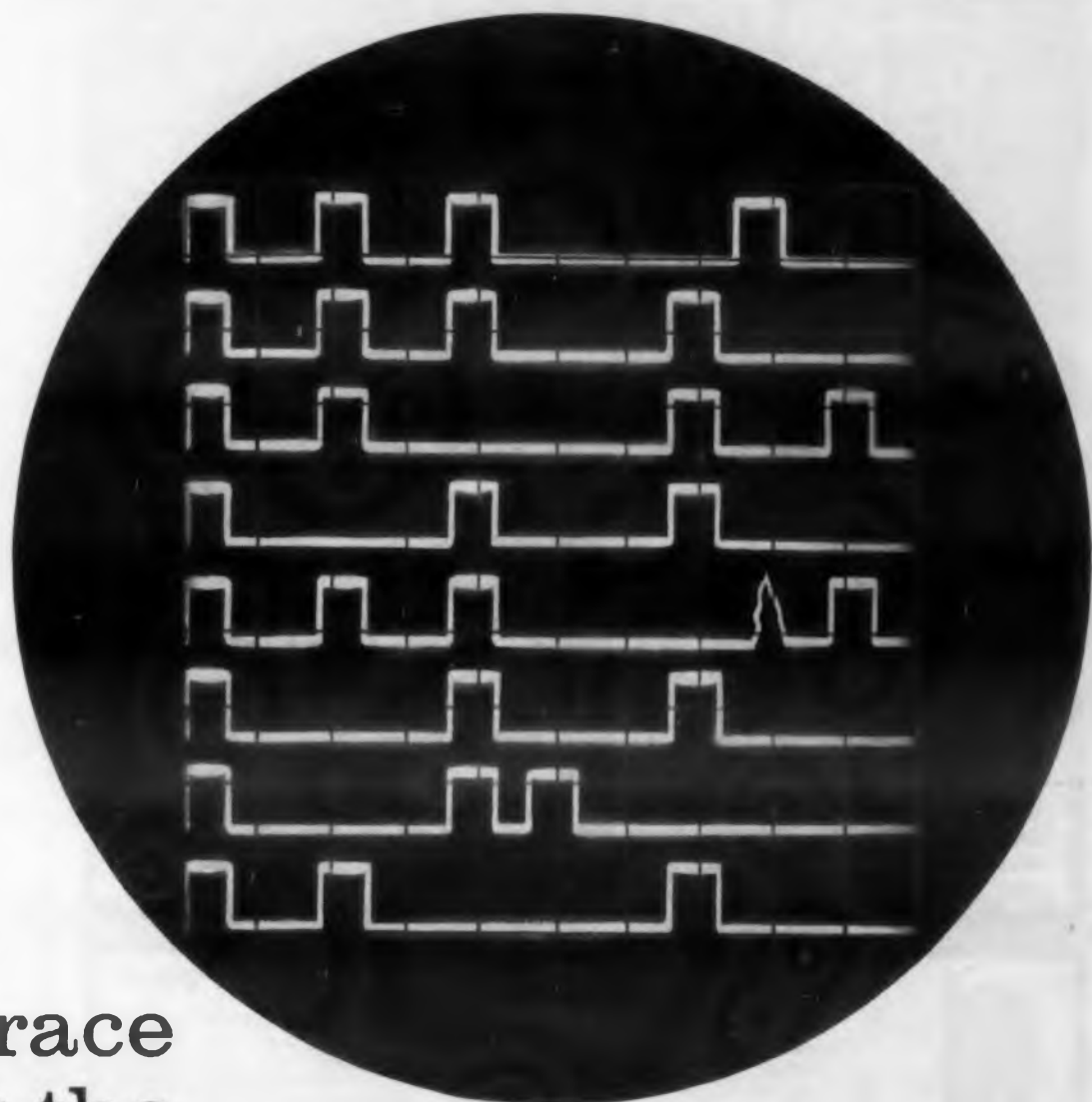


Schematic of fuel cell exaggerates proportions for clarity. Working model is a plastic disc three inches diameter about one-half inch thick.

WESCON Design Competition Drawing Many Entries

As of last week, the committee handling the industrial-design competition for the Western Electronic Show and Convention had received over 150 150 entries. About 30 will win awards, roughly 10 will receive a WESCON Award of Excellence for Industrial Design, and the rest a WESCON Award of Merit for Industrial Design. Though the judges have not been announced, all are expected to be industrial design contestants. The competition is planned as an annual feature of the WESCON show.

Trace Retention with MEMO-SCOPE recorder. Application No. 2



which trace has the transient?

Data reduction systems have long been plagued by false signals from intermittents and transients—particularly those using digital bits and words. With the MEMO-SCOPE® recorder you can locate this false information with comparative ease.

For example, the above display shows 8 traces—one showing a non-recurrent transient pulse. The MEMO-SCOPE recorder freezes this transient information on the face of the tube until intentionally erased. Therefore, transients can be retained for study, regardless of the fact that they are intermittent in nature and last only a few microseconds. For more information concerning this application, write for Data Sheet MSAD-A2.

Many unique problems have been solved with the MEMO-SCOPE recorder through trace retention. Refer your problems to us by writing: Hughes MEMO-SCOPE recorder, Hughes Products, International Airport Station, Los Angeles 45, California.

A new MEMO-SCOPE recorder accessory... the **Multitracer**... makes it possible for you to automatically program up to 20 different traces on the tube face.

In addition to data reduction trouble shooting, the MEMO-SCOPE recorder makes it possible for you to save time and money in problems associated with:

- Ultrasonic flaw testing
- Drift measurements
- Ballistics, explosives research
- Switch, relay contact studies
- Welding
- Transducer testing
- XY plotters
- Medical diagnosis problems
- Physical testing
- plus many more

SPECIFICATIONS:

Sweep Speed for Storage: 10 microseconds per division to 10 seconds per division (0.33").
Frequency Response: DC to 250 KC down 3 db.
Sensitivity: 10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.



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CIRCLE 8 ON READER-SERVICE CARD

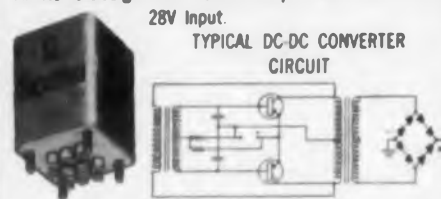
MINIATURE TRANSISTOR TRANSFORMERS from stock!

MICROTRAN transistorized transformers are ruggedized, military-type components developed to meet the growing demand for miniaturization. Design and performance meets or exceeds all applicable commercial and government specifications including MIL-T-27A, MIL-T-9219, AN-E-19, CAA-R-9786, MIL-E-5400, MIL-E-16400, MIL-E-4158, MIL-E-8189A, MCREE-553, MIL-T-945A. Available for immediate delivery from Franchise Stocking Distributors.



DC-DC CONVERTER

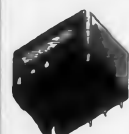
All Items Designed for 13.6V. Except 8034 which is for 28V Input.



| Part Number | Total V.A. Output | D.C. Output | | | |
|-------------|-------------------|--------------------|------------|----------------------|-----|
| | | F. W. Bridge Volts | R.M.S. Ma. | C.T. Full Wave Volts | Ma. |
| M8034 | 125 | 500 | 250 | 250 | 420 |
| M8035 | 125 | 500 | 250 | 250 | 420 |
| M8036 | 40 | 450 | 90 | 225 | 155 |
| M8037 | 22.5 | 250 | 90 | 125 | 155 |

TRANSISTOR DRIVER

Designed specifically for transistor, servo and audio



Frequency response 70-20K
Size AF mill through AH Hermetically sealed to MIL-T-27A.

EPOXY MOLDED See catalog for exact sizes and weights.

| Part Number | Application | Pri. Imp. | Sec. Imp. | Pri. D.C. Unbal. Ma. | Level Watts |
|-------------|---------------------|-----------|------------|----------------------|-------------|
| M8002* | Coll. to P.P. Emit. | 560 | 400 C.T. | 18 | .15 |
| M8003* | Coll. to P.P. Emit. | 625 | 100 C.T. | 20 | 1.5 |
| M8004 | Coll. to P.P. Emit. | 5,400 | 600 C.T. | 15 | .075 |
| M8005 | Coll. to P.P. Emit. | 7,000 | 320 C.T. | 7 | .040 |
| M8006 | Coll. to P.P. Emit. | 10,000 | 6,500 C.T. | .75 | .005 |

*Bi-Filar wound to minimize switching transients.

TRANSISTOR OUTPUT

Frequency Response 200-15,000 ~
See catalog for case size



| Part Number | Application | Pri. Imp. | Sec. Imp. | Level Watts |
|-------------|----------------------|------------|-----------|-------------|
| M8008 | P.P. Output to Spkr. | 25 | 3.4 | 3 |
| M8007* | P.P. Auto Transf. | 30 C.T. | 4 | 2 |
| M8009 | P.P. Output to Spkr. | 48 C.T. | 3.2 | 8 |
| M8010 | P.P. Coll. to Servo | 120 C.T. | 1,000 | 6 |
| M8011 | P.P. Output to Spkr. | 125 C.T. | 3.4 | 1.5 |
| M8012* | P.P. Coll. to Servo | 140 C.T. | 500 | 6 |
| M8013* | P.P. Output to Spkr. | 250 C.T. | 3.4 | .4 |
| M8014 | P.P. Output to Spkr. | 400 C.T. | 11 | .25 |
| M8015 | P.O. Coll. to Servo | 1,600 C.T. | 800 | 2.5 |
| M8016 | P.O. Output to Spkr. | 2,550 C.T. | 12 | .10 |

*Bi-Filar wound to minimize switching transients.

LOW LEVEL CHOPPER

Efficiently transfers 30 to 500 cps. Transducer or Thermocouple signals to instrument amplifiers. Signal level range from .5 μ V. to .5 volts. Resin impregnated to minimize mechanical vibration noise signal. Low hum pick up assured by 3 mu-metal and 2 copper shields.



| Part Number | Turns Ratio | | Ind. of Full Pri. @ 5V 60 Cycles | Imped. of Full Pri. @ 5V 60 Cycles |
|-------------|------------------------|-----------------------|----------------------------------|------------------------------------|
| | Full Pri. To Full Sec. | 1/2 Pri. To Full Sec. | | |
| M8025 | 1:7.7 | 1:15.4 | 17.5 | 6,600 |
| M8026 | 1:3.2 | 1: 6.4 | 60 Hy | 22,500 |

| Part Number | D.C. Resistance | | Mag. Shield. | Hght. | Dia. | Wt. Oz. |
|-------------|-----------------|------|--------------|--------|--------|---------|
| | Full Pri. | Sec. | | | | |
| M8025 | 365 | 4140 | 90 DB | 125/32 | 13/8 D | 4.5 |
| M8026 | 455 | 3500 | 90 DB | 125/32 | 13/8 D | 4.5 |

SILICON RECTIFIER Power Supply



Circuitry Primary 105/115/125 Volts**. Hermetic sealed to MIL-T-27A. See Catalog for additional information.

| Part Number | Secondary A.C. Volts | Rectifier Circuit | | |
|-------------|----------------------|-------------------|------------------|---------------|
| | | R.M.S. Amperes | C.T.** Full Wave | F.W.** Bridge |
| M8018* | 18.5 C.T. | 1 | 7V. | 14V. |
| M8019* | 18.5 C.T. | 3 | 7 | 14 |
| M8020* | 35 C.T. | 3 | 14.5 | 29 |
| M8021* | 70 C.T. | 1 | 30 | 60 |
| M8022* | 18.5 C.T. | 3 | 7 | 14 |
| M8023* | 35 C.T. | 3 | 14.5 | 29 |
| M8024* | 70 C.T. | 1 | 30 | 60 |

**380-1600 Cy. **DC output volts stated are for resistive or inductive loads. Capacitor input may be used if RMS AMPS is not exceeded.

ULTRA MINIATURE TRANSISTOR



Wt. 08 oz size 3/8" x 7/8" x 11/32" Nylon Bobbin, Nickel-Alloy Core. 4 color coded leads, resin impregnated. Encapsulated on special order

| Part Number | Application | Primary Impedance (D.C.) | Secondary Impedance |
|-------------|-------------|----------------------------|---------------------|
| UM 21-F | Input | 100,000 | 1,000 |
| UM 22-F | Driver | 20,000 | 1,000 |
| UM 23-F | Driver | 20,000 | 1,200 C.T. |
| UM 24-F | Output | 1,000 | 50 |
| UM 25-F | Output | 400 | 50 |
| UM 26-F | Output | 400 | 11 |
| UM 27-F | Output | 400 C.T. | 11 |
| UM 28-F | Choke | 10 Hy. (0 dc) 8 Hy. (5 ma) | 650 |

MICROTRAN company, inc.
145 E. MINEOLA AVE., VALLEY STREAM, N. Y.

CIRCLE 9 ON READER-SERVICE CARD

NEWS

Survey Finds Capacitor Makers Split On Major Trends

CAPACITOR manufacturers differ on subjects that affect their branch of the electronics industry. This was brought out in a recent ELECTRONIC DESIGN survey in which 20 leading manufacturers were interviewed personally or by letter. They were asked among other questions:

"Is the number of orders for custom capacitors too high, about right, or too low?"

Of those who ventured a judgment, seven thought it was too high, eight considered it about right and one said it was too low.

Several who thought there was not enough standardization blamed the customer. One engineering executive of a leading concern, said:

"We've got hundreds of thousands of different drawings to turn out that many different capacitors for our customers. It's a terrible waste. Most of the fault lies with young whippersnappers out of school a year or two. These engineers specify a new varnish, a new marking, a different terminal without getting any attendant benefit. It means we have to change our procedures and turn out another special capacitor for them.

"Radio and TV manufacturers could standardize on less than 100 different types of capacitors. If they did, we could automate around here and cut unit cost by 50 per cent. Everyone would benefit. But this will only happen when all users get together and decide what they need and want."

The engineering head of another firm said:

"Sure standardization is good because it cuts costs, unclutters stockrooms and has other advantages. But there is one danger in standardization; it impedes progress. Why should a user be limited in his choice of units? If he can get a special product that does his job better, he should specify it."

Another capacitor man felt: "It's their money; if the customer wants to spend

more on special units, who are we to argue. We make our profit, and they get their product."

EIA and MIL specifications were praised for the effect they have had in standardization. Those in favor of more standardization listed these areas where more work was necessary: Physical size, Capacitance values, Temperature coefficients, Leakage currents.

"How big is the market?"

Only four manufacturers ventured to estimate the total 1959 electronic capacitor market. But they agreed roughly. One estimated it at \$230,000,000. Two pegged it at \$200,000,000, and the fourth said \$190,000,000.

Other figures included: \$100,000 for layer-wound-type units in 1959; \$15,000,000 for ceramic types in 1959. One manufacturer reached out to predict a \$500,000,000-year in 1968.

Outlook of a company was often closely connected to its size. The medium-sized companies seemed optimistic about their future. They stressed their new products and high sales. But most of the larger companies, having already been in contact with all segments of the market, were not as cheerful though still hopeful.

An executive of one large company said:

"Radio and TV sales last year haven't been hot at all. The market is just about saturated. Another thing is that the use of transistors means that lower-voltage capacitors are being used. And these lower voltage capacitors cost less money."

"A capacitor company will have to diversify if it wants to stay large. The next big thing we're looking forward to is the introduction of color TV sets."

"Will foreign competition hurt?"

On the question of capacitor competition from abroad, 14 companies said they

wer not concerned and four said they were. Some said the foreign units they had tested were of good quality. Others said "not so good." One estimated that 10 per cent of the capacitors being marketed in the U.S. today were foreign-made.

Will imports increase in time? Nine firms expected them to increase, and four did not. Those who said "yes" mentioned the low cost (through cheap labor) as the foreign manufacturer's chief advantage. Another explanation was that foreign companies were becoming increasingly aware of U.S. needs.

Those who believed imports would not increase offered these explanations:

"You can't be sure they'll meet delivery schedules."

"Someone in Congress will raise the import tax and reduce the quantity brought in."

"They won't ship too many, because they don't want to offend anyone."

American capacitor manufacturers do not seem to be tying into foreign companies as much as other U.S. component companies are.

Most every manufacturer mentioned a different kind of capacitor when asked:

"Is there a trend for any types to become especially popular?"

Types mentioned were ceramic disk, tantalum, mylar, polystyrene, metallized teflon, glass, mica paper and epoxy-resin impregnated units.

The answers seemed to reveal more of what each company was working on than anything else. In mentioning the growth of plastic types, one manufacturer said he seriously questioned whether the prices of some plastic materials were fair. "Highly suspect," he said.

Another trend often mentioned was that toward miniaturized units. One engineer explained:

"This miniaturization won't be the result of any major breakthrough. There hasn't been a major breakthrough in years. Smaller units will be made because the voltage requirements will be lower. And as voltage goes down, so does size."

Very few companies are engaged in micro-miniaturization programs at present. The reason, explained one executive: "The people who need the units make them."

"What about testing problems?"

Cost and time were the two problems most often mentioned in testing.

"It's a headache," one manufacturer said. "Everyone seems to want a high-quality and reliable capacitor these days, but no one wants to pay for it."

What makes the cost high? Respondents' factors: The need for expensive test equipment, trained technicians and many parts; lack of stand-



Guaranteed protection in Ku band!



BALANCED DUPLEXER: DUAL PRE-TR, DIODE PROTECTOR, SHUTTER



BALANCED DUPLEXER: DUAL TR, SHUTTER



FERRITE DUPLEXER: DIODE PROTECTOR, SHUTTER

New Microwave Associates Ku Band duplexers give you guaranteed crystal protection - for life - at full rated power and elevated temperatures.

For the first time, Ku Band users are enjoying crystal protection never before attained in this band!

New, highly successful gas tube and ferrite devices of proven design but previously produced for L, S & X bands, are now in actual production for Ku Band . . . and available for immediate delivery.

These new duplexers developed by Microwave's Switching Devices Laboratory under the direction of Dr. Lawrence Gould are guaranteed to solve premature crystal burnout problems. One of these systems will bring you optimum duplexer performance and reliability. All three use the MA-760 shutter for standby receiver protection.

If you work with the Ku Band, you owe it to yourself to see how these latest developments from Microwave will bring you new concepts in receiver performance and crystal protection. Write or call our application engineering department.



MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASS. TEL. BRowning 2-3000

CIRCLE 10 ON READER-SERVICE CARD

FREE BULLETIN... TURN TRASH INTO CASH



Just produced by Handy & Harman—this new Refining Bulletin describes the great cash potential in precious metals industrial waste... lists many possible sources. Types and forms of refinings are illustrated photographically and described in text. Equally important, the bulletin calls attention to the fact that much of industry's valuable waste is truly wasted.

For your free copy of this new and cash-provoking bulletin, write to Refining Division, Handy & Harman, 82 Fulton Street, New York 38, N.Y. Your biggest dividend will come when you send a refining lot to Handy & Harman and see for yourself the cash benefits you get from the country's leading refiner of precious metals waste.

Your No. 1 Source of Supply, Refiner and Authority
on Precious Metals Alloys

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New York 38, N. Y.
82 Fulton Street
Toronto 20
141 John Street

CIRCLE 11 ON READER-SERVICE CARD

NEWS

ardization, and the simulation of operating conditions.

To cut costs, one manufacturer has automated some of his testing procedures.

All manufacturers said they were testing their capacitors fully before shipping them. And the trend is for purchasers to take the manufacturer's word that the units meet the levels specified. Customers used to re-test the units. Now they seem content with a certificate of compliance.

"Is Capacitor Pricing Fair?"

Pricing seemed to cause some rancor between some of the large and small manufacturers. A top executive in a large company complained:

"Today's capacitor prices are essentially what they were 10 years ago. That's because shoe-string companies are holding prices down. They're making just enough money to keep their heads above water, and they're stopping other companies from making a decent profit."

A smaller company answered: "The big companies have a name, a reputation and many customers they've developed over the years. Our only way of competing is by keeping our prices down. How else could we stay in business?" ■ ■



Antenna Pattern Unchanged by Mylar Guys

Mylar makes an effective rope for support of this 110-foot telescoping antenna designed by Sylvania Electronic Defense Lab for the Signal Corps. The synthetic, fashioned into three strand guy wires one-quarter and three-eighths of an inch thick, is reported more than twice as strong as Manila rope of the same size. And unlike steel guy wire, Mylar's electrical properties do not change the antenna pattern.

Radio and Radar React Erratically to Stratospheric Atom Blasts

Tricky interruptions to radio and radar resulted from the first two megaton devices ever exploded in the stratosphere by the United States.

The devices, detonated over Johnston Island in the Pacific Ocean last year, disrupted communications in an area of 1500 mile radius under the blasts, according to DOD and the AEC. The first shot, Teak, was detonated July 31 at 11:50 P.M. at an altitude higher than 200,000 feet. The second, Orange, was exploded Aug. 11 at 11:30 P.M. at about 100,000 feet.

Ionizing radiation from the blasts so upset the ionosphere that some radio waves were absorbed or scattered. Auroras that resulted cluttered radar reception. But the disruptions were not uniform. Such factors as height of explosion, time of day, channel of communication and distance from Ground Zero appeared to vary the reactions.

"When altitudes such as that of Shot Teak are reached," the Government agencies noted, "high-frequency communication blackout occurs on some but not all channels within the affected region. For example, operators working similar frequencies through the same areas experienced markedly different degrees of blackout. Some communications channels were operable at all times.

"Absorption on the order of minutes occurs near the shot at even ultra-high frequencies. Clutter from the shot-caused aurora would also be of concern to some radar operations in the vicinity of the shot for as long as half an hour.

"After the Orange detonation, the major effects were delayed until after sunrise, when apparently the sun's radiation caused photo-dissociation of the remaining negative ions. This created a great increase in ionization and absorption of the lower layers of the ionosphere."

An increase in absorption—but more moderate—was also noted after sunrise with the Teak shot.

"Shots Teak and Orange were also observed using two uhf airborne radars," the agencies continued. "The radar of lower frequency detected strong returns from both bursts for a period slightly under an hour. The other radar received returns from both shots but substantially weaker and of shorter duration. Stronger returns were received from the lower-altitude shot (Orange) at both frequencies."

Riometers (relative ionospheric opacity meters) at Johnston Island, French Frigate Shoals and Hawaii provided a constant measure of the integrated cosmic noise overhead. Since this noise is constant from day to day, absorption can be detected to better than ± 1 db by observing depressions in the record.

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of specific interest to engineers

Folio 59-5

REFERENCE
DATA FILE



Important factors in specifying toroidal inductors

The powdered molybdenum permalloy toroidal inductor is finding increasing use in today's complex electronic equipment. Excellent magnetic stability, superior temperature stability, high Q values, and small physical size are but a few of the outstanding features which explain the popularity of molybdenum permalloy toroids. To fully realize the advantages of these inductors, the components application engineer must accurately specify those parameters which are of critical importance in a given application. "Under-specification" may result in a component which fails to give adequate performance in the circuit. "Over-specification", on the other hand, may result in a component of extremely high cost. An understanding of the factors involved in the design and manufacture of toroidal inductors at Sangamo will enable the components application engineer to effectively judge the consequences of his specification in relation to the cost and performance of the final product.

THE EQUIVALENT CIRCUIT of a toroidal inductor is illustrated in figure 1.

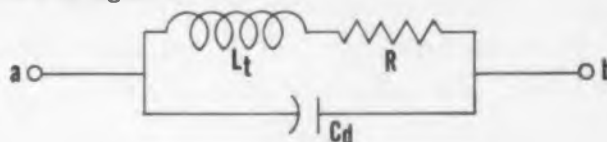


FIGURE 1

L_t is the so-called "true inductance" of the toroid and is assumed to be constant at all frequencies. R represents the sum of copper losses and core losses which increase with frequency. C_d , the distributed capacitance, approximates the capacitance between turns of the winding and between the winding and core. Due to the fact that the dielectric constant of the insulation on the windings and on the core itself is not constant with frequency, the distributed capacity will also vary with frequency. This variation, however, is usually small and may be neglected in the following discussion.

THE APPARENT INDUCTANCE (L_a) is the equivalent inductance between terminals (a) and (b). As might be expected, the apparent inductance varies with frequency. If R is neglected the expression for L_a becomes:

$$L_a = \frac{L_t}{1 - \omega^2 C_d L_t}$$

Inductors for single frequency or resonant circuit applications are usually specified in terms of apparent inductance. The standard tolerance on L_a is 1% or one turn whichever is greater.

THE Q FACTOR is usually specified in lieu of R since most applications are concerned with the ratio of inductive reactance to equivalent resistance. The accepted method of specifying Q is to set a limit on minimum Q at the operating frequency or over a range of frequencies. Normally, the Q of a given design at a given frequency will vary some 20% between units. Where direct current flows through the inductor it may sometimes be desirable to set a limit on the d-c resistance as well as on Q. Analysis of the equivalent circuit, assuming constant R, shows that:

$$Q_{equiv} = \frac{\omega L_t}{R} - \omega R C_d - \frac{\omega^3 L_t^2 C_d}{R}$$

From the above equation one may deduce that anything which increases the distributed capacitance must necessarily reduce the Q.

DISTRIBUTED CAPACITY becomes most important in wide band or multiple frequency applications, since C_d will determine the variation of L_a with frequency. The majority of users do not find it necessary to specify C_d . Where C_d must be specified, the accepted method is to set a limit on the maximum allowable distributed capacitance. An alternative method of specifying C_d is to set a tolerance on the apparent inductance to be measured at two different frequencies (usually corresponding to the upper and lower frequencies encountered in a given application). The design engineer controls the C_d by varying the method of winding the inductor. In decreasing order of capacity he may choose 1) random continuous windings; 2) progressive winding, or segmented winding. Unfortunately, winding costs increase as distributed capacity decreases. Wax or varnish impregnation will increase the distributed capacity. In applications where it is necessary to insure that L_a be reasonably constant over a wide frequency range, it is also usually desirable that L_a be reasonably constant with temperature and with time. These features are best achieved using a stabilized core, a low capacity winding, and an unfilled hermetically sealed enclosure. In this way, the undesirable effects of impregnation may be avoided.

REQUIREMENTS FOR STABILITY OF INDUCTANCE with temperature, with a-c voltage level, and with direct current are additional factors which will influence the cost and the size of a given inductor. Temperature stabilized cores are available only in certain core sizes and are, of course, more expensive than the standard unstabilized cores. High values of a-c voltage and direct current will lead to larger cores and increased cost.



The Sangamo design engineering department is ready to discuss your inductive components problems. Typical examples of specialty components designed and produced by Sangamo are described in engineering bulletin series IC-260. Address: Sangamo Electric Company, Inductive Components Section, Springfield, Illinois.

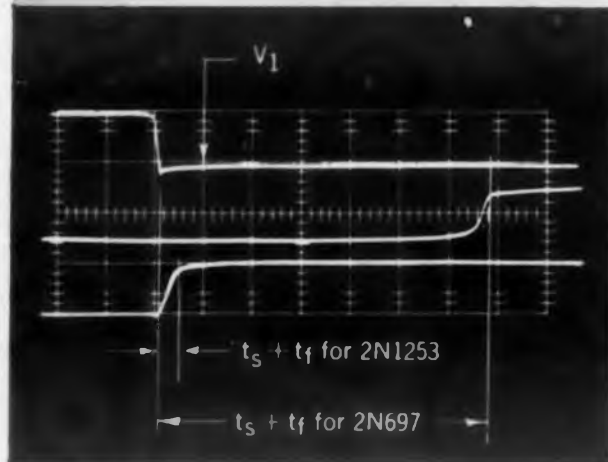
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CIRCLE 12 ON READER-SERVICE CARD

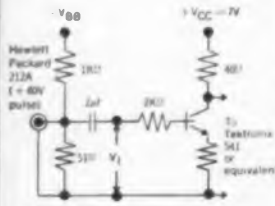
New from Fairchild

LOW STORAGE SILICON TRANSISTORS



Comparison of storage-and-fall-time performance between the new Fairchild 2N1253 and Fairchild's 2N697. The 2N1253 has performance otherwise equivalent to the 2N697 plus the additional advantage of low storage. An actual Polaroid photo is shown. Scale is 0.2µsec. per oscilloscope division. Scope was a Tektronix 543 with 53/54S plug-in giving a rise time of 15µsec.

CIRCUIT USED IN COMPARING 2N697 AND 2N1253



NOTE

V_{BB} is adjusted to make $V_{11} = 30V$ during turn-on and $V_{11} = -10V$ during turn-off

TENTATIVE SPECIFICATIONS, 2N1252 AND 2N1253

ABSOLUTE MAXIMUM RATINGS (25°C)

| | | |
|-------------------|---|-----------|
| V_{CE} | Collector to Emitter Voltage ($R_{\theta} = 10 \Omega$) | 20V |
| V_{CB} | Collector to Base Voltage | 30V |
| V_{EB} | Emitter to Base Voltage | 5V |
| Total Dissipation | at Case Temperature 25°C | 2 watts |
| | at Case Temperature 100°C | 1 watt |
| | at 25°C Free-Air Ambient | 0.5 watts |

ELECTRICAL CHARACTERISTICS (25°C)

| SYMBOL | CHARACTERISTIC | MIN. | TYPICAL | MAX. | TEST CONDITIONS |
|--------------|---|-------|---------|-------|---|
| β_{DC} | D.C. pulse current gain | 15 | 45 | 90 | $I_C = 150mA$, $V_C = 10V$ |
| β_{FE} | Base saturation voltage | 1.0V | 1.3 | 1.5V | $I_C = 150mA$, $I_B = 15mA$ |
| $V_{CE SAT}$ | Collector saturation voltage | 0.8V | 1.5V | 1.5V | $I_C = 150mA$, $I_B = 15mA$ |
| β_{FE} | Small signal current gain at $f = 20mc$ | 25 | 5.0 | 90 | $I_C = 50mA$, $V_C = 10V$ |
| C_{ob} | Collector capacitance | 30pF | 45pF | 45pF | $I_E = 0mA$, $V_C = 10V$ |
| I_{CBO} | Collector cutoff current | 0.1µA | 10µA | 10µA | $V_C = 20V$, $T = 25^\circ C$ |
| $t_s + t_f$ | Turn-off time | 75µs | 150µs | 150µs | $I_C = 150mA$, $I_B = 15mA$, $I_{B2} = 5mA$ |

$R_L = 400 \Omega$, 10µs pulse

Fairchild's 2N1252 and 2N1253 provide the guaranteed shorter total switching time necessary for direct-coupled transistor logic circuits (DCTL) in combination with the inherent reliability and power dissipation that silicon mesa construction affords.

75 µseconds is typical storage-plus-fall time at 150 ma collector current on these new devices; 150 µs. is guaranteed. For low level operation, typical storage time is 35 µs. for $I_C = I_{B1} = I_{B2} = 10$ ma. This performance makes them usable for saturating type logic circuits and high-current-level saturating switching circuits. A few of the many applications are magnetic core drivers, drum and tape write drivers, high-current pulse generators and clock amplifiers. They also provide extra safety factor in less critical applications.

To achieve high reliability, these transistors are preaged at 300° C, a temperature that would destroy most other types. This preaging time at 300° C accomplishes a stabilization of characteristics equivalent to thousands of hours of operation at junction temperatures as high as 175° C.

For full information, write Dept. B—6.



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CIRCLE 13 ON READER-SERVICE CARD

NEWS

Transistorizing 2-Way Mobile Set Gets 0.04-Amp Stand-by Drain

According to G.E. its transistorized Progress-line mobile radio receiver can deliver full-volume output when switched from a stand-by state that draws only 0.040 amp.

GE's engineers report start-from-scratch design for miniaturization gives the set its performance figures. Crystal ovens have been replaced by module heaters that supply heat only when needed, and the receiver and power supply are completely transistorized.

New circuit design provides 0.0005 per cent frequency stability despite the absence of crystal ovens, the company asserts.

Output of the four-tube, high-band transmitter is 75 watts. Later, GE may produce low-band sets with outputs higher than 75 watts.



Plated-through circuit boards, modular construction, separate power and control units, and waffle-type heat sink are design features of 75 w, high-band mobile line.

Rad Backed as Radiation Unit

Use of the rad as a national standard unit for reporting radiation dosage has been recommended by a study group of the American Society for Testing Materials. The rad, representing 100 ergs of energy absorbed per gram of material, differs from most other units used to measure radiation in that it is independent of the type of ionizing radiation in use as well as the material. It was adopted in 1953 by the International Commission on Radiographic Units for measuring radiation.

New Bus Equipment on Way

Two electronic improvements under development for motor coaches promise benefits for operators and passengers. One is a million-mile, maintenance-free generating system. The other is experimental transistorized fluorescent lighting.

The generator was described to a Seattle meeting of the AIEE by its developer, the Delco-Remy Division of General Motors. It is an alternating type with built-in silicon rectifiers, is brushless, has permanently lubricated bearings and is "free of environment" to prevent damage from dirt and other foreign matter. It is designed for a minimum capacity of 200 amp, with 125 amp available at engine idle speed. The regulator is completely static.

GE's high-frequency fluorescent lighting system utilizes a transistorized electrical inverter that converts dc to 3000-cycle ac. It can operate 16 fluorescent lamps on a bus from the vehicle's battery.

GE says its test installation produces three to nine times the light of a filament system while consuming three-fourths the wattage.

Over-the-Horizon Radar Tested

A radar guidance system that can deliver commands over the horizon has been demonstrated for the Air Force.

The new microwave system, built by Sperry Gyroscope uses a ground-air link to achieve its great range. The ground director station originates the radar signals, and a second station in a high-altitude aircraft relays the signals beyond the horizon.

The system is intended to control, track and monitor pilotless drone aircraft and missiles over hundreds of miles. A single radar frequency band commands and tracks the pilotless vehicles and telemeters flight data. Formerly three systems were needed to do this, Sperry said.

Antenna for Space Ship Tested



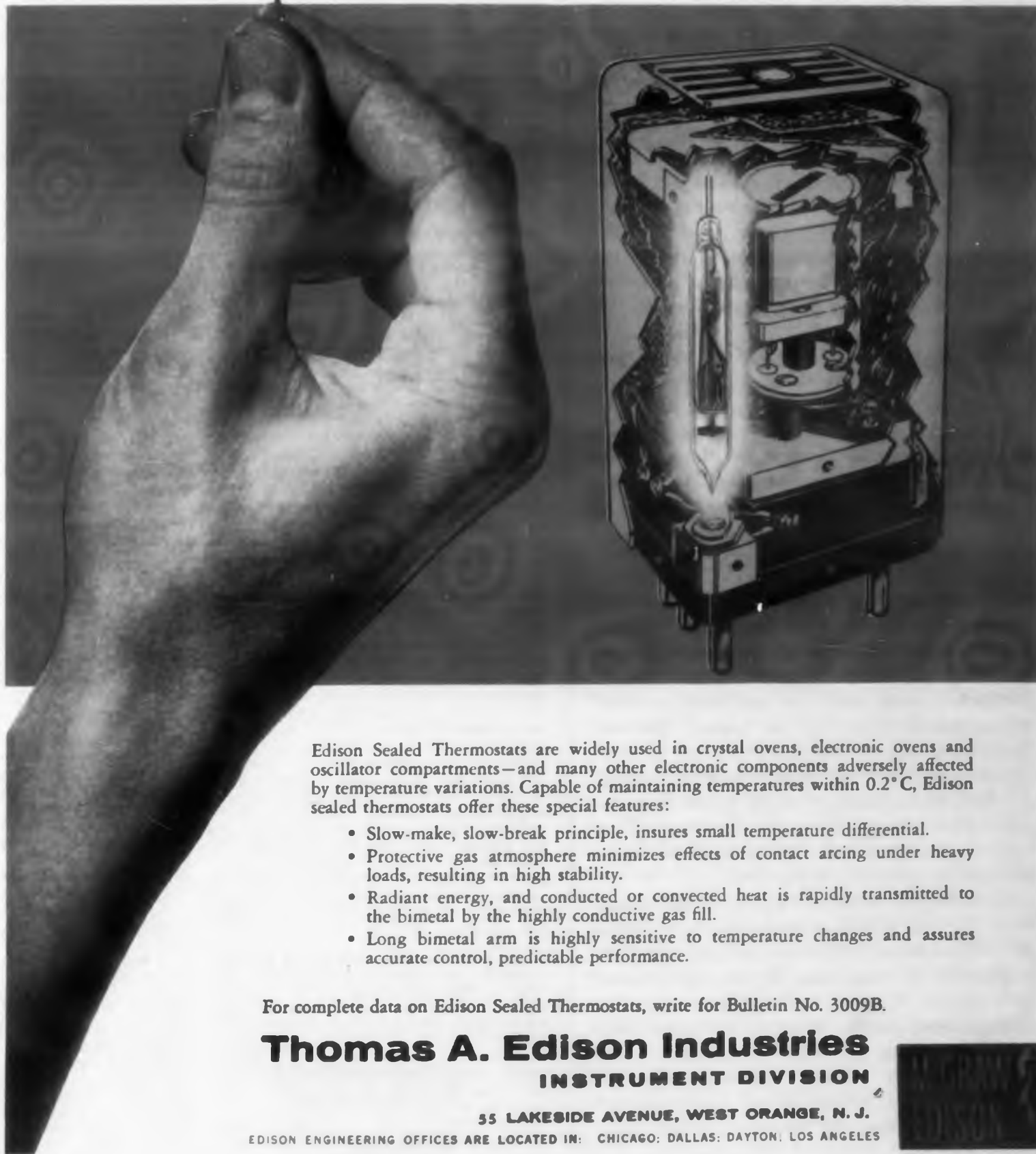
Mock up of antenna designed for the Project Mercury manned space vehicle is inspected by officials of the Collins Radio Co. who say the company has finished all design work on the project's antennas and is now testing and evaluating them.

THOMAS A.

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Edison Sealed Thermostats are widely used in crystal ovens, electronic ovens and oscillator compartments—and many other electronic components adversely affected by temperature variations. Capable of maintaining temperatures within 0.2°C, Edison sealed thermostats offer these special features:

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- Radiant energy, and conducted or convected heat is rapidly transmitted to the bimetal by the highly conductive gas fill.
- Long bimetal arm is highly sensitive to temperature changes and assures accurate control, predictable performance.

For complete data on Edison Sealed Thermostats, write for Bulletin No. 3009B.

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CIRCLE 14 ON READER-SERVICE CARD

WASHINGTON REPORT



Ephraim Kahn

Military Presses Program To Standardize Equipment

Changes are being made in military procedures for stocking and buying that will eventually have a considerable impact on the electronics industry. The Defense Department has set a target date of December 31, 1961, for completing its Accelerated Item Reduction (AIR) program, designed to cut to a minimum compatible with supply support requirements the number of items in the military supply systems. The Air Force has apparently decided to standardize on high-quality electron tubes. A report examining the question of having a single buyer for all electron tubes for military use has been turned in to the office of the Assistant Secretary of Defense for Supply and Logistics.

The AIR program is already well under way. Its objectives include systematic reduction in the varieties of types and the number of sizes of items stocked, an inventory clean-up, and establishment of controls to assure that the minimum practicable number of items remain in the military supply systems.

Electric Supply Limit Planned

Net effect of the AIR program for the electronics inventory will be a form of standardization. A limited range of types and sizes of electronics components will be stocked for support, and an effort will be made to standardize on things that can be used by all the Armed Services. Purchase of items which are not listed as standard approved types will be banned. Defense Department officials will not, of course, prohibit purchase of items that deviate from an existing standard when this is necessary to the functioning of an electronic device. Instead, they will set up a new category (and Federal Catalog System number) to take care of the need.

For example, some military electronic equipment now may include resistors of a stated capacity and tolerance. Other devices might include resistors of the same capacity but with different tolerances. In the past, each has been assigned a different stock number since the catalogers were not in a position to judge whether slightly different tolerances made a significant difference in the end-use of the part or not. Under the AIR program, a decision will be made on this point.

THERMOCOUPLES MADE PRACTICAL

...or how a completely floating and isolated differential DC amplifier can be of assistance in obtaining overall system accuracies of 1% to 0.1% when measuring the output of grounded thermocouples or strain gages.

Designers and users of data-handling systems, particularly systems for evaluating high-performance rocket or jet engines, are constantly under pressure to provide higher and higher measurement accuracies. According to recent statistics, a large percentage of these measurements involve narrow-band data from grounded thermocouples. Even on a bench, the measurement of temperature in a DC to 100-cycle bandwidth with 1% accuracy isn't too easy, and 0.1% measurements get pretty messy. Now, if you have fifty thermocouples and they happen to be or have to be grounded at the source, and the source is a rocket or jet engine separated from your amplifiers by, say, 300 feet of interconnecting cable, and the amplifiers are driving a load such as a large data-handling system that must be grounded, you are probably in trouble. In fact, with a system anything at all like this, it's likely that you had great difficulty getting 1% system accuracy and found 0.1% accuracy virtually impossible to obtain.

5 more microvolts of trouble from outside causes, or a little less than 2 microvolts RMS AC at 60 cycles. Can we expect 2 microvolts of trouble from ground loops? You bet we can! The normal, average common mode voltage at installations we know of is approximately 1 volt RMS at 60 cycles. In a number of cases, this common mode potential is as high as 4 volts at 60 cps.

In an attempt to better this situation by a rather common remedy, we shall tie a big fat bus bar between the rocket engine and the amplifier case ground, as shown in Figure 1. Our bus bar will be an eight-inch pipe filled with water, 300 feet long, with an impedance of about 0.2 ohms at 60 cycles. (An actual installation.) The common mode voltage generator shown in Figure 1 will have some impedance associated with it, and the ratio of this impedance to the bus bar impedance will determine how much we reduce the common mode voltage. If the impedance of the common mode generator is 0.2 ohms, we will reduce 1 volt

bus bar is connected through the rocket engine to the exact center of the thermocouple, the input signal will be reduced to half. If the thermocouple impedance (or, more accurately, the emf generating part of the thermocouple) is all in series with the ground (low) side, the signal would be almost zero. You can see now why we said that obtaining 1% accuracy was difficult and 0.1% accuracy virtually impossible.

Are we completely whipped? Yes and no. If our system must look exactly like that of Figure 1, we probably are. If we can change the system somewhat, perhaps not. What we need to beat this common mode voltage problem is some impedance in series with our ground loop. If we can float the amplifier, or the thermocouple, we can solve or at least improve the situation. It's actually impossible to float a thermocouple bonded to a rocket or jet engine. Even if the whole stand sits on concrete, there will still be a big potential difference between engine and amplifier. This leaves the amplifier end to work on.

You have probably noticed that we show a grounded load, but not a grounded amplifier in Figure 1. This is realistic. It is possible, for example, to float our 111 series single-ended DC amplifiers by about 500 kilohms at 60 cps. This would be enough to keep us out of trouble with up to 10 millivolts of common mode voltage, since, in this case, we would produce only 2 microvolts of noise (100/500K x 10 mv). We are assuming that the load can be floated sufficiently so that the impedance of the low side of the amplifier to ground is the only consideration. However, if the load must be tied to ground as in Figure 1, either directly or through the low impedance of long cables between amplifier and load, then we cannot use a single-ended amplifier. Or, even with the load floated, if the common mode voltage is too high, we cannot use a single-ended amplifier.

THE DIFFERENTIAL AMPLIFIER

In the foregoing discussion we have pointed out that single-ended amplifiers can severely limit the performance of systems employing both grounded transducers and grounded loads. The differential amplifier (sometimes called floating amplifier), if it meets certain re-

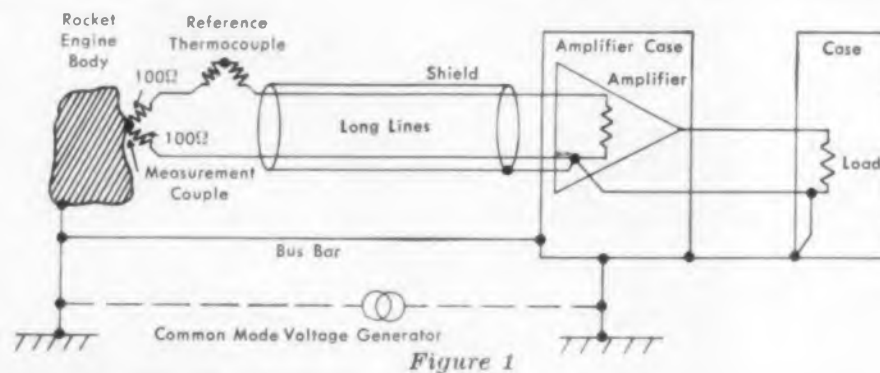


Figure 1

WHAT'S THE PROBLEM?

In Figure 1, we see a grounded thermocouple with a reference couple, 300 feet or so of shielded input leads from the couples to the amplifier, and a single-ended DC amplifier driving a grounded load. (For the moment, we will ignore the bus bar.) This is a typical system. It doesn't give very good accuracy. Nevertheless, it is a typical system. In our experience, the problem with such systems has always been noise, noise which results from ground loops. The troublesome part of this noise will consist of hum at the power line frequency. It will be random in magnitude and phase at the amplifier, precluding accurate cancellation. This noise, this difference in potential which exists between the thermocouple ground point and the amplifier ground point—since it is common to both input leads—is called common mode voltage, as shown in Figure 1. And any noise voltage appearing here will be applied directly to the input of the amplifier.

Let's examine the magnitude of the problem. A typical thermocouple will have a peak output of about 10 millivolts. If the system resolution is to be 0.1%, then the maximum peak error caused by noise, drift, non-linearity and what-have-you can't exceed 10 microvolts. Good single-ended amplifiers (such as KIN TEL's 111 series) will contribute less than 5 microvolts of equivalent input error from all of these causes. This means we can tolerate only

of common mode voltage to 0.5 volts. If the common mode generator impedance is 20 ohms, the common mode voltage will be reduced to 5 millivolts, or a little more than two thousand times greater than the 2 microvolts RMS we said we could stand. Even if the common mode voltage had been 1 millivolt instead of 1 volt, with 20 ohms of common mode generator impedance, the bus bar would reduce the common mode voltage to only 5 microvolts. This is still too much.

Unfortunately, most of the figures we have chosen are a little on the favorable side. More than likely, the common mode voltage will be 1 volt, more than likely the common mode generator impedance will be less than an ohm, and more than likely you won't have a bus bar with as little as 0.2 ohms impedance at 60 cycles. In fact, there's even more to the big bus bar fallacy than this, for if the generated common mode voltage is partly caused by electromagnetic pickup from high-voltage power lines or other sources, it may actually increase after the bus bar is installed. Admittedly, the bus bar may be far removed from power lines, but it's not even safe to be in the same world with high-voltage, high-current power lines when only 2μv of noise will ruin you. The bus bar may also short out part of the input signal. We show the thermocouple as a device with 100 ohms each side of the point at which it contacts the rocket engine. If this is true, and our

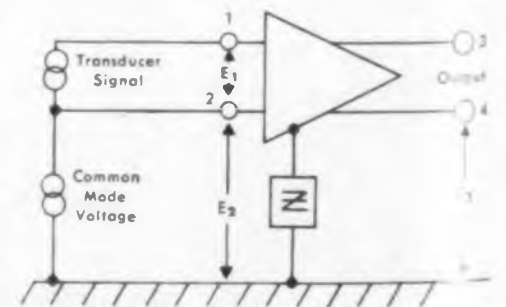


Figure 2

requirements, will permit the use of grounds at both ends of a long line without forfeiting adequate system performance. Figure 2 is a diagram of the differential amplifier. Note that, unlike the single-ended amplifier in which

ag, E_2 and E_3 would be equal, input terminal 2 and output terminal 4 are not common. The output of the true differential amplifier is only equal to the difference in potential between input terminals 1 and 2, times the gain of the amplifier, and is not affected by any voltage between terminal 1 and ground or terminal 2 and ground. Thus, E_2 , the common mode voltage, does not affect the input. The major figure of merit of a differential amplifier is common mode rejection, or how much of the common mode voltage, E_2 , is converted to normal mode voltage, transducer signal E_1 . For example, if common mode voltage of 1 volt produces 1 microvolt of equivalent input signal, the common mode rejection is 1,000,000 to 1 (120 db).

There are two basic types of differential amplifiers. The most familiar is probably the balanced amplifier shown in Figure 3. This amplifier requires an exceptionally well-balanced input if common mode rejection is to be good. Figure 3 can be redrawn as the bridge circuit shown in Figure 4. From this it

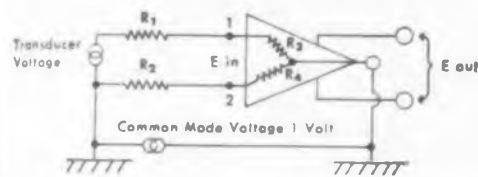


Figure 3

can be seen that the common mode rejection is determined by the equality of R_1/R_3 and R_2/R_4 . With no transducer input signal and 1 volt of common mode voltage, an unbalance of only 2 ohms will introduce 20 microvolts of noise, which is a common mode rejection of 50,000 to 1. Even a simple system employing only a measurement thermocouple and a reference thermocouple may well have a resistive unbalance of a 100 ohms or more. Considering the reactive component of the impedances involved and the fact that most large installations employ calibration or level-setting potentiometers in the transducer circuit, it is desirable to have an amplifier that will provide high common mode rejection with up to several thousand ohms input unbalance. This the balanced-input differential amplifier cannot do. Internal limitations—such as the necessity of having carefully balanced feedback circuits—

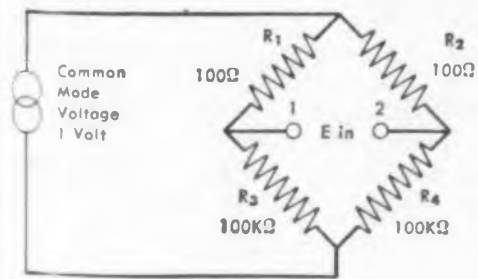


Figure 4

also conspire to limit the performance of balanced amplifiers.

If the balanced amplifier can be floated, that is, not tied to ground as it is in Figure 3, common mode rejection can be improved. Since good input to output isolation cannot usually be obtained in balanced amplifiers, the load must be floated too. Considering all of these fac-

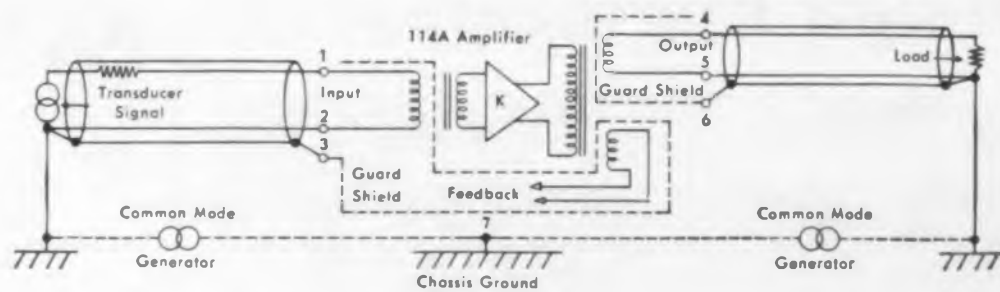


Figure 5

tors, it is difficult in practice to obtain a common mode rejection of more than 1000 to 1 with the balanced amplifier. Nevertheless, it will improve system performance in the few cases where common mode voltage is low, but still too high to provide adequate performance with no common mode rejection at all. If common mode voltage is low enough, it is probably better to use a single-ended amplifier. Balanced amplifiers are generally more expensive than single-ended and, except for common mode rejection, their performance isn't usually as good.

All of our common mode voltage problems could be solved with an amplifier that had nearly infinite impedance between input circuit and amplifier case or chassis ground, and, further, had only magnetic coupling between input and output with virtually no stray capacitance. Then the input would be isolated from the output and it wouldn't make any difference whether the load were grounded or not. Is there such an amplifier? Yes.

KIN TEL's 114A Differential DC Amplifier meets all these requirements and more. Common mode rejection of the 114A is 1,000,000 to 1 or better for 60 cps voltages, and practically infinite for DC. And it provides this rejection with up to 10,000 ohms unbalance in either input lead. To obtain this kind of performance, it can be seen that R_3 and R_4 in Figure 4 would have to be 100,000 megohms, and, at 60 cps, leakage capacity to ground could not exceed about 0.3 micromicrofarads for each side of the input. In order to meet these tough isolation requirements, the KIN TEL 114A employs guard shielding similar to that used in fine AC bridges. These guard shields surround the entire input and output circuits and are extended out to the transducer and load by means of input and output cable shields. Figure 5, a considerably simplified version of the 114A, illustrates this principle. (The transformers are given DC response by means of input chopper and output demodulator circuits which are not shown.) If the guard shields were perfect, there would be no capacitance and therefore infinite impedance between input and output signal leads and chassis ground for the common mode voltage.

In practice, the KIN TEL 114A provides 10,000,000 megohms and less than 0.3 micromicrofarads impedance between each input signal lead and the amplifier case or chassis ground. Output circuit impedance to chassis ground is almost this high, and input and output are completely isolated from each other. In other respects—linearity, gain stability, noise, drift—the 114A closely equals the performance of the very best single-ended DC amplifiers. However, bandwidth is forfeited for common mode rejection. This is a penalty the present

state of the art requires of all completely floating and isolated differential amplifiers that are capable of providing high common mode rejection with an unbalanced input. Fortunately, the 100-cycle bandwidth of the 114A is more than adequate for bonded thermocouples, which cause most common mode voltage problems, and is usually adequate for strain gage measurements. The advantage of using the 114A with strain gauges is that it eliminates the necessity of having exceptionally well-isolated power supplies and permits using one supply for a number of gauges.

IN SUMMARY

When you are designing a large, fairly complex narrow-band data-handling system with long lines between a grounded transducer and amplifier and/or amplifier and load, you will have ground loop problems. To determine the magnitude of the problem, measure the voltage, electromagnetic field strength, and earth impedance between transducer and amplifier ground points. From this information you can roughly calculate whether installation of an expensive bus bar between amplifier and transducer will provide enough reduction in common mode voltage. Examine power sources and loads that may be generating unwanted currents. Perhaps they can be ungrounded. If common mode voltage is still too high to provide desired system resolution (it probably will be), use a differential amplifier.

If you have a common mode voltage problem, and you need a differential amplifier, it must have very high common mode rejection at 60 cps. If 60-cycle rejection is only marginal, you may be in serious trouble at slightly higher frequencies. The amplifier must be capable of providing this common mode rejection with whatever input unbalance is present. If calibration or level-setting potentiometers are used to permit commutation of multiple channels, this unbalance can be several thousand ohms. To retain common mode rejection in the quite likely event that the load is grounded, the input circuit of the amplifier must be well isolated from the output circuit. And, if long output cables are used, the amplifier output circuit must be isolated from ground to almost the same degree as the input. Otherwise, the common mode voltage between output and load can cause trouble. All signal cables and shields must be arranged to provide both adequate shielding and maximum ground loop impedance for minimum ground loop current. Finally, call your nearest KIN TEL Engineering Representative, you'll want a demonstration of the 114A Differential DC Amplifier.



Write today for descriptive literature or demonstration. 5725 Kearny Villa Road, San Diego 11, California

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If it appears that such a variance is not really important to function, then both types of resistors would be issued interchangeably under a single stock number.

At present, it does not appear that there is in the offing any sharp cutback in buying from the electronics industry. In the middle distance—after the program has been completed—there may be a tendency on the part of purchasing officers to buy a more limited number of types of electronic components than there is now, when the line of least resistance is to duplicate as a spare the item chosen by the manufacturer for incorporation into original equipment.

Minimization of electronic equipment failures caused by electron tubes is being sought by the Air Force through upgrading. In the future, only tubes listed in MIL-STD-200() or MIL-E-4682() will be used in connection with Air Force design, development, modification, or procurement of electron-tube-using equipment. A specific waiver will be needed for use of any other tubes. MIL-STD-200 lists the preferred types of tubes to be used by designers and makers of military electronic equipment. "Improved" and "high quality" tubes are found in MIL-E-4682.

Inventories of non-conforming tubes are to be used "until exhausted or disposed of in the most efficient and economical manner."

Air Research and Development Command is to make sure that all technical requirement documents specify use of approved tubes. The ARDC will also check contractor compliance with the tube standards in the case of equipment development contracts.

Single-Buyer Concept Studied

Feasibility of having a single buyer for electron tubes for military use has been examined in an unpublished report that has been submitted to E. Perkins McGuire, Assistant Secretary of Defense. It is believed that the group that made the report failed to agree completely, and comments now being formulated by the individual Armed Services are expected to show a lack of unanimity on the practicability of such a move at this time. After the Defense Department has completed its program of standardization of common-use items for the Services, it is possible that the single-buyer concept might meet with a more friendly reception. A policy decision by the Department, however, could force the individual services to accept such a move now. In this connection, it is worth noting that the Comptroller General is conducting an investigation of supply and procurement of electronics by the military. The study, requested by the Majority Leader of the House, John McCormack (D., Mass.), will undoubtedly recommend changes in the military's present methods of buying, stocking, etc.

Electronic Design Engineers Have Helped to Build This Study



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MEETINGS

Calendar of Events

July

15-17 Radio Technical Commission for Aeronautics, RTCA, IRE, Ambassador Hotel, Los Angeles, Calif.

August

4-6 Annual Convention of Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Calif.

9-12 ASME-AICE Heat Transfer Conference, University of Connecticut, Storrs, Conn.

17 National Ultrasonics Symposium (PGUE), Stanford University, Stanford, Calif.

18-21 WESCON Show and Convention, Cow Palace, San Francisco, Calif.*

23-26 AIEE, 6th Electrical Conference of the Petroleum Industry, Wilton Hotel, Long Beach, Calif.

31-2 Semiconductors Conference Metallurgical Society of AIME, Statler Hotel, Boston, Mass.

September

1-2 Conference on Chemistry in Aerodynamic and Space Flight, Air Force Office of Scientific Research, General Electric Co., University of Pennsylvania, Philadelphia, Pa.

1-3 14th National Meeting, Association of Computing Machinery, MIT, Cambridge, Mass.*

7-10 6th Annual International Meeting, The Institute of Management Sciences (TIMS), Paris, France.

17-18 Engineering Writing and Speed Symposia, IRE, Boston, Mass. and Los Angeles, Calif.

18-19 3rd Technical Symposium, Cedar Rapids section IRE, Sheraton-Montrose Hotel, Cedar Rapids, Iowa.

18-20 8th Annual High Fidelity Show, International Sight and Sound Exposition, Inc., Palmer House, Chicago, Ill.

20-25 14th Annual Conference and Exhibit, Instrument Society of America, Chicago, Ill.

21-22 Standard Engineers Society 8th Annual Meeting, Boston Section, Hotel Somerset, Boston, Mass.

23-25 4th Annual Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, AIEE, IRE, Shoreham Hotel, Washington, D.C.

28-30 National Symposium on Telemetry, IRE, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif.

28-1 3rd Annual Industrial Film and A-V Exhibition, Oct. New York City, N.Y.

28-1 American Welding Society Meeting, Sheraton-Oct. Cadillac Hotel, Detroit, Mich.

30-1 Industrial Electronics Symposium, Mellon Institute, IRE, AIEE, Pittsburgh, Pa.

* Includes meetings described herewith.

WESCON Show and Convention, August 18-21

The show will feature numerous exhibits which will fill the Cow Palace in San Francisco. Complementing the product lines will be papers covering all phases of professional group interests. A "new look" in the technical program is being planned this year which will limit each of the usual 40 daytime sessions to three full-length papers in each. A second innovation will be the

introduction of a "panel of peers," a group of experts in the field, invited to comment on the group of papers at the completion of each session. Registrants will be able to obtain and review all papers prior to their presentation through the Convention Record.

14th ACM National Conference, September 1-3

Conference of the Association of Computing Machinery will be held at the Massachusetts Institute of Technology, Cambridge, Mass. Technical papers to be presented will cover numerical analysis, data processing, automatic programming, language translation, digital and analog devices, and various applications of computers. Chairman of Local Arrangements is: Frank M. Verzuh, Computation Center, MIT, Cambridge, Mass.

Paper Deadlines

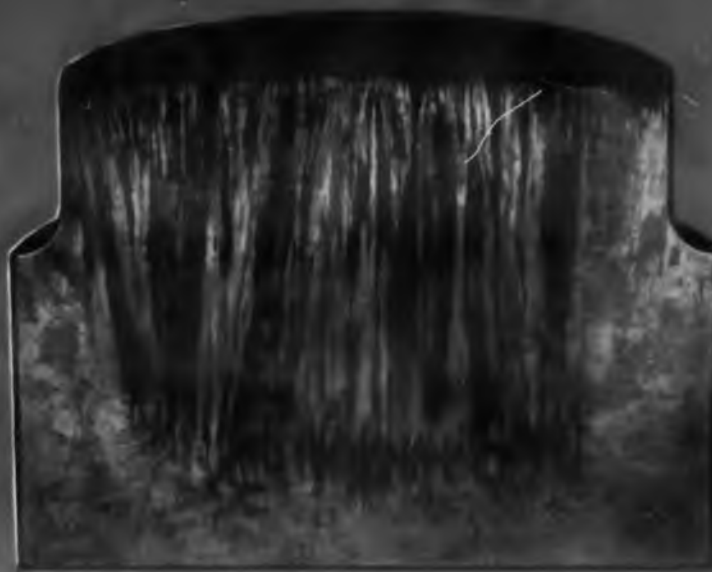
July 15: Paper deadline for the **Fourth IRE Instrumentation Conference and Exhibit** to be held **November 9-11, 1959** at the Atlanta Biltmore Hotel, Atlanta, Ga. An informative abstract of approximately 200 words is required. Earlier submission of papers is requested although final deadline for acceptance of abstracts is July 15. Send titles of abstracts to *W. B. Jones, Jr, School of Electrical Engineering, Georgia Institute of Technology, Atlanta 13, Ga.*

August 15: Submit by this date four copies of a 100 word abstract and a 1000 word summary of papers on any phase of computing for the **1959 Eastern Joint Computer Conference**. The Conference will be held **December 1-3, 1959**. Forward abstracts to: *J. H. Felker, Chairman, EJCC Program Committee, Bell Telephone Laboratories, Mountain Ave., Murray Hill, N.J.*

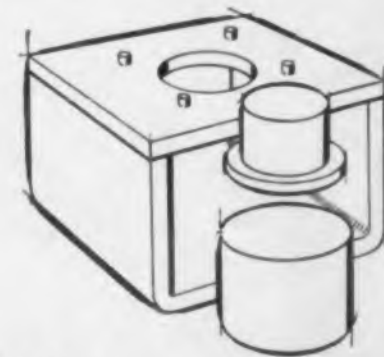
August 3: Deadline for an original and four copies and an informative abstract of approximately 200 words for papers for the **1959 Electron Devices Meeting, IRE, Shoreham Hotel, Washington, D.C., being held October 29-30**. Papers to be presented should deal with material of an applied or developmental nature in the broad field of electron devices. Emphasis should be on the device itself, or important new device technology. Send abstracts to: *Dr. J. R. Hornbeck, Bell Telephone Laboratories, Murray Hill, N.J.*

October 23: Deadline date for papers for the **1960 IRE Convention** to be held **March 21-24, Waldorf-Astoria Hotel and New York Coliseum, New York**. Send a 100-word abstract in triplicate, including title of paper, name and address, and a 500-word summary in triplicate, including title of paper, name and address to: *Gordon K. Teal, Chairman, 1960 Technical Program Committee, The Institute of Radio Engineers, Inc., 1 E. 79 St., New York 21, N.Y.*

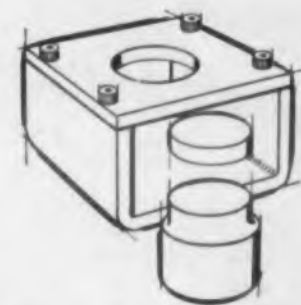
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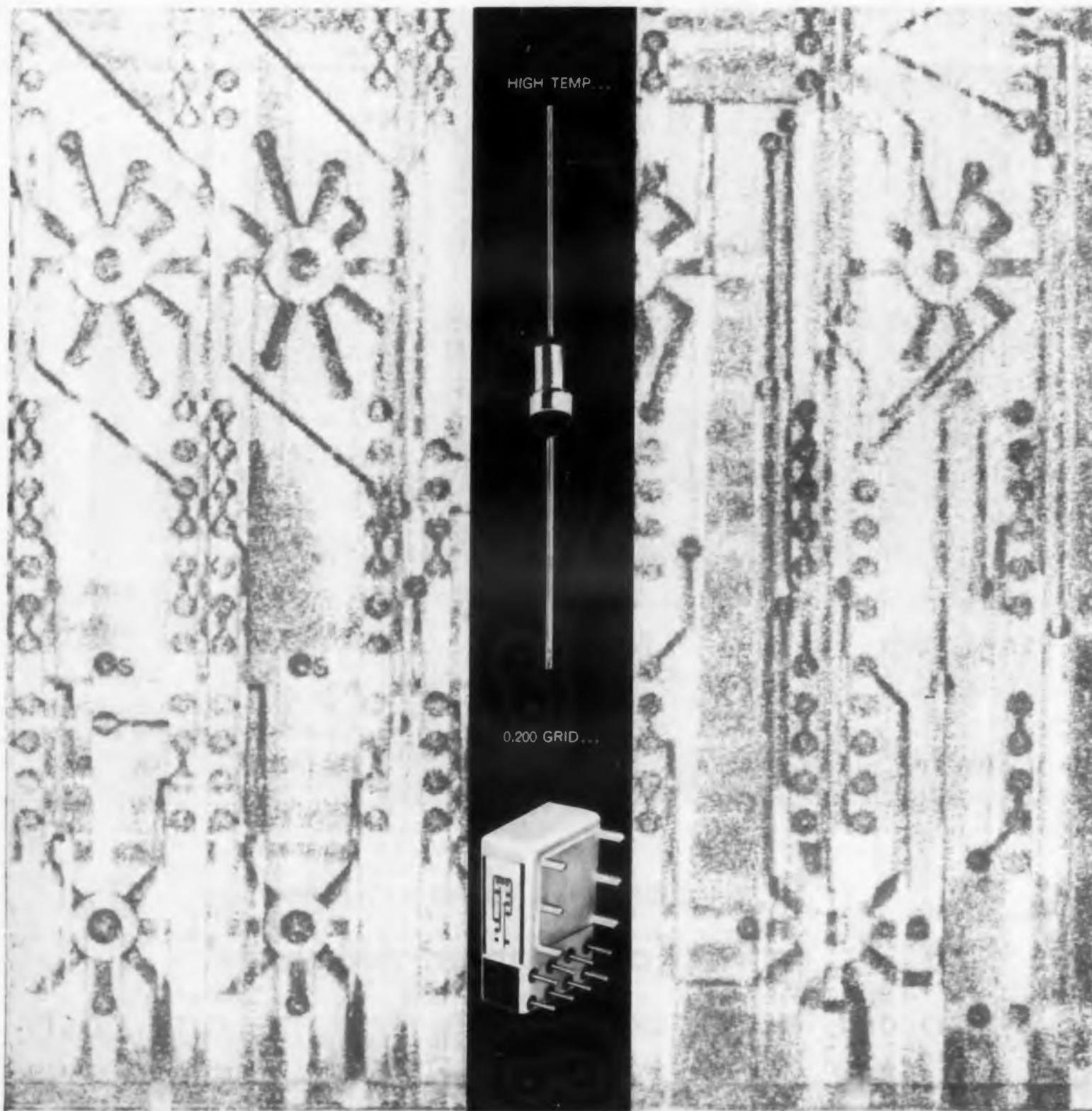
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EDITORIAL

We Need a Radio to Export to Japan

One of the "best buys" in transistor radios today is a Japanese import. To meet the competition, some American manufacturers are incorporating low-cost Japanese components, such as capacitors and speakers, into their sets. We also hear of American manufacturers importing complete Japanese radios to sell under their own name. Just as American-brand watches have Swiss movements, our American-brand radios may soon have Japanese chassis. Forty-five Japanese firms are now actively exporting to the USA, as the articles on pp. 3-5 and pp 106-109 reveal.

Japan is able to undersell American manufacturers only because of her low-cost labor. A typical hourly pay of a Japanese laborer is 19 to 20 cents, compared with an American rate of \$1.65 (less fringe benefits). Although Japanese design is good, it is not more clever than American.

What can our electronics industry do to survive the competitive onslaught of imports? American foreign-affairs experts say that we must have free world trade for free-world survival. Without the protection of an import duty, American businessmen are inclined to join the Japanese rather than try to beat them. Licensing agreements, stock-acquisition plans and other trade agreements are not uncommon.

But instead of defensive action against imports, American businessmen should be on the offensive by being exporters themselves. Outstanding managerial ability coupled with technological advances have made it possible for the U.S. to get the greatest productivity per hour of human labor. This nation's brainpower resources are the best, because of its policy of educating everyone, not just a select few.

We can go a long way toward meeting the challenge of low-price labor by intelligent use of machines and investment in R & D. An automatically produced molecular-electronic radio can certainly be less costly than the cheapest import made with hand labor.

Great Britain's electronics industry, which has to export to survive, realizes that it must automatize to produce competitively priced products. American companies, even in a technologically-oriented country like Germany, find U.S. labor can out-produce lower-priced German labor when we have the edge on know-how and experience.

If the American consumer electronics industry is to remain healthy, it must push ever more toward greater production per hour of labor. As a measure of our success, we might some day export radios to Japan.

James G. Kopp

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This article presents a series of simplified charts designed to show the maximum expected error introduced into a guidance system by any one component.

Charts for Fast Checking of Guidance System Accuracy

Richard F. Scharmann

U. S. Naval Air Development Center
Johnsville, Pa.

OVERALL accuracy of an inertial guidance system for missiles may be quickly evaluated using a series of simplified charts. Based upon maximum tolerances of individual components, these charts enable the systems designer to predict accuracy based upon the maximum error introduced into the system by any one component.

Five charts are given from which performance requirements may be determined. These charts cover performance of instruments or components designed to measure four variables of motion. They are (1) angular acceleration, (2) angular velocity, (3) angular displacement and (4) linear acceleration. Each chart gives the maximum allowable error in the measuring device for the chosen time of flight of the missile for a target error of up to 1 nautical mile. Table 1 gives six basic motions with possible method of determining position and possible instrumentation. As noted, linear velocity and linear displacement are unmeasurable for the reasons given.

To use the charts, pick the time of flight of the missile, project this to the "1 nautical mile error" line, then read the maximum allowable component error from the other axis.

Or, locate the component manufacturer's advertised error and determine, with the known time of flight, whether the missile will hit the target within 1 nautical mile. If it doesn't, the component does not fall within the designer's specifications.

On the charts given, the diagonal line represents an error at target of 1 nautical mile. Other errors may be plotted on the charts if desired. In fact, the system designer may desire to equip his set of working charts with an entire family of lines representing a wide range of errors.

Assumptions

In deriving these charts, several assumptions, which would not be justifiable in a rigorous study of any particular system, have been made. The effect of these assumptions is to make the accuracy requirements of these instruments somewhat less stringent than would actually be required. It has been assumed that:

- The vehicle is to be guided over an appreciable fraction of the earth's surface.
- Inertial systems operate without information either from or through the atmosphere through which the vehicle travels. Reference to inertial space by celestial observation is prohibited.
- The acceleration of the earth's gravitational field is invariant and is 32.2 ft/sec² over the earth's surface.
- The earth is round.
- The length of a mean solar day is 24 hours.
- There is no uncertainty in the position of the vehicle with respect to the earth at time of launch or take-off.
- The error contributed by the inaccuracies in

the particular instrument being discussed is the only error in the system, the errors in all other instruments are zero.

The maximum allowable uncertainty in the position of the vehicle being guided is one nautical mile or 1 minute of arc.

Angular Acceleration

Angular displacement of a body as a function of time and angular acceleration is given by the expression:

$$\phi = 1/2 at^2 \quad (1)$$

where ϕ = angular displacement
 a = angular acceleration

$$= \frac{2\phi}{t^2}$$

$$t = \text{time} \quad (2)$$

If the maximum allowable error in determination of displacement is to be taken as 1 nautical mile then ϕ will be 1 minute of arc = 0.29×10^{-3} radians = 1 nautical mile (by definition). From Equation 2:

$$\Delta a = \frac{0.58 \times 10^{-3}}{(\text{flight time in secs.})^2}$$

$$= \text{max. allowable acceleration error in radians/sec}^2 \quad (3)$$

Fig. 1 is a plot of Equation 3 showing the maximum allowable error or uncertainty in the measurement of angular acceleration vs. time of flight for a maximum allowable position error of 1 mile.

For a 1 hour flight this error is not to be more than 45×10^{-12} rad/sec². This is indeed a small angular acceleration. Angular accelerometers have been known to be built having an uncertainty of approximately 5×10^{-3} radians/sec². Such an uncertainty is a few hundred million times greater than the maximum allowable.

An idea of the magnitude of this acceleration can be realized from the fact that a shaft starting from rest and accelerating at the rate of 45×10^{-12} rad/sec² would require more than 10,000 years to achieve an angular velocity of 16.2 radians/sec. which is not quite 3 revolutions per second. Such an instrument is beyond practical achievement at any time in the foreseeable future using presently known techniques.

Angular Velocity

Angular displacement can be established by the integration of angular velocity with time. If the maximum allowable error in the measurement of linear displacement is to be 1 mile then the maximum allowable error in the measurement of angular displacement will be 0.29×10^{-3} radians. The

maximum allowable error in the measure of angular velocity ΔW will be:

$$\Delta W = \frac{0.29 \times 10^{-3}}{\text{time of flight in secs.}} \quad (4)$$

Fig. 2 shows the maximum allowable error or uncertainty in the measurement of angular velocity versus flight time for a maximum position uncertainty of 1 nautical mile. Using 72.9×10^{-6} radians/sec as the angular velocity of the earth

the maximum allowable uncertainty in the measurement of angular velocity can be expressed as a fraction of earth's rate. This has been done in Fig. 3.

From these figures, the maximum allowable uncertainty in the measure of angular velocity for a 1 hour flight is 1.1×10^{-3} of earth's rate or 0.081×10^{-6} rad/sec. A body rotating at this velocity would require approximately 1000 days or nearly 3 years to make one revolution. This velocity is also about 0.0167 degrees/hour. High perform-

Table 1—Six Basic Motions in Space

| Basic Motion | Possible Method of Position Determination | Possible Instrumentation |
|----------------------|--|---|
| Angular Displacement | Angular displacement and the radius (earth) about which displacement occurs, yields position | Free gyroscope |
| Angular Velocity | Integrate once and treat as angular displacement | Constrained gyroscope |
| Angular Acceleration | Integrate twice and treat as angular displacement | Coupled linear accelerometers |
| Linear Acceleration | Integrate twice to obtain linear displacement | Pendulus devices |
| Linear Velocity | Integrate once to obtain linear displacement | Linear velocity with respect to inertial space is unmeasurable because of the fundamental law of restricted relativity which states that there is no such thing as an absolute or unique inertial space |
| Linear Displacement | (Yields position directly) | Meaningless because of the restriction on linear velocity |

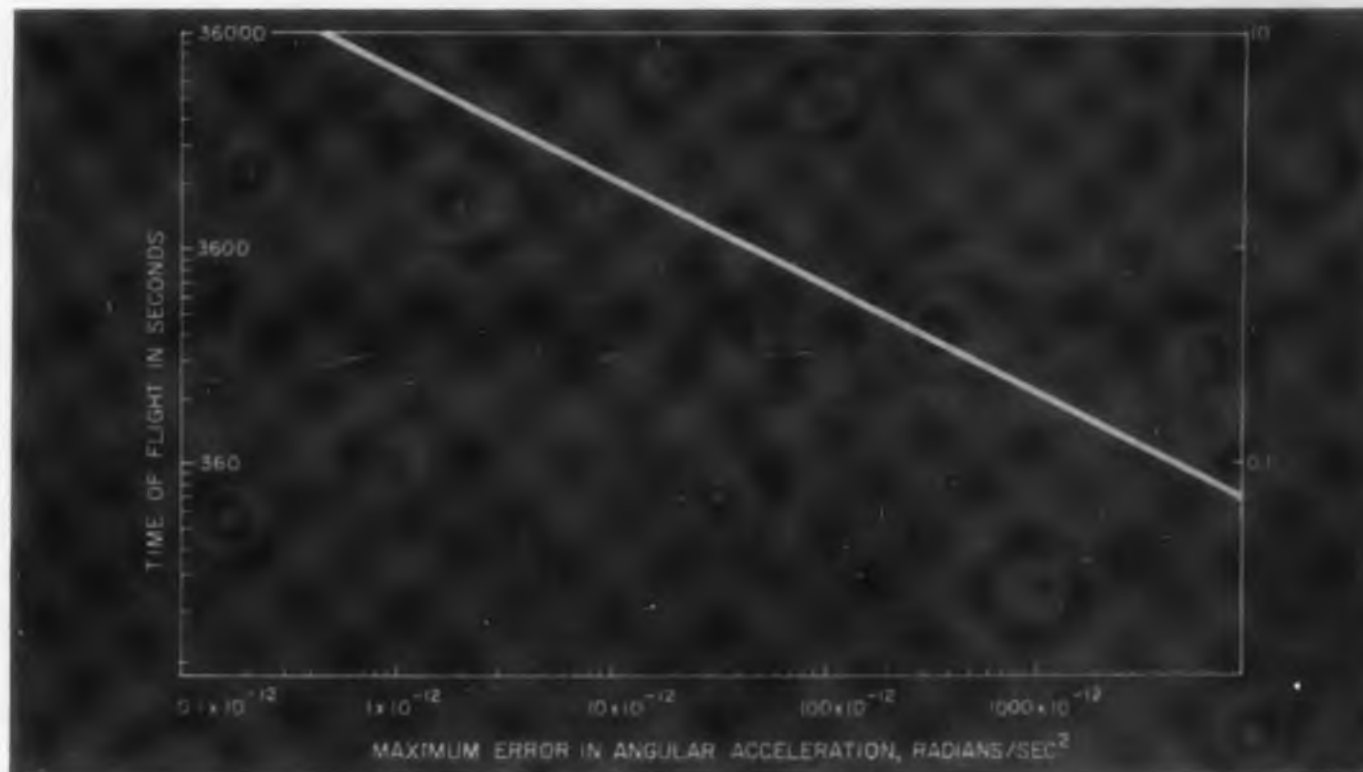


Fig. 1. Inertial guidance performance requirements of angular acceleration measuring instrument vs flight time based upon a maximum allowable position uncertainty of one nautical mile.

Fig. 2. Inertial guidance performance requirements of angular rate measuring instrument vs flight time based upon a maximum allowable position uncertainty of one nautical mile. Angular velocity measured in deg per hr.

Fig. 3. Inertial guidance performance requirements of angular rate measuring instrument vs flight time based upon a maximum position uncertainty of one nautical mile. Angular velocity measured as a fraction of earth's rotation.

ance angular rate measuring devices are available which are capable of measuring angular velocity below 0.1 deg per hour. This is 10 times greater than the maximum allowable uncertainty in measurement of angular velocity for a 1 hour flight. For flight times which are considerably less than 1 hour it is possible to develop inertial guidance systems using angular rate measuring devices currently available. Possibilities exist for improving the performance of presently available instruments and hence in improving the range and/or accuracy of this type of system.

Angular Displacement

A fundamental law of gyro dynamics states that: When a constant torque is acting as an unconstrained symmetrical spinning body about an axis perpendicular to the spin axis then the spin axis will precess about an axis which is perpendicular to both the spin axis and the torque axis with an angular velocity:

$$W_p = \frac{L}{I_s W_s} \text{ radians/second} \quad (5)$$

Where I_s is the moment of inertia of the spinning mass about its spin axis and W_s is the spin velocity. The torque required to produce a given precessional velocity is then:

$$L = W_p I_s W_s \quad (6)$$

If W_p and W_s are expressed in radians per sec and I_s is expressed in gram cm sec² then L will be given in gram cm. The product $I_s W_s$ is called angular spin momentum and for a practical gyroscope having a total weight of approximately 5 pounds is of the order of magnitude 10^6 cgs units.

The maximum allowable angular precessional velocity of a gyro instrument used in an inertial guidance system having a maximum allowable uncertainty in position of 1 nautical mile is the same as indicated in Figs. 2 and 3 and can be calculated from Equation 4. From Equation 4 and in terms

of radians/sec and flight time in hours and maximum allowable gyro precessional velocity (Gyro Drift) is equal to:

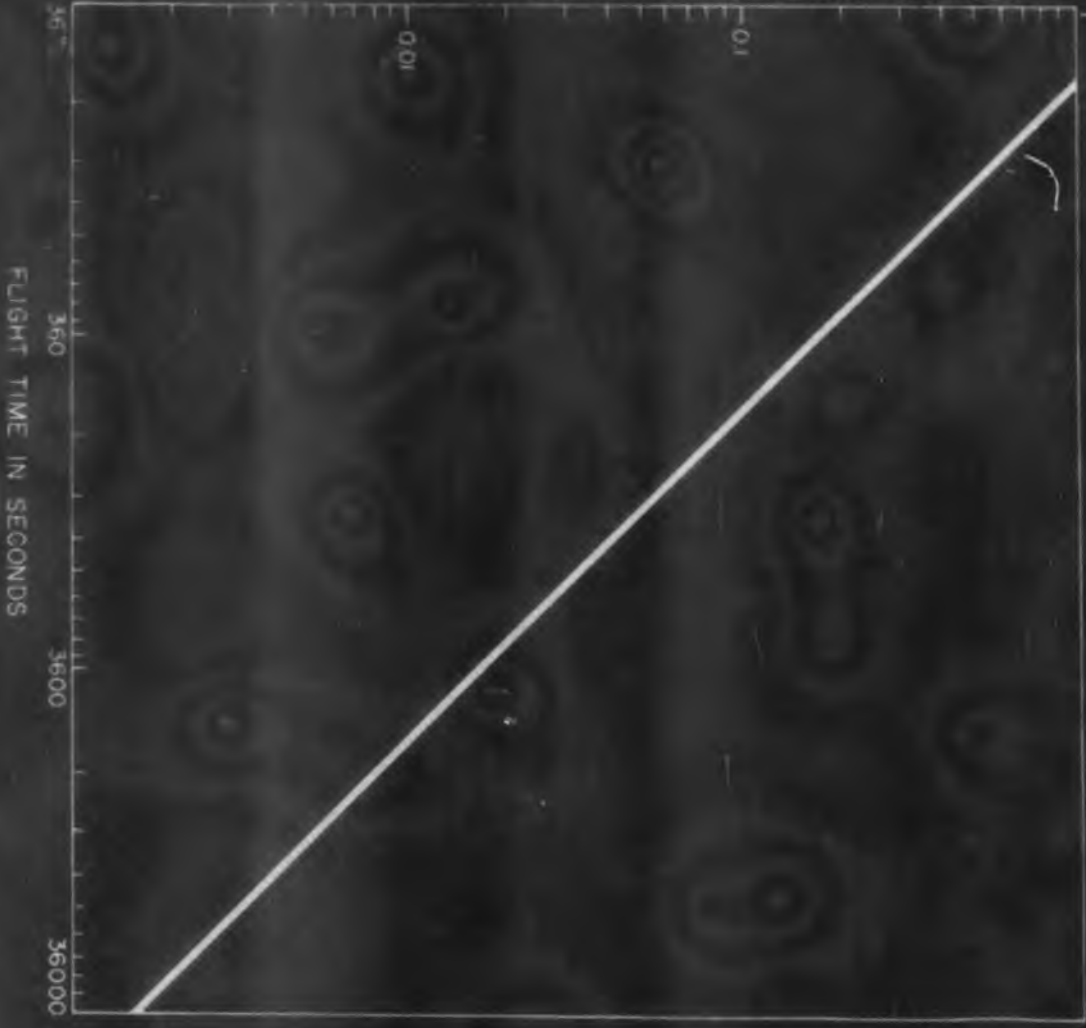
$$W_p = \frac{0.29 \times 10^{-3} \text{ radians/sec}}{3600 \times \text{flight time in hours}} \\ = \frac{0.0805 \times 10^{-6} \text{ radians/sec}}{\text{flight time in hours}}$$

Substituting this maximum allowable angular precessional velocity into Equation 6 and remembering that $I_s W_s$ is the angular momentum of the gyro about its spin axis, the maximum allowable uncertainty torque in the gyro is equal to

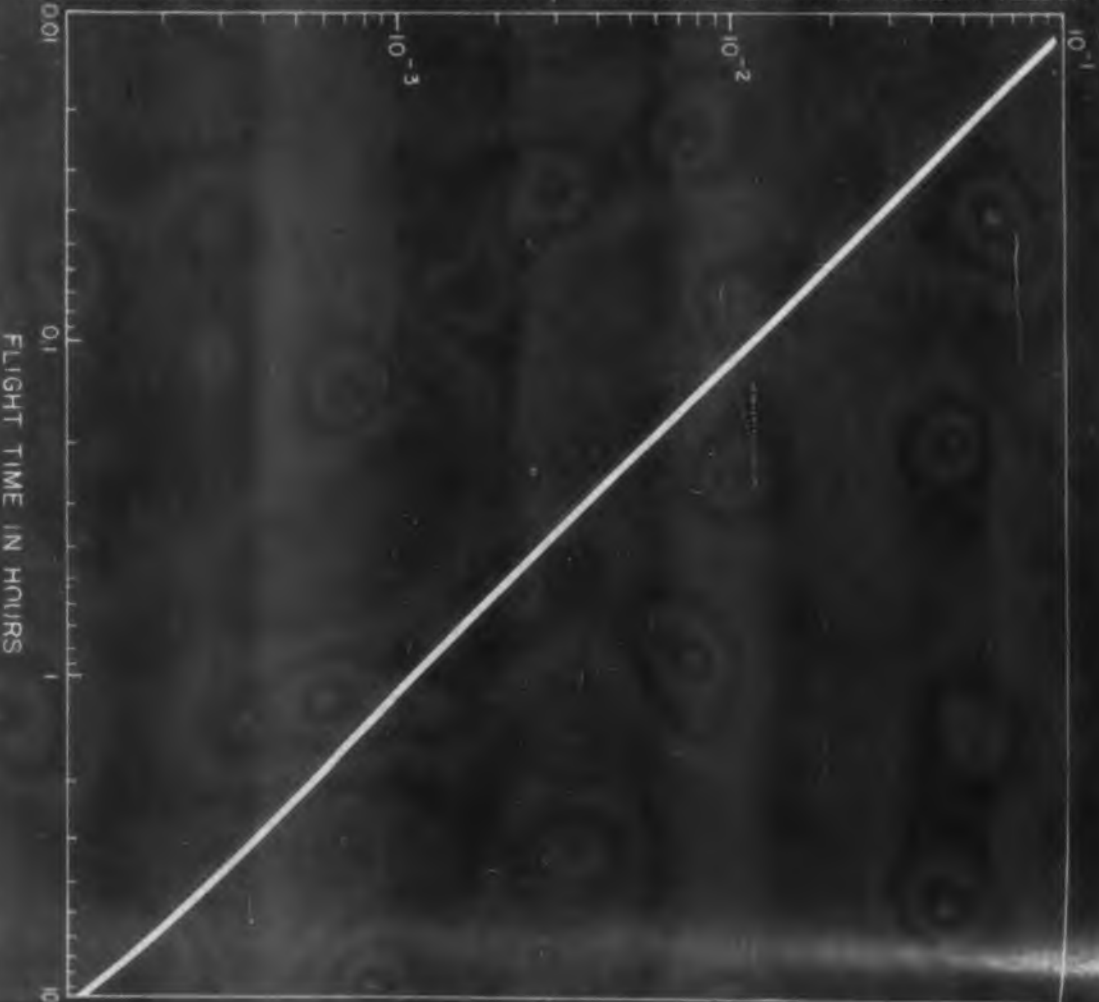
$$0.0805 \times 10^{-6} \times (\text{angular momentum}) \\ \text{flight time in hours} \quad (7)$$

The maximum allowable torque uncertainty of a gyro as a function of flight time has been

MAXIMUM ERROR IN ANGULAR VELOCITY, DEGREES PER HOUR



MAXIMUM ERROR IN ANGULAR VELOCITY, FRACTION OF EARTH'S ANGULAR VELOCITY



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lated from equation 7 and plotted in Fig. 4 for gyroscopes with various angular momentums. Assume that a gyro wheel weighing 1000 grams is spinning at a velocity such that its angular momentum (I, W_s) is 10^8 gram cm^2/sec . From Fig. 4 we determine that for a flight time of 1 hour and a maximum allowable uncertainty in position of one mile that the maximum allowable torque uncertainty in the spinning mass suspension system is about 0.081 dyne cm. There are 1.02×10^{-3} grams per dyne. This torque is equal therefore to

$$0.081 \times 1.02 \times 10^{-3} = 0.0826 \times 10^{-3} \text{ gram cm.}$$

If all of the allowable uncertainty torque to be assigned to a mass unbalance in the wheel assembly due to mass shift from bearing end play then the allowable bearing end play would be equal to 0.0826×10^{-3} gram cm divided by the weight of the wheel or 1000 grams. This is then 0.0826×10^{-6} centimeters. It is clear that this is a frightfully small amount of allowable end play in bearings supporting a 1000 gram wheel. This small tolerance poses some special problems in the design of gyros as angular displacement measuring devices for inertial guidance work.

Torque uncertainties in inertial gyroscopes are largely the result of:

- Shift in the location of the center of gravity of the spinning mass usually called mass unbalance. It may be caused by end play in bearings, temperature changes, material creep and wear.
- Friction in the gimbal bearings. There is no

"perfect" bearing, i.e. a bearing having zero friction. From Fig. 4 again one observes that the maximum allowable torque uncertainty level can be increased by increasing the angular momentum of the wheel. This can be accomplished by:

- (1) increasing the size and weight and hence the moment of inertia of the wheel
- (2) increasing the spin velocity of the wheel
- (3) increasing the density and hence the moment of inertia of the wheel

There are practical limitations on the size and weight of an airborne gyro which set a limit on (1). The spin velocity of the wheel is limited by the strength and dimensional stability of the material of which it is made. In addition all of the energy used to drive the wheel is ultimately dissipated in the form of heat which raises the temperature and the friction levels in bearings. These factors place a limit on (2). Increasing the density of the wheel (3) is only desirable when it can be done without dictating a reduction in spin velocity. A lead wheel would be unsatisfactory because of a very low limit on its velocity dictated by the low strength of lead and the poor dimensional stability of this material.

Linear Acceleration

The control of a moving body by the measurement of linear acceleration is based upon the fundamental principle that all departure or displacement from a predetermined line in space is asso-

ciated with an acceleration the first integral of which is velocity and the second integral of which is displacement.

$$\text{displacement } l = 1/2 at^2$$

where a = acceleration and t = time.

If the maximum allowable error in the determination of position is to be 1 nautical mile, then the maximum allowable error in the measurement of linear acceleration expressed as a fraction of the acceleration of gravity is $300/t^2$.

Fig. 5 is a plot of this value as a function of time. From Fig. 5 it can be seen that for a flight time of 1 hour the maximum allowable error in the determination of linear acceleration is 2.9×10^{-5} gravitation units. ■ ■

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2. J. M. Slater, and D. B. Duncan "Inertial Navigation," *Aeronautical Engineering Review* Vol. 15 No. 1, January 1956
3. S. H. Brown, and J. J. Gilvarry "Theory of Errors in Automatic Navigation, with Integrating Accelerometer Systems." U. S. Air Force Project Rand R-154, 5 May 1952, The Rand Corporation
4. Charles S. Draper and Sidney Lees "Instrumentation Problems of Inertial Guidance" July 1957, Instrumentation Laboratories of Massachusetts Institute of Technology.

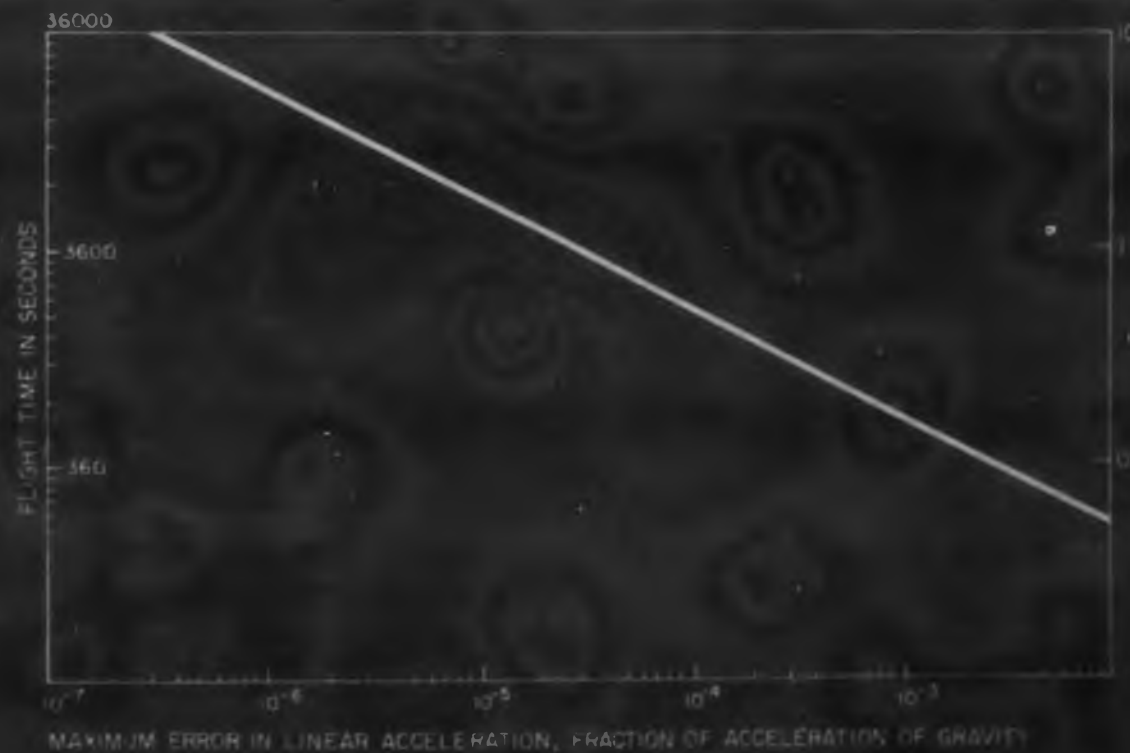
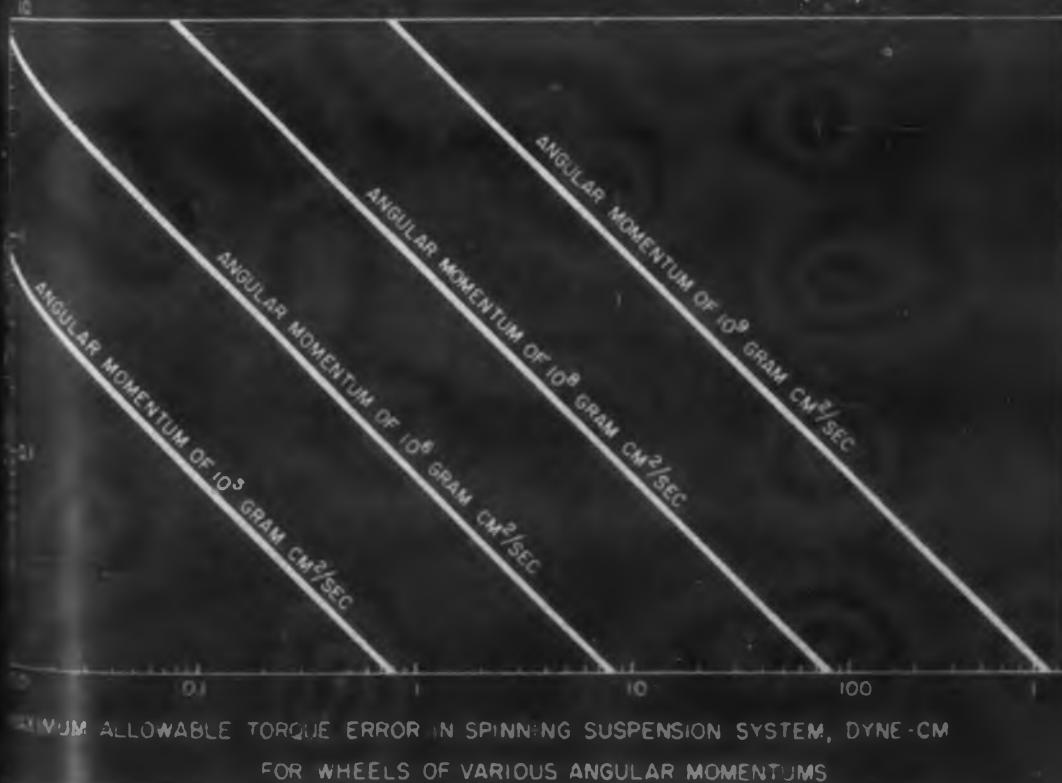
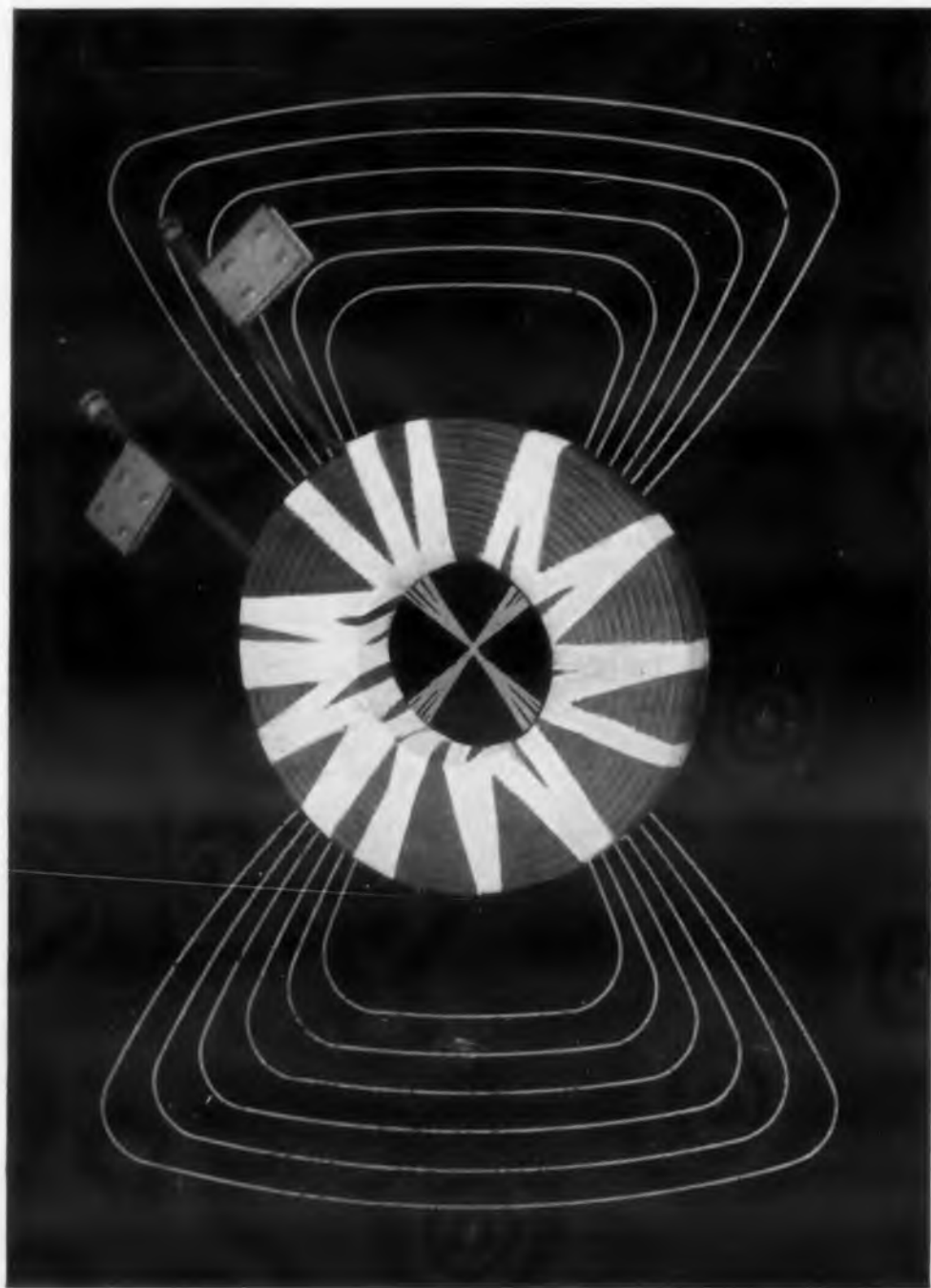


Fig. 4. Inertial guidance performance requirements of free gyroscope allowable torque uncertainties vs flight time based upon a maximum allowable error in determination of position of one nautical mile.

Fig. 5. Inertial guidance performance requirements of linear accelerometers vs flight time based upon a maximum allowable position uncertainty of one nautical mile.



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Precision Synchros Checked Faster

Production time and money is saved using this superaccurate angular indexing head for testing synchros and resolvers.

PRODUCTION testing of synchros and resolvers to accuracies of 2 seconds of arc is accomplished with a specially designed indexing stand. Designed under the direction of Werner Theilheimer, Norden Div., Kety Dept. of United

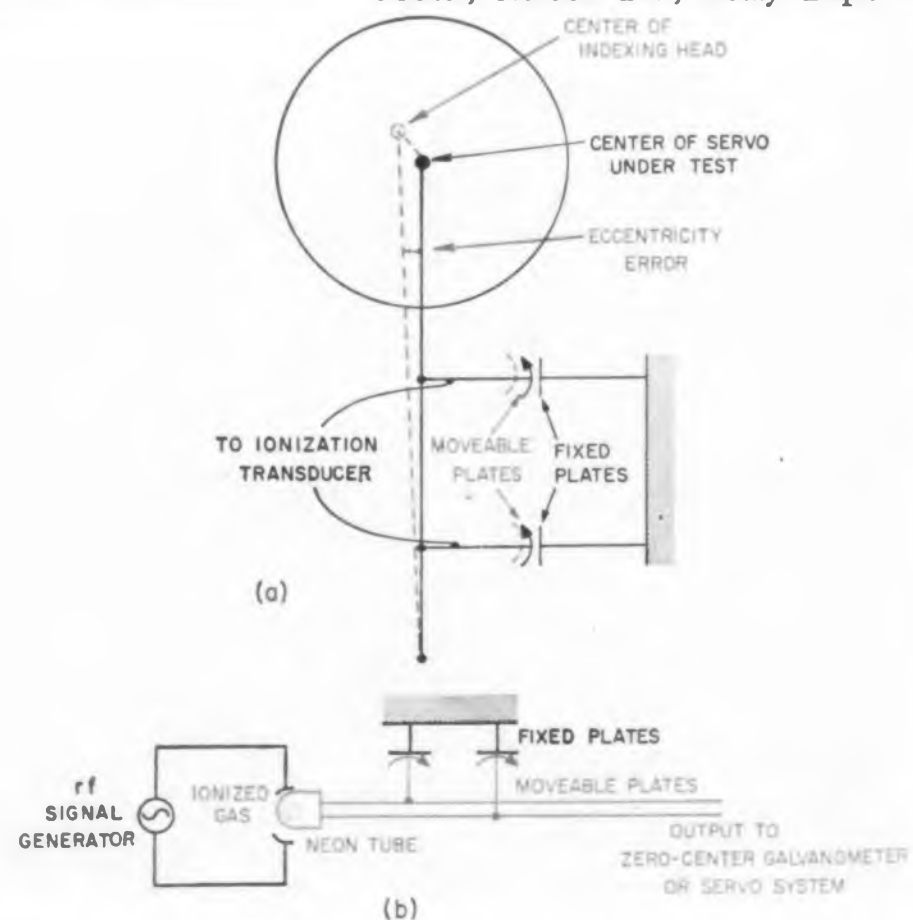


Fig. 1. Diagram showing how capacitor plates detect eccentricity in the test stand (a), and schematic (b) of eccentricity compensation connection to the ionization transducer.

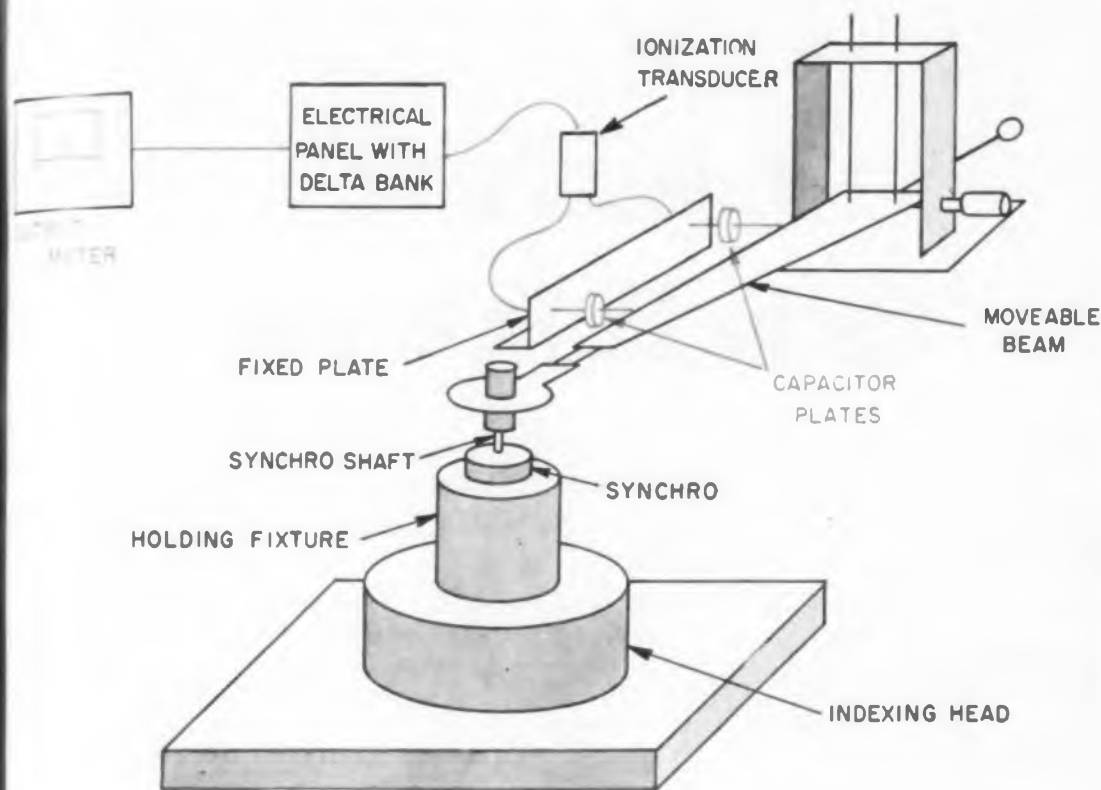


Fig. 2. Angular indexing stand showing eccentricity compensation.

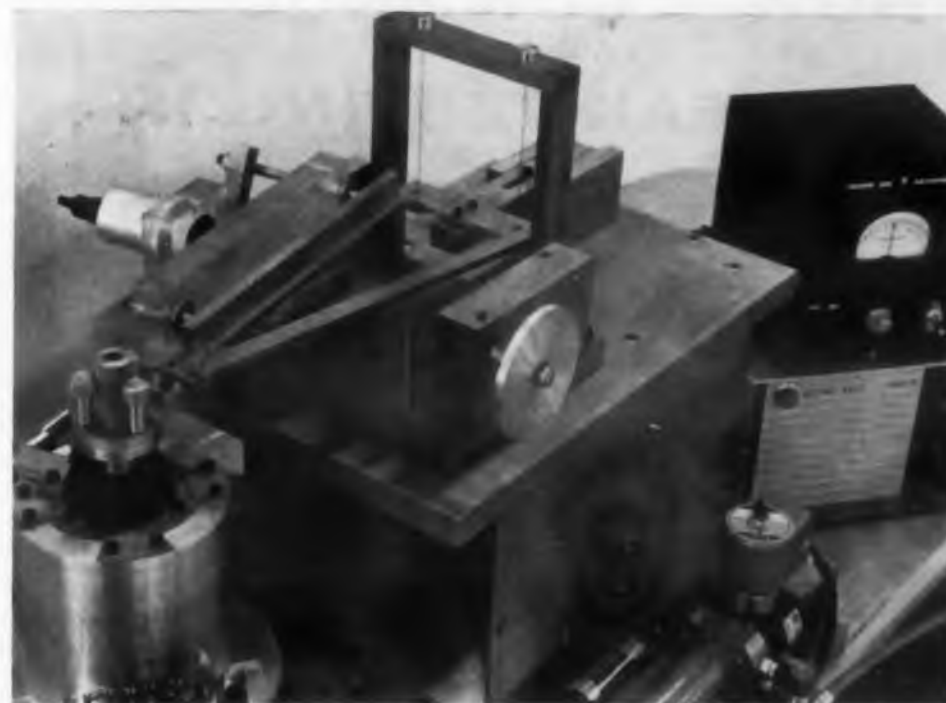


Fig. 3. Eccentricity in the synchro mounting is detected by lateral movement of the triangular-shaped arm. Moveable capacitor plates are the disks shown at the upper left.

nd resolv-
is accom-
ng stand.
er Theil-
f United

Aircraft Corp., Commack, L.I., N.Y., the device is automated to provide quick readings with repeatable accuracy.

Synchros and resolvers have become increasingly accurate. And the test procedures, to keep up with these accuracies, have involved more complex equipment. This takes time and, of course, costs money. The test could conceivably cost more than the unit being tested. Benjamin Sachs, Ketay's planning manager feels that to maintain adequate standards, an ideal system would require an accuracy ten times better than the units themselves. And the test equipment must be capable of operation by a relatively unskilled operator with a minimum of time per test.

Many unique features are combined to provide this economical and precise method of testing precision synchros. This system solves the problem of errors introduced by the positioning device and the human operator.

Simply, these are the problems encountered in any positioning device:

- Basic built-in angular accuracy limit
- Inaccuracies caused by mechanical wear, or non-repeatability
- Eccentricity introduced by the mounting of the unit in the test stand
- Length of time for making each test and human operator error.

To achieve basic built-in accuracy of angular measurement a precise indexing head is necessary. Ketay purchased theirs from AA Gage Co., Detroit. It is designed to be accurate within 0.5 sec

of arc with no backlash. Rack-type teeth engage perpendicularly so that 360 teeth (1 degree intervals) engage simultaneously. Mechanical wear does not affect the accuracy of the head. Thus, the first two problems are overcome.

Eccentricity Troublesome

In 1 inch, an eccentricity error of only 0.000005-in. results in an angular error of 1 sec of arc. An error of 0.0003-in. results in an angular error of 1 min of arc. The only possible solution to the eccentricity problem is to correct for it at each reading.

One method of compensating for these angular deviations is the use of the autocollimator. This is a telescopic device using optical methods of measurement. But it takes too much time.

Werner Theilheimer has devised a unique method of automatic compensation utilizing the Decker T-42 Ionization Transducer. The basic circuit is shown in Fig. 1. When both capacitors are adjusted to equal capacity, the output is zero. Sensitivity of the device is about 2 volts of output per 1 μmf change in capacity.

Application of the Decker T-42 to the indexing stand is shown in Fig. 2. Obviously, when the beam is parallel to the fixed plate, the capacity between the two moveable plates is equal.

As the synchro is rotated by the indexing head, the eccentricity in mounting results in an unparallel condition. Consequently, the spacing of the capacitor plates becomes unequal, with a re-

sulting output voltage. Movement of the bar by the operator or the servo back to a parallel position corrects the error, and reduces the output voltage to zero. A trimmer is provided on one of the capacitor plates to correct for stray capacity.

To reduce time in making a test, two operations can be mechanized. First, the indexing head is rotated by a system of air cylinders and a ratchet drive. Movement of the synchro under test in increments as fine as 1 degree may be had. Thus, readings at each 1 degree of rotation may be taken automatically.

Reference Voltage Provided

A separate delta bank of precision resistors provide the reference output voltage for each angular position. Comparison of the output voltage from the synchro at each test position with the delta bank voltage gives the error of the unit.

In Ketay's test stand (Fig. 3), precise mounting is essential. There must be no deformation or stress in the device. At the present time only one of these test setups has been constructed. Eventually they will be provided to handle all of the inspection at accuracies not previously possible.

In future units, a servo system will be incorporated to balance the output of the ionization transducer and thus automatically correct for eccentricity. Further, the error voltage resulting from comparing the output with the delta bank may be tied to a printing readout. Thus, the complete operation, including a permanent record will be achieved automatically. ■ ■

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Today CEC 24-210A Leak Detectors are in continuous operation sampling corrosive atmospheres...for example, from an iodide-type silicon purification system. Although large quantities of corrosive iodine collect on the instrument's cold trap and silicon dust coats the manifold, rated accuracy is unimpaired and background remains virtually non-existent. This is true because (1) stainless steel is used for the sample carrying manifold, (2) good vacuum geometry is employed, and (3) a liquid nitrogen cold trap is part of every 24-210A.

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AUXILIARY TEST STATIONS... PSM 102 & 202 may be used with all CEC Leak Detectors for hooding, probing, and inside-out leak testing techniques. PSM 102 is a semi-automatic or manual unit. PSM 202 is fully automatic. Write for Bulletin CEC 4-62.

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CIRCLE 23 ON READER-SERVICE CARD



Video Pulse Cathode Follower

George M. Walls

Senior Engineering Technician
Packard-Bell Electronics Corp.
Technical Products Div.
Los Angeles 64, Calif.

Pulse distortion caused by varying receiver gain can be eliminated by using a gain-control video pulse cathode follower.

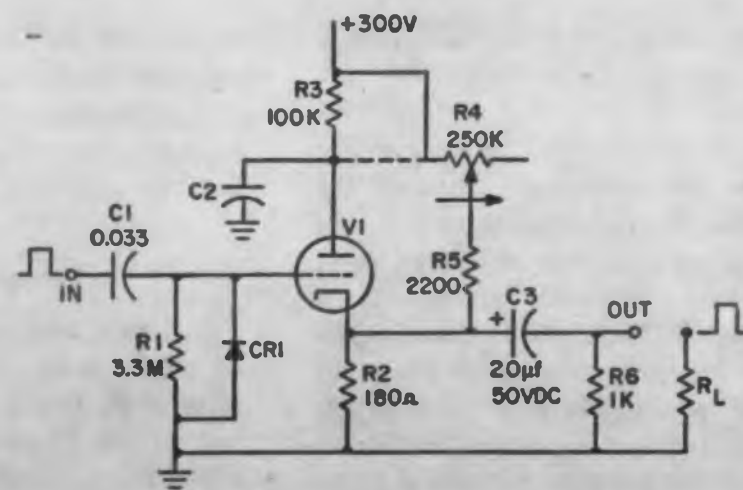


Fig. 1. Gain-control video pulse cathode follower. Diode CR1 which shunts R1, prevents any dc shift at the grid of V1.

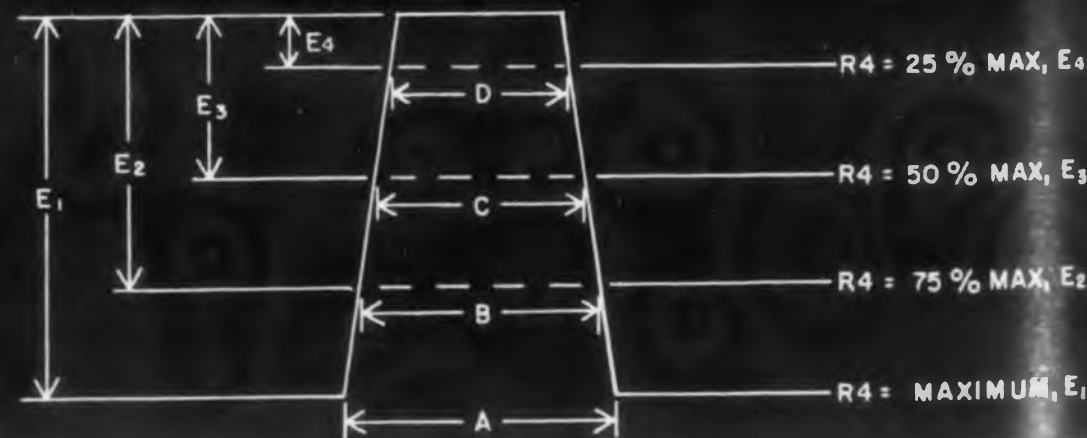


Fig. 2. Effect of R4 on pulse shape at cathode of V1.

VIDEO PULSE cathode followers can be designed to control pulse amplitudes and remove baseline noise. At the same time, the output pulse width is reduced instead of stretched, thereby increasing individual pulse definition. The circuit is particularly useful in detector stages of receiving equipment and with pulse-shaping amplifiers.

Preventing DC Shift at the Grid

A video pulse cathode follower used as a gain control is shown in Fig. 1. Positive pulses are applied to the grid of *V1* through dc blocking capacitor *C1*, and grid leak resistor *R1*. Restorer diode *CRI*, which shunts the grid leak, conducts any negative dc potential from the grid of *V1* to ground. This potential could be negative-going noise spikes or pulse undershoot. However, the most important function of *CRI* is to prevent dc shift at the grid of *V1*. Such shift can result from high pulse repetition rates, long duty cycles, and long pulse trains. In this manner, the grid of *V1* is clamped to ground with respect to any negative dc shift which might occur.

The value of plate load resistor *R3* is determined by the average dc plate current limitations of the tube selected, in this case, one-half of a type 5687 medium-mu miniature twin triode. This triode was chosen because of its 65-ma cathode current rating.

Plate bypass capacitor *C2* places the plate of *V1* at ac ground potential, and in conjunction with *R3*, forms a decoupling network between *V1* and the power supply. The signal applied to the grid of *V1* is conducted through *V1*, appears across cathode load resistor *R2*, and is coupled through electrolytic capacitor *C3* to output load *R_L* in this case, a 75-ohm resistor for matching impedance to a coaxial cable. *R6* is a 1 K resistor for protection of *C3* in the event that the external load is disconnected while the circuit is in operation. *R4* and *R5* form the amplitude control in conjunction with *R2* as follows.

The dc voltage developed across *R2* will be the resultant of the bleeder current through *R2*, *R5*, and *R4*, and the cathode current of *V1*. When the arm of *R4* is set to the maximum resistance position, the bleeder current through *R2*, *R5*, and *R4* is small compared to the tube's plate current and therefore has little shunting effect on *V1*. When the arm of *R4* is rotated to a lower resistance position, the shunt bleeder current increases. This current is drawn through *R2* causing an increase in cathode voltage due to the IR drop across cathode resistor *R2*. The increase in cathode voltage in effect lifts the dc baseline at the cathode of *V1*, thereby reducing the amplitude of the pulse above the baseline. See Fig. 2. This baseline shift is not seen across the load because of dc blocking capacitor *C3*. The effect



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|-------------|-----------------------------|----------------|------------------|
| 3AVP5 | 1500 | Blue | Very Short |
| 3AVP11 | 1000 | Blue | Short |
| 3AVP16 | 500 | Near UV | Very Short |
| 3AWP5 | 2000 | Blue | Very Short |
| 5CQP5 | 1500 | Blue | Very Short |
| 5CQP11 | 1000 | Blue | Short |
| 5CQP16 | 500 | Near UV | Very Short |
| 5CRP5 | 2000 | Blue | Very Short |
| 7AVP5 | 1500 | Blue | Very Short |
| 7AVP11 | 1000 | Blue | Short |
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CIRCLE 24 ON READER-SERVICE CARD

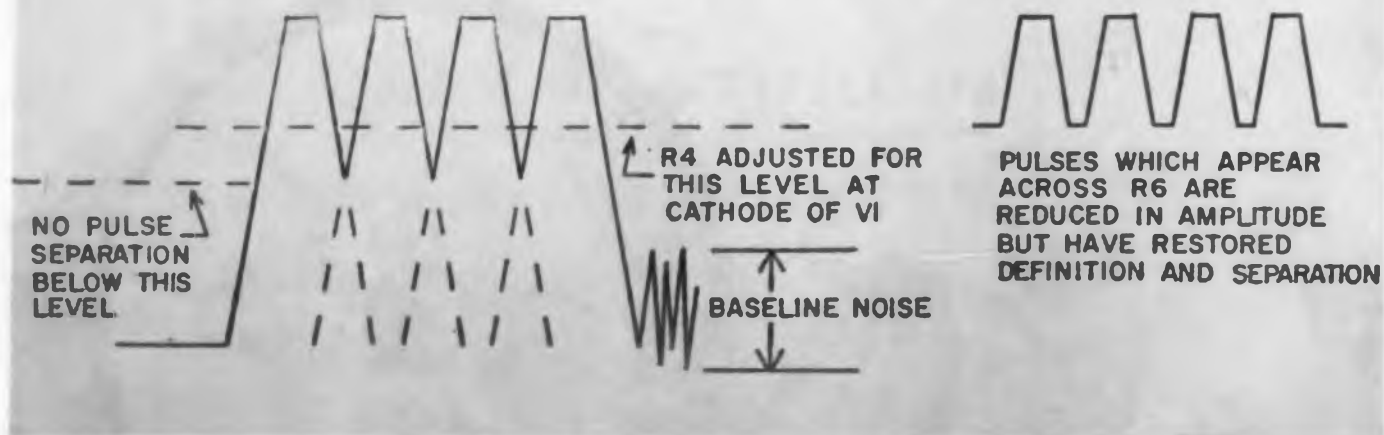


Fig. 3. Gain-control cathode follower pulse reshaping principle. Baseline clipping improves separation of pulses and removes noise peaks.

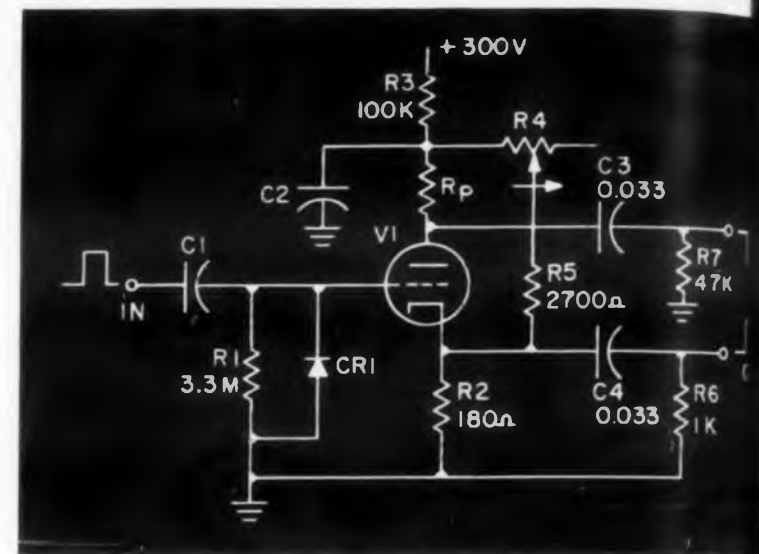


Fig. 4. Another type of video pulse cathode follower.

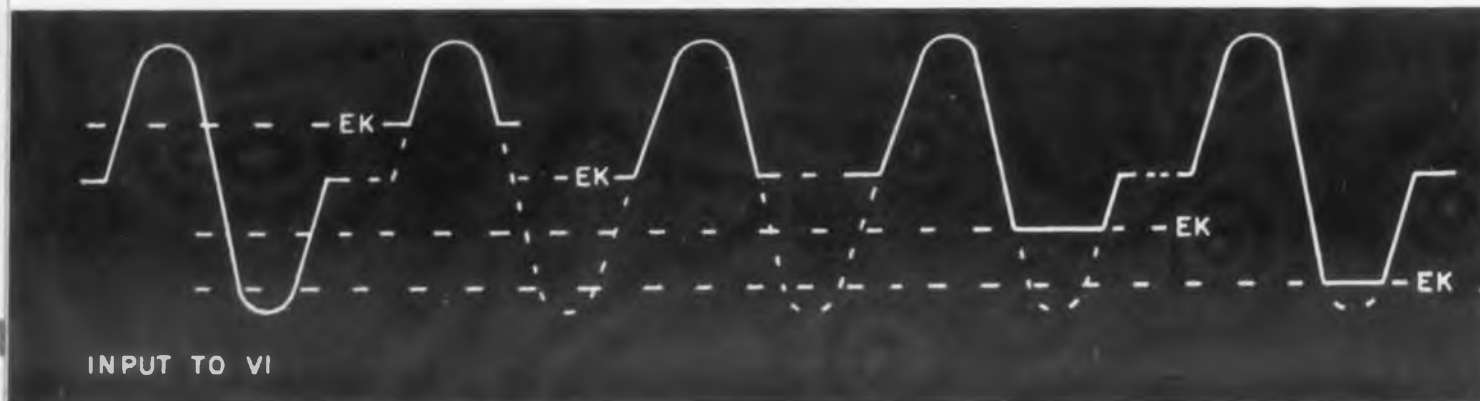


Fig. 5. Outputs of VI depending on cathode level E .

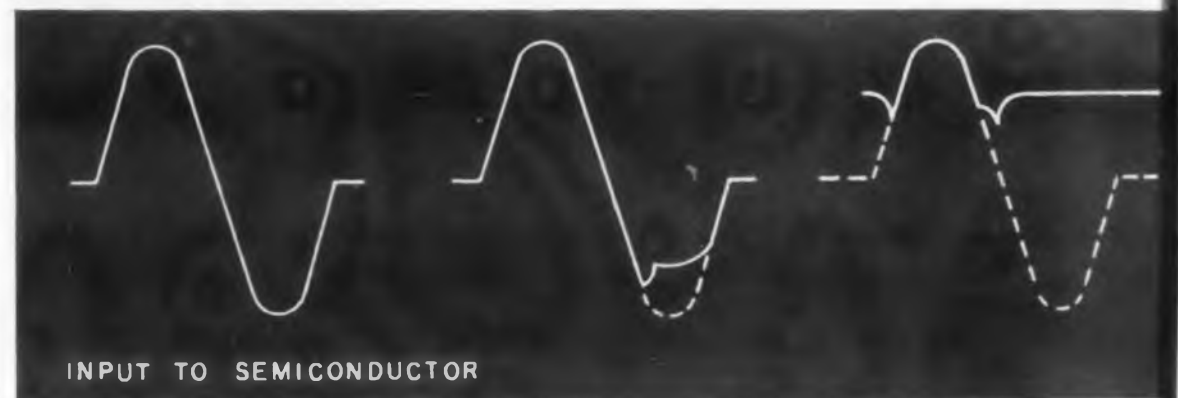


Fig. 6. Typical outputs of a semiconductor diode.

seen across $R6$ is a decrease in pulse amplitude and a narrowing of the output pulse with the pulse positive-going with respect to ground.

Because all pulses do have rise and fall times other than zero, the pulse is narrower at the top than at the base. In Fig. 2, with $R4$ set to maximum resistance, the output pulse will have an amplitude E_1 with the baseline width A . Widths B , C , and D at the intermediate points represent other corresponding settings. When $R4$ is reduced to 75 per cent of maximum, the baseline width will become the width at point B , and the amplitude corresponds to E_2 . By further reducing the value of $R4$, the baseline is lifted progressively and the output amplitude and width reduced. This effect is actually observed on dc input to an oscilloscope. The pulse can be displayed on expanded sweep to study the change in width for various settings of $R4$.

Baseline Clipping

The results obtained when pulses of poor definition are applied to the gain-control cathode

follower are shown in Fig. 3. Here baseline clipping improves separation of pulses that actually overlap at and above the baseline as well as removes noise peaks and any other baseline irregularities.

In Fig. 3, $R5$ is a minimum amplitude limiting resistor. When $R4$ is set to minimum resistance, an output indication of some small amplitude will prove circuit operation. This small feature will preclude an erroneous "no output" condition when $R4$ has been set to minimum resistance and the fact "forgotten" or not noticed by operating personnel. As shown in Fig. 1, $R4$ is returned to $B+$ and the power ratings of $R2$, $R4$, and $R5$ must be taken into account. To reduce the extra power requirements of the above arrangements, $R4$ can be connected to the plate of VI as shown by the dotted line in Fig. 2. This connection reduces the voltage applied to the bleeder from 300 v to 100 v approximately, and therefore reduces the wattage requirements for $R2$, $R4$, and $R5$.

With $R4$ connected to the plate of VI , there

is, however, an additional effect on the output pulse with the adjustment of $R4$. The baseline will still lift as $R4$ is decreased in value, but there will also be a compression downward on the tip of the pulse. In other words, amplitude is reduced by simultaneously lifting the baseline and pushing the top of the pulse down. The amount that the top of the pulse is moved downward is a function of the value of $R3$. This reduction in amplitude is caused by inverse dc feedback due to the shunting of the bleeder network applied directly between plate and cathode of VI .

Another Type of Pulse Cathode Follower

A further modification of the circuit can yield the often desirable condition of both positive and negative pulses from the same source and in exact time relationship. Fig. 4 shows plate load resistor R_p added for the negative output pulse. Here the amplitude of the pulse at the plate of VI is determined by the value of resistor R_p and the peak pulse plate current through VI . The output impedance at the plate, however, is con-

siderably higher than that at the cathode, being in the order of 100 K. In this circuit, the output amplitudes of both the positive and negative pulses are controlled simultaneously and proportionally with adjustment of gain control R_4 . Selection of R_p is governed by the pulse amplitude desired at the plate of V_1 . In choosing R_p , it must be remembered that V_1 is a low-gain stage with variable feedback controlled by R_4 . In practice, when R_p exceeds 1 K, stretching of the plate pulse will occur. With R_p equal to 1 K and other component values as shown in Fig. 4, both output pulses were approximately 7 v amplitude with 15 v peak applied to the grid of V_1 . Higher amplitude output pulses can be obtained by changing the values of R_3 , R_p and R_2 to allow the flow of higher tube current. This increased current flow will place a heavier demand on the power supply, but can allow more latitude for adjustment of R_4 . Such a condition might be desirable for the further pulse separation that could be gained by the higher clip-level action possible with the gain control.

A value of 0.1 μ f for C_2 can be used depending on the repetition rate and densities of the pulses applied to the tube. In general, however, an electrolytic at this point is more satisfactory. The larger the value of C_2 , the smaller will be the negative staircase decrease in plate voltage which can occur with high repetition rates and long pulse trains.

The basic circuit described is noncritical and does not require a well-regulated power supply for operation. The tube could be a 12AU7, 12AT7, 12AX7, 6C4, 12BH7, depending on circuit design requirements. The circuit lends itself to further versatility as a half-wave detector or amplitude demodulator. In this use, the cathode voltage is established such that output occurs above the desired reference level. See Fig. 5.

Another application of the circuit shown in Fig. 4 is as a peak clipper. Here only the desired portion of the peak is clipped depending upon the cathode level established. The peaks are clipped cleanly as compared to the more or less typical sloping effect produced by a semiconductor diode. This sloping effect is caused by the change of resistance across the semiconductor as the current through it varies according to the voltage applied, and the change of capacitance which becomes quite noticeable at higher frequencies. When the applied voltage is reduced after conduction, forward resistance begins to increase. At the point considered to be recovery of a diode, still only perhaps 400 K ohms, current reduces sufficiently for the resistance to rise faster, and a fully nonconducting state is reached. This characteristic causes stretching in the case of pulses, and incomplete detection or rectification in the case of ac signals, Fig. 6. ■ ■



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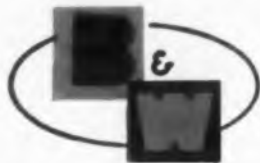


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- Stability: Better than 1%.
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- Distortion. Less than .2% at 5 volts output.



MODEL 400 DISTORTION METER

- Frequency Range. Fundamentals from 30 to 15,000 cycles. Measures Harmonics to 45,000 cycles.
- Sensitivity: .3 volts minimum input required for noise and distortion measurements.
- Calibration: Distortion measurements $\pm .5$ db. Voltage measurements: $\pm 5\%$ of full scale at 1000 cycles.
- Residual Distortion: .05%—30—15,000 cycles.
- Residual Noise: .025% or less.



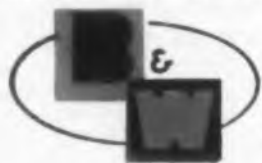
MODEL 300 FREQUENCY METER

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CIRCLE 27 ON READER-SERVICE CARD



Plastic Positions Precision Parts

W. A. Fitz Maurice

Ass't to the General Manager

Bendix-Pacific

N. Hollywood, Calif.

An epoxy casting resin used by Bendix-Pacific is an essential ingredient in a telemetry commutator now in use on ICBM missiles. It makes and breaks 3600 contacts per second under missile environmental conditions.

HIGHLY FILLED epoxy resins have a unique combination of properties, making the design of a precision high-speed commutator plate feasible. Each of 120 segments shown in Fig. 1, is separately embedded in epoxy. Of a total segment length of 13/32-in., 11/32-in. is held in the plastic. Connection to the segment is made either by means of a wire or through interconnection between segments with both operations taking place prior to casting in the epoxy. Brush bounce at high rotational speeds is eliminated by minimizing variations in height between adjacent segments.

This latter requirement has been met so successfully that height variations of this sort are held to less than ten millionths of an inch over operating temperatures varying from -65 to $+212$ F.

In addition to the stability requirements, the rotating brush assembly requires a relatively stable plane at the contact surface in order to maintain constant contact orientation. In spite of

the problems introduced by the combination of metal and plastic parts surrounded by a heavy metal ring, dishing has been contained within a few thousandths over the operating temperature range. The entire bearing assembly for the rotor is held in place in the plate by the epoxy resin. The perpendicularity of the rotating shaft to the contact plane is held to 0.001-in. per inch.

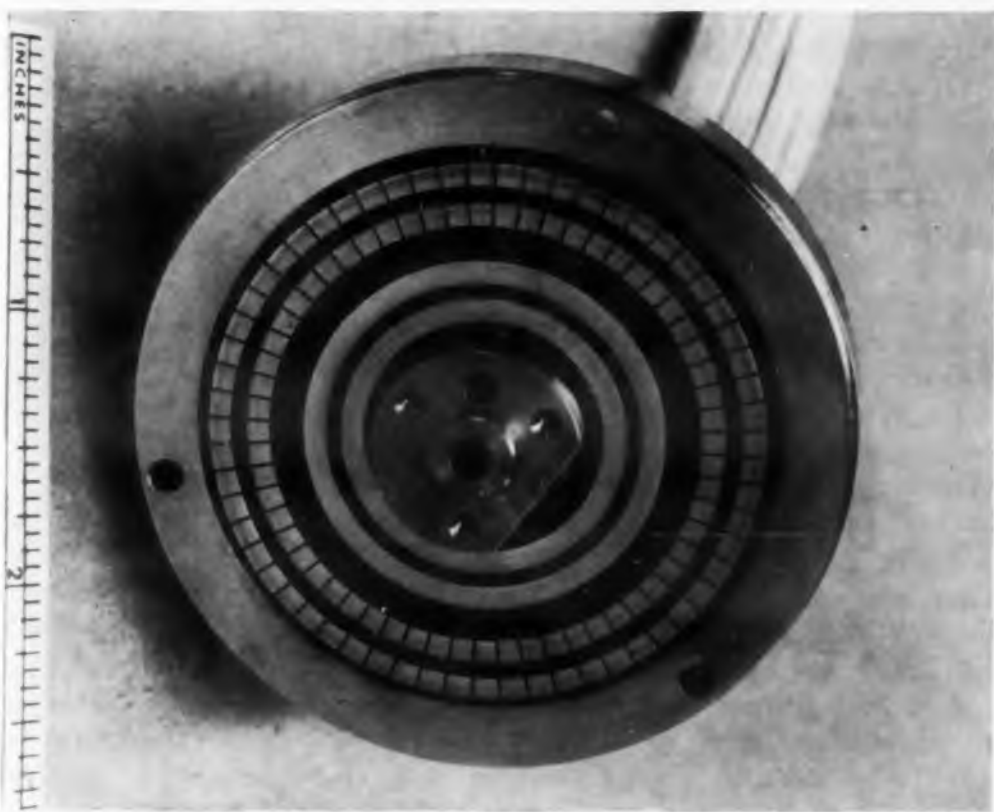
These close tolerances are necessary in order that the pulse width be held within the narrow limits demanded by telemetry.

Use Silica Filler

The initial attractiveness of the epoxy series was the high stability obtainable in a pourable plastic combined with the chemical resistance necessary to allow immersion in a rhodium plating solution. Silica was found to produce the best stability characteristics. A 67 per cent fill (two parts silica to one part of resin by weight) was determined to be a practical fill limit to avoid lamination.

Silica also provided the best characteristic with regard to the coefficient of thermal expansion of the cast material, approximating that of aluminum. The higher heat conductivity available with the silica fill minimizes temperature gradients across the plate when it is subjected to the temperature changes.

The choice of a hardener presented some problem with respect to the requirements



Commutator face showing how the segments are positioned in the plastic.

of low mold shrinkage, high heat distortion temperature, heat controllable exotherm and reasonably long pot life. One of the aromatic amines, p,p'-methylene dianiline proved to be the most satisfactory. A two-stage cure was found to give optimum results.

The assembly is cured at 200 F for 2 hours followed by 250 F for 4 hours. A heavy metal rack acts as a heat sink to avoid sudden temperature changes during and after the curing process. In spite of the two-stage cure, it was noted that internal stresses caused slight dimensional shifts during immersion in the heated plating baths. This problem was overcome by a 16 hours soak at 230 F following the cure.

Prior to casting, the metallic assembly is continuous across the contact area with leads and internal wiring completed. Because standard vapor degreasing proved unsatisfactory due to the tendency of trichlorethylene to inhibit curing, the entire assembly is anodically cleaned. In addition, the anodic cleaning provides an etched surface which takes maximum advantage of the exceptionally high bond strength of the resin. A complex structure at the rear of the plate, involves over 120 soldered connections and requires that the resin be highly fluid for adequate penetration. Both the resin and

the metallic assembly are preheated, and subsequent to the pour, the assembly is subjected to a vacuum deaerating operating at an elevated temperature. The casting is done with the contact side down. A vinyl gasket extends the segments beyond the resin surface.

Following the cure, the metal is machined down to expose and separate the contacts. The vinyl is dissolved out with tetrahydrofuran, leaving a completely unmachined, recessed surface of epoxy with a glossy finish. Another condition requiring almost ideal penetration arises from the numerous plating baths to which the finished plate is subjected following the casting and final machining. Any small cracks or voids in the vicinity of the individual contact segments tend to entrap plating solution and carry it into subsequent operations with a consequent fault in the plating. The vacuum impregnation completely eliminated difficulties of this sort.

This plate, now in production at Bendix-Pacific's North Hollywood plant, shows an order of magnitude improvement over prior commutator plates in both performance and reliability. Electrical noise has been reduced over anything previously available. While the plate's life is rated at 1000 hours in actual use, 3000 hour life spans are common. ■ ■

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FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 29 ON READER-SERVICE CARD

Simple Generator Gives More $F(x)$ Per Dollar



The Quadratron (from L quadrare to square) enables engineers to set up nonlinear problems easily on the analog computer and study them. Octal-plug unit weighs only three ounces, occupies only 0.004 cubic feet and costs about \$40.

NONLINEAR FUNCTIONS can be generated cheaply and easily with a new component called a Quadratron. An octal-plug-in device, it costs about \$40, replaces equipment priced up to \$3500. It weighs three ounces and occupies 0.004 cubic feet, compared with equipment weighing 65 pounds and taking up three cubic feet.

It can be used in control systems, automation, analog computing, instrumentation, simulation, data reduction and medical electronics. The designer, Douglas Aircraft Co., El Segundo (Calif.) division,

reports that some units have already been used:

- To simulate the nonlinear characteristics of a control valve on the Trisonic Wind Tunnel.
- To reduce flight-test data on the DC-8 jet airliner.
- To remove an unwanted nonlinearity from a transducer.

In medical electronics, which abounds in nonlinearities, many applications have been found. An expression for the square root of the sum of three squares—the three orthogonal components of the electrical vector of the heart—is easy to obtain with three Quadratrons and one amplifier—a large gain in simplicity and economy over the special-purpose computer now being used.

Transcendental, trigonometric, exponential, hyperbolic and algebraic functions, like x^2 , $x^{2/3}$ and $x^{1.27}$, can all be produced easily by combining one or more Quadratrons with one or more dc operational amplifiers. Dr. Ladis Kovach and William Comley of Douglas, co-designers of the Quadratron, suggest the use of little amplifier packages, like the Philbrick, costing around \$25.

What's Inside?

A varistor is the heart of the Quadratron. Since the current-voltage relationship of this silicon-carbide element is $I = k(e^n)$, for years multipliers have been designed by summing squared outputs from the varistor (with $n = 2$).

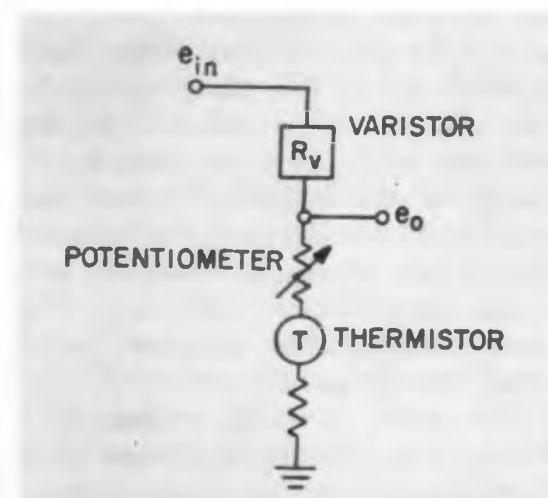


Fig. 1. Box holds only passive elements. Non-linear characteristics of varistors are used. Inaccuracies and temperature coefficients are compensated for by a network of resistors and thermistors. Quadratrons are factory-set, need no adjustments.

But there have been considerable inaccuracies. Varistors are not ordinarily supplied in close tolerances; they have a large negative temperature coefficient, and there is a slight degree of semiconductivity.

The Douglas Quadratron contains assorted resistors and thermistors, as in Fig. 1, to compensate for these errors. The result is a device capable of a basic squaring accuracy of better than 99.6 per cent of 100 v full-scale (better than 99.8 per cent of 200 v peak-to-peak—as commercial equipment of this type is commonly rated). This 0.4 (or 0.2) per cent error is known exactly. A correction curve is supplied with the device. Frequency response is good to 400 cps.

Another model of the Quadratron will furnish the cube of an applied voltage. With these basic operations of squaring and cubing, many other functions can be obtained.

Most Nonlinear F(x) Generated

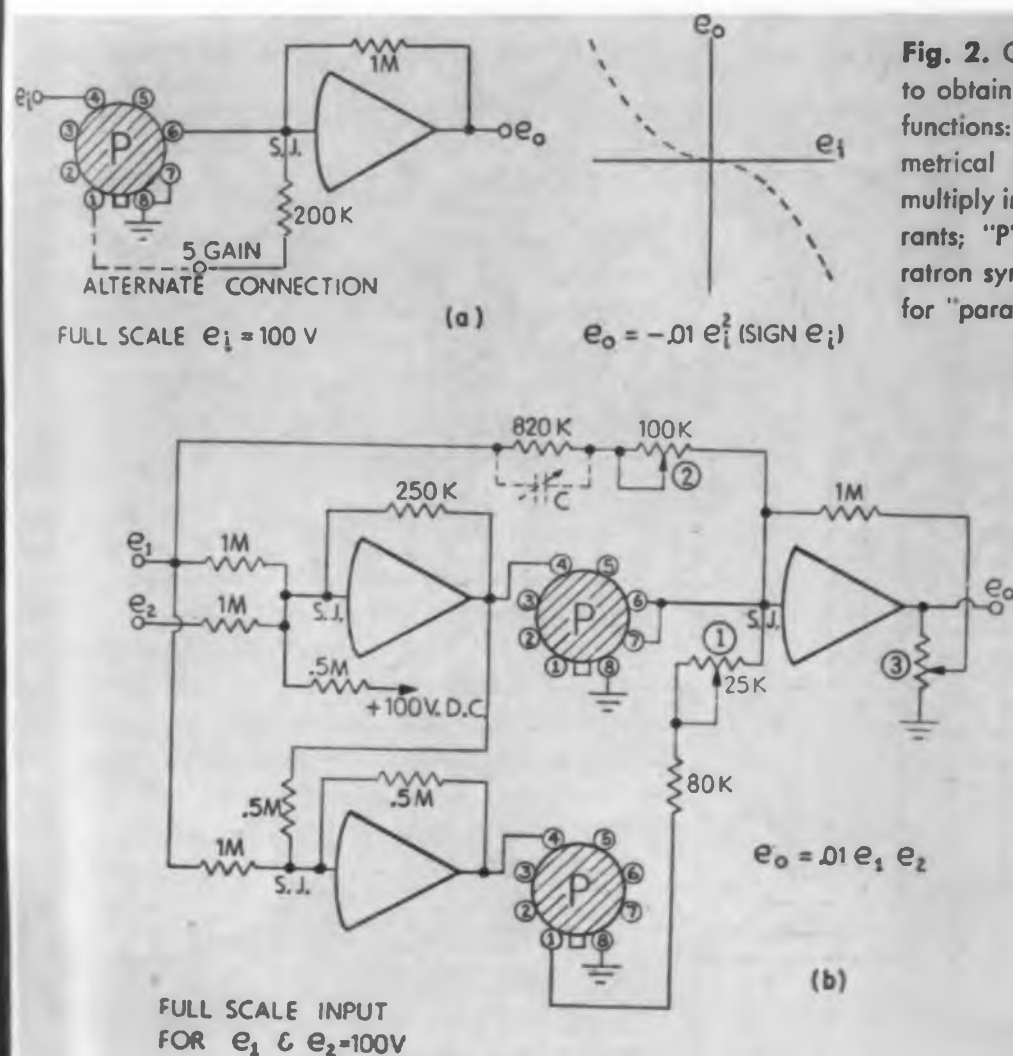
Two squaring operations give the fourth power of an applied signal; a square followed by a cube yields the sixth power. See Fig. 2. An antisymmetrical

square is shown in 2(a); a symmetrical square could easily be produced by feeding in the absolute value of e_i . The multiply circuit of 2(b) uses the least number of amplifiers for a four-quadrant multiplier.

Some nonlinear functions are produced in the usual manner by using a truncated Taylor's series. Others are obtained by using new and unusual methods of approximation. If the terms ax^3 and bx^5 appear in a series, for example, both of these can be replaced by a single term $(kx^4 \text{ sign } x)$ with no loss of accuracy. The factor "sign x ," which stands for $x/|x|$ maintains the necessary odd symmetry. Dr. Kovach and Mr. Comley remark that procedures of this type may have far-reaching mathematical possibilities.

Other functions easy to obtain with a few Quadratrons and amplifiers are: $\sin x$ ($-\pi/2 \leq x \leq \pi/2$ —only one Quadratron necessary), $\cos x$, $\tan x$, $\sin^2 x$, e^{x^2} , $e \exp(-x^2)$, $\sinh x$, $\cosh x$, $\tanh x$, x^3 , square and cube roots of x , solution of right triangle and the divide function.

For further information on this multi-function generator turn to the Reader Service Card and circle 101.



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BASIC MODULE ASSEMBLY

THE CONVENTIONAL approach of potting electronic assemblies to meet extreme conditions of shock and vibration is not without disadvantages. To name just a few, potted units generally weigh more, are not inexpensive, and component replacement is impossible.

Westinghouse technical associate, Kenneth D. Cowan, took a hard look at the problem and

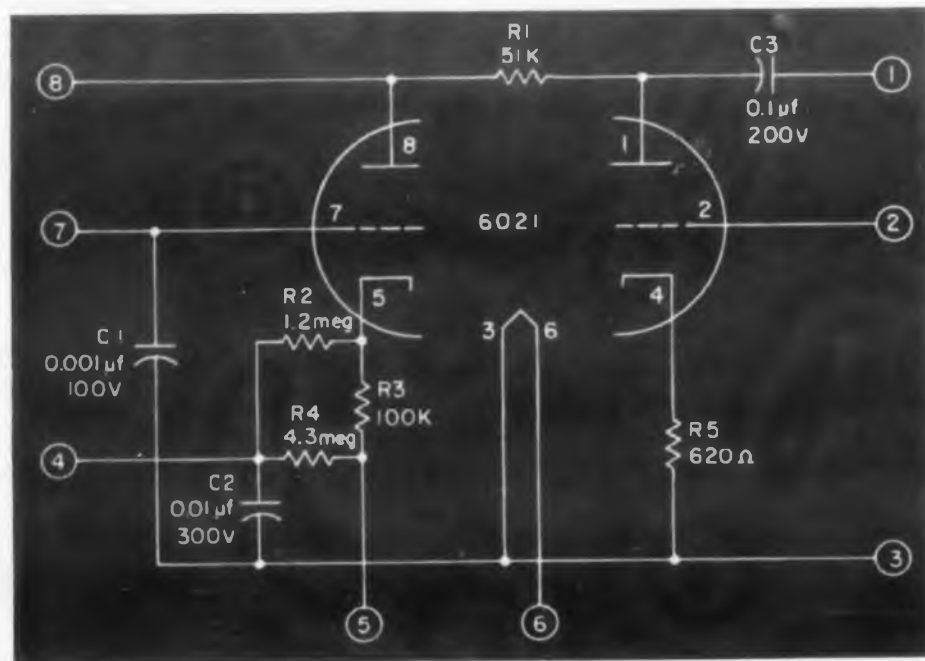


Fig. 1. (left) Schematic diagram of basic amplifier circuit

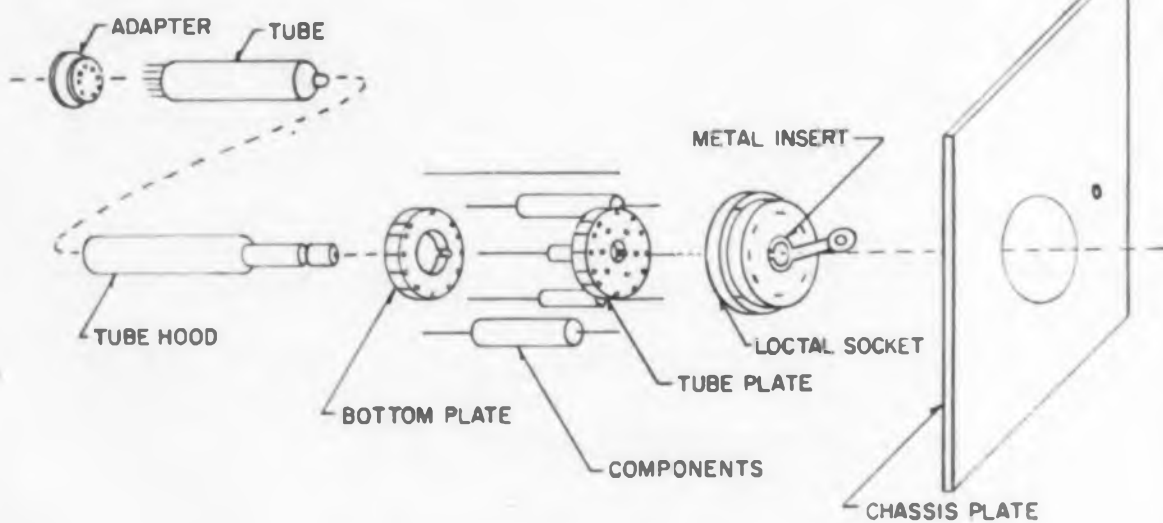


Fig. 2. Exploded view of module assembly

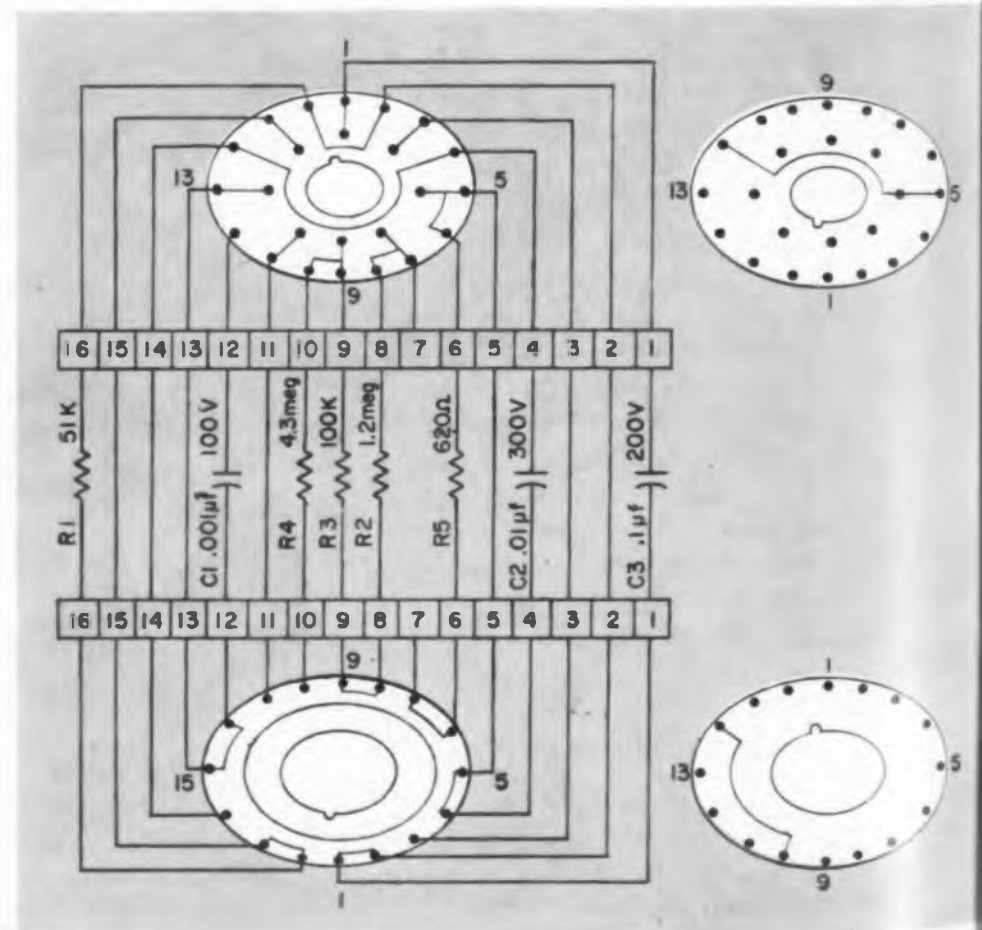


Fig. 3. Module layout sheet

ting with a MODULE APPROACH

came up with a simple method that is worth noting. Standard components, resistors and capacitors, are used as supporting members for two printed card plates which form a basic module. Although this approach is by no means new, a primary advantage of the unit is its adaptability to automatic assembly. Compared with a similar molded unit, the module weighs (dependent on the type of potting material used) from 60-85 per cent less, requires 60 per cent less space, and costs six times less to manufacture. Better heat dissipation, simplified testing, and easy component replacement are additional advantages.

Circuit Simplification

Starting with the schematic diagram, the complete unit is reduced to groups of simple circuits, each consisting of a single tube with its associated components, as shown in Fig. 1. The overall arrangement is then formulated into a sketch, as shown in Fig. 2, which includes the tube and its component plus four additional parts.

Layout

The simple tube circuit is redrawn on a module layout sheet, shown in Fig. 3. Printed circuit wiring is applied on both sides of the upper and lower plates for simplicity in assembly and ease of component replacement. The appearance of the upper side of the top plate is shown in Fig. 4. An assembly instruction sheet is prepared to serve as a guide for component placement during final construction.

Module Construction

Overall dimensions of 1 in. diameter and 2-1/8 in. length are specified for the particular design. Eight components are included in the circuit al-

This month's news from Raytheon...



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FASTER TUBE DELIVERY—Raytheon Distributors' inventory backup program has been extended to

Machlett tubes. This means 24-hour local delivery of any tube when you need it. Simply list your tube requirements with your Raytheon Distributor.

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About Machlett Quality . . .

by John Hickey,
Raytheon Industrial Products Manager

Merger of Machlett and Raytheon means that Raytheon Tube Distributors now offer fast local delivery of the finest quality power tubes for your industrial heating and communications sockets. Machlett Laboratories' people have a watchword: "What is good, stays good." They back it with 100 per cent inspection and the finest quality control in the industry. If you have equipment or designs which can use one of the more than 100 Raytheon-Machlett types, I believe you will see measurable improvement in performance, reliability, and tube life. Just specify "Raytheon-Machlett" as the brand, "Local Raytheon Distributor" as the supplier.



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Fig. 4. Printed circuit pattern of upper plate

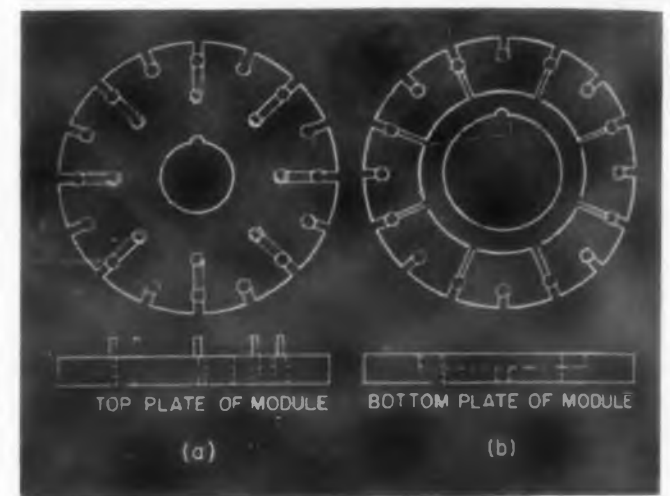


Fig. 5A. Top plate 5B. Bottom plate

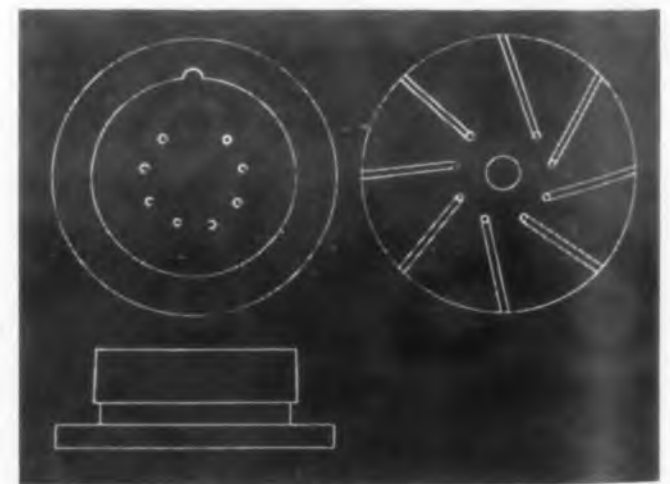


Fig. 6. Tube base adapter

though provisions exist for a maximum of sixteen. Potting of the unit is not required, resulting in lower weight, cost and size. In addition, testing is simplified and component replacement due to defects or design changes is not difficult.

Top and Bottom Plates

The top plate, shown in Fig. 5A, contains sixteen slots equally spaced around the periphery to accommodate the component leads, and eight pins to mate with a standard octal socket. Groups of octal sockets with interconnecting wiring are mounted to a main chassis and accept

their respective modules. Both upper and bottom plates are molded of a ceramic or thermosetting plastic with high strength characteristics.

The bottom plate, shown in Fig. 5B, has no pins for external connections but has a hole to accommodate the tube adapter. There are eight radial channels to receive the leads from the tube.

Tube Adapter

Teflon or a similar plastic is used for fabrication of the tube adapter, shown in Fig. 6. The tube leads are accepted by the eight holes in the adapter and the eight radial channels bring the leads to the corresponding section of the bottom plate. A slight taper and undercut on the minor diameter of the adapter permit it to be snapped into place on the bottom plate. A key is incorporated on the adapter to mate with a keyway in the bottom plate for proper tube orientation.

Tube Hood

The tube hood is used to shield the tube, conduct heat from the module to the chassis, and orient the module in its socket. To permit cooling air to flow around the tube, a hole is included at one end. A key in the tube hood mates with the keyway in the top plate and the loctal socket to insure proper orientation. One end of the hood is a heavy walled section which, when plugged into the loctal socket and chassis, acts as a heat sink.

Final Assembly

Resistors and capacitors connected between the bottom and top plates serve as supporting members. Protection against humidity and salt spray may be achieved by application of a varnish or resin coating during final assembly.

Tests

Modules constructed along the above design were subjected to vibration tests with peak accelerations of up to 30 g with no resonance or damage noted. A shock test with 62 g impact along the radial axis likewise produced no failure.

To check the heat transfer ability of the module, Tempilac spots were placed on the tube to indicate maximum envelope temperature. With an air flow of 0.0022 lbs/min/watt at a pressure of 0.09 psi, a temperature rise of 70 deg C resulted. For the application involved, this figure is well below the critical level.

Test data thus substantiated the validity of the module design approach.

With the increasing demand in airborne and missile applications for more complex circuitry in more compact packaging, module design offers an attractive solution. ■ ■

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| CSS7W | 7 Watts | 80,000 Ohms | $1\frac{1}{4}'' \pm \frac{1}{16}''$ | $\frac{5}{8}'' \begin{matrix} +\frac{1}{64} \\ -\frac{1}{32} \end{matrix}$ |
| CSR7W | 8 Watts | 125,000 Ohms | $1\frac{3}{8}'' \pm \frac{1}{16}''$ | $\frac{3}{4}'' \begin{matrix} +\frac{1}{64} \\ -\frac{1}{32} \end{matrix}$ |
| CS10W | 10 Watts | 200,000 Ohms | $1\frac{1}{2}'' \pm \frac{1}{16}''$ | $\frac{7}{8}'' \begin{matrix} +\frac{1}{64} \\ -\frac{1}{32} \end{matrix}$ |

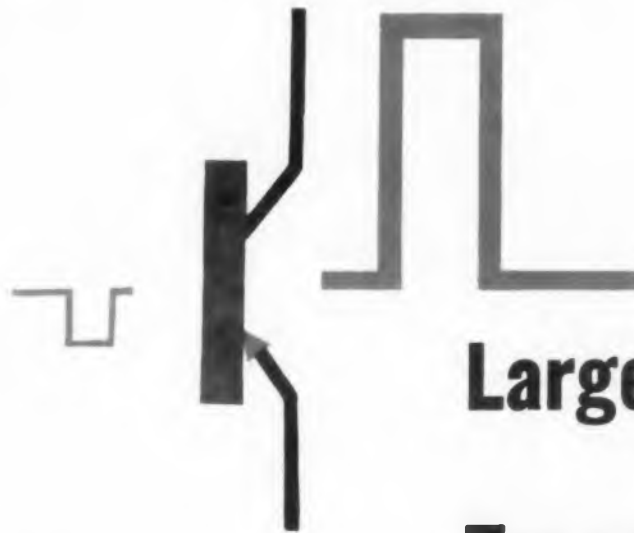
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CIRCLE 34 ON READER-SERVICE CARD



Large Signal

Transient Behavior of Transistor Pulse Amplifiers

Richard C. Dorf
 University of New Mexico
 Albuquerque, N. Mex.

LARGE signal transient behavior of a transistor pulse amplifier can be determined with a few handy equations. Several pitfalls of improper biasing can, however, trip the unwary designer. One common mistake is attempting to achieve minimum rise time by making the input base current pulse a maximum allowable value. However, this biasing causes excessive storage time. A compromise is necessary in order that rise, time, storage time, and decay time are approximately equal. By a practical example it will be seen that satisfactory operating conditions are achieved when the base current is approximately one half the maximum collector current.

Calculating Rise Time

Switching circuits using transistors as the active elements are difficult to analyze since an equivalent circuit applies only in a single operating region. However, approaches to the problem use the double diode equivalent circuit and develop the relations for the transistor currents.¹

If we assume the load resistance is small, so that we may neglect the effect of the collector capacitance, then the output pulse rise time for

the common emitter amplifier circuit can be calculated:

$$T_r = \frac{1}{(1 - \alpha_N) \omega_N} \ln \frac{I_B}{I_B - 0.9 \frac{(1 - \alpha_N)}{\alpha_N} I_C} \quad (1)$$

where α_N = normal current gain (C.B.)

ω_N = normal alpha cutoff frequency

I_B = base current applied

I_C = limiting value of collector = V_{cc}/R_L

Typical Pulse Amplifier

The relation for the rise time and relations for decay and storage time will now be used to analyze a typical pulse amplifier shown in Fig. 1. In order to have the rise time approaching a minimum,

we select $T_r = \frac{1}{\omega_N}$ as a desirable value. Then from (1), we must have:

$$1 - \alpha_N = \ln \frac{I_B}{I_B - 0.9 \frac{(1 - \alpha_N)}{\alpha_N} I_C}$$

for the base current we have:

$$I_B = \frac{0.9 \left(\frac{1 - \alpha_N}{\alpha_N} \right) I_C}{1 - e^{\alpha_N - 1}}$$

Let us consider an amplifier which uses a 2N207 pnp alloy junction transistor which has a maximum

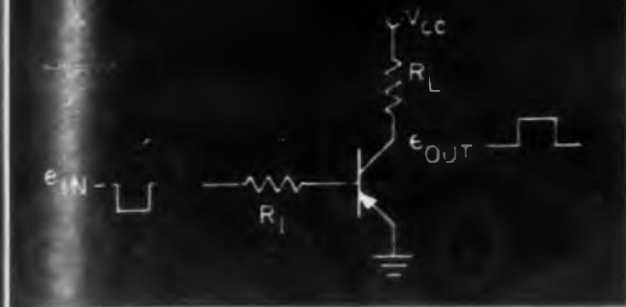


Fig. 1. Common emitter pulse amplifier.

collector current of 20 ma, $\omega_N = 2$ mc and $\alpha_N = 1.985$.

Then:

$$I_B = \frac{0.9 \left(\frac{1 - 0.985}{0.985} \right) I_C}{0.015} \cong I_C$$

Therefore, in order to have the rise time one-half of a microsecond, one must introduce a base current pulse of 20 ma. If the supply voltage is reduced, then the maximum collector current (saturated) is reduced proportionately.

The decay or fall time of the output pulse will be approximately twice the magnitude of the rise time and may be expressed as:

$$T_f = \frac{1}{(1 - \alpha_N) \omega_N} \ln \frac{I_B + (1 - \alpha_N) I_C}{\alpha_N I_B}$$

However, the storage time becomes excessive as a result of a large input pulse. The storage time may be expressed as:

$$T_s = \frac{1}{(1 - \alpha_N) \omega_N} \ln \frac{I_{B_1} - I_{B_2}}{I_{C_1} \left(\frac{1 - \alpha_N}{\alpha_N} \right) - I_{B_2}}$$

where α_I , ω_I = inverted alpha, and cutoff frequency of α_I ; I_{B_1} , I_{B_2} = base current before, after turn off step is applied;

I_{C_1} = initial collector current.

Assuming $I_{B_2} = 0$ and the initial currents $I_{B_1} = I_C$ from the previous calculation, then,

$$T_s = \frac{\omega_N + \omega_I}{\omega_N \omega_I (1 - \alpha_N \alpha_I)} \ln \frac{I_{B_1} \alpha_N}{I_{C_1} (1 - \alpha_N)}$$

Since ω cutoff is inversely proportional to the base width, we may assume that $\omega_I = 1/2 \omega_N$ which has been justified experimentally.

Then $T_s = 2.34 \ln \alpha_N / 1 - \alpha_N = 9.8 \mu\text{sec}$ which is twenty times the rise time and ten times the fall time and storage times are approximately equal, when $\alpha_N = 1/2$. For this case the rise time is 1.15 μsec , the fall time is 1.5 μsec and the storage time is 1.5 μsec . ■ ■

Reference

J. J. Ebers and J. L. Moll, "Large Signal Behavior of Junction Transistors," *Proc. IRE*, pp 1761-1772, Dec. 1954.

Some Ideas

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CIRCLE 35 ON READER-SERVICE CARD

1003

Measuring Capacity of Two-Conductor Cables

MEASUREMENT of the capacity between the conductors of a balanced coaxial cable is often complicated by the fact that one side of the measuring device is grounded. When using a standard "Q" meter, a fairly accurate reading can be obtained by simply connecting the two conductors to the "Q" meter terminals and keeping the shield far from any associated grounds.

But, this method has an inherent error since it is affected by the stray capacitance between the cable shield and ground, and this error becomes intolerable when long cables are to be measured.

The following procedure overcomes this problem in symmetrical two-wire cables:

Connect the cable shield and one conductor to the "Q" meter as shown in Fig. 1. With a short between the other conductor and the shield, measure the capacitance, using the conventional substi-

tution method. The capacitance thus measured can be referred to as C_a .

Place the short between the two conductors and measure C_b . The cable capacitance, C_c , can now be computed:

$$C_c = C_a - \frac{C_b}{4}$$

Referring to Fig. 2, it can be seen that there is a capacitance between each conductor and the shield in addition to the capacitance between conductors. Thus the total effective capacitance C_c between the conductors will be:

$$C_c = C_1 + \frac{C_2}{2}$$

In the case of the first reading, with C_2 shorted, the effective capacitance to Y is:

$$C_a = C_1 + C_2$$

In the second case, with C_1 shorted, the effective capacitance to X and Y is:

$$C_b = 2C_2$$

By substitution:

$$C_1 = C_a - \frac{C_b}{2}$$

$$C_2 = \frac{C_b}{2}$$

and it follows:

$$C_c = C_a - \frac{C_b}{2} + \frac{C_b}{4}$$

$$\text{or } C_c = C_a - \frac{C_b}{4}$$

J. M. Tewksbury, Aviation Electronics Engineering, Bendix Radio, Baltimore, Md.

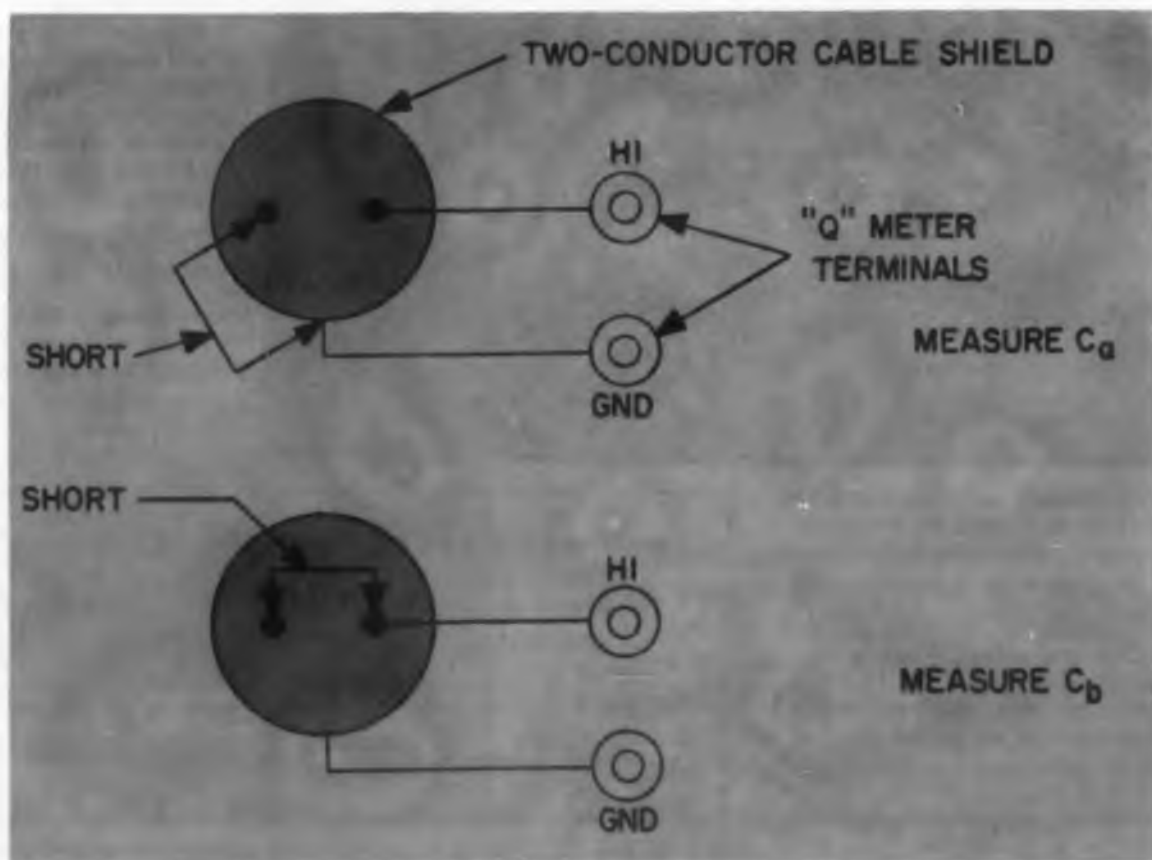


Fig. 1. (left) The measurement called C_a results when one conductor and the cable shield are shorted. The measurement C_b requires a short between the two conductors.

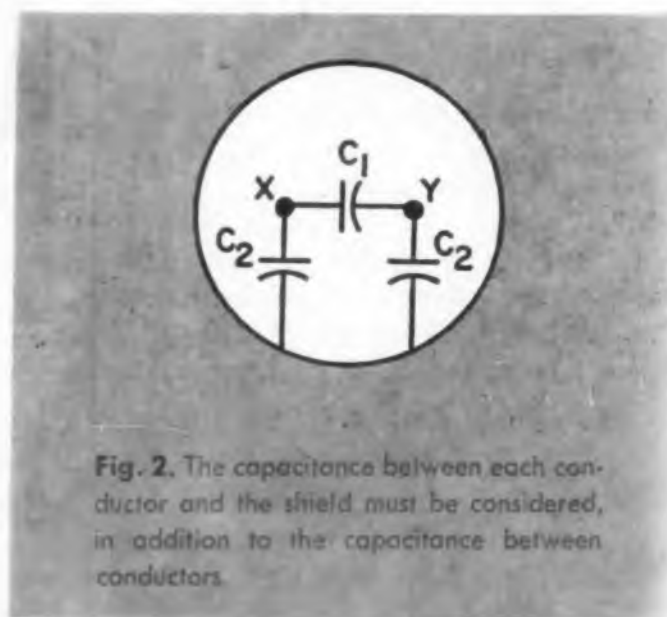


Fig. 2. The capacitance between each conductor and the shield must be considered, in addition to the capacitance between conductors.

Two-Tube High Gain Amplifier With Low Output Impedance

A high gain, low output impedance voltage amplifier was required for equipment with limited space available. The circuit in Fig. 1 shows how this was accomplished using only two tubes.

The low output impedance is obtained in the first place by a modified cathode follower having less than 100 per cent feedback and a low value of R_K . One arm of the feedback voltage divider is provided by R_a of the first tube $V1$, the other is $R2$.

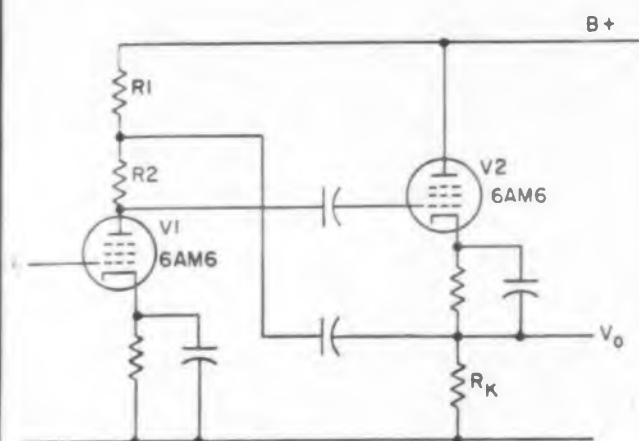


Fig. 1. This amplifier provides a gain of about 1500 with an output impedance no more than 9 K.

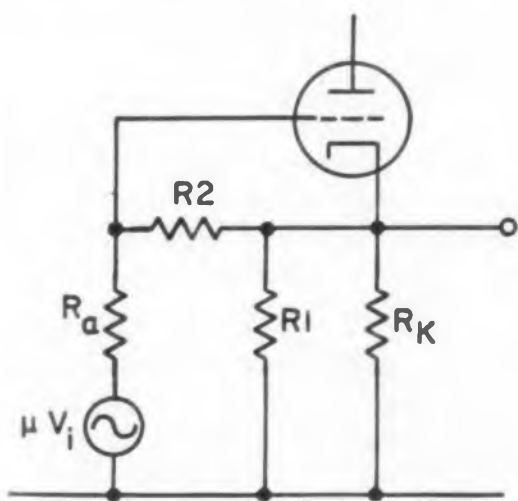
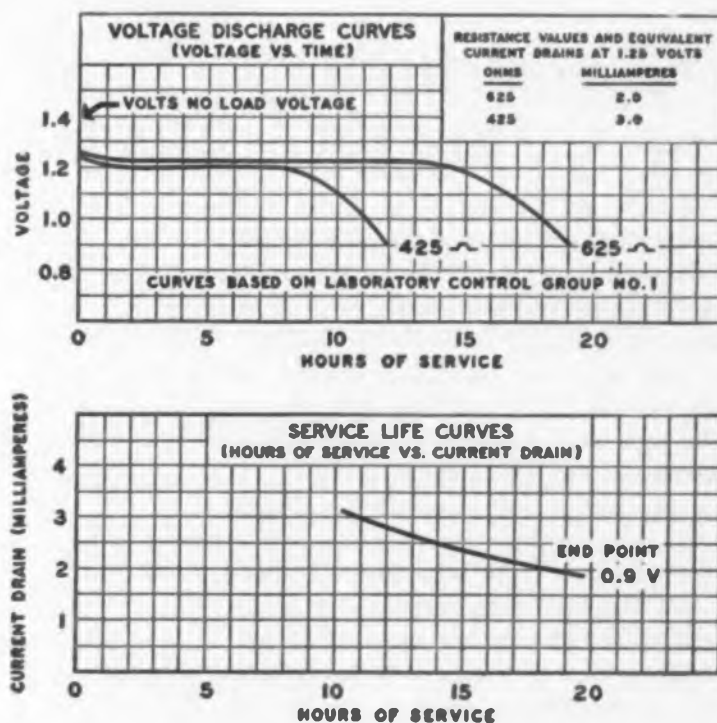


Fig. 2. Equivalent circuit of the high gain, two-tube amplifier.

However, the ac load presented to $V1$ is very high, being the input impedance of the same cathode follower with full feedback, since the equivalent generator of $V1$ is applied in series with $R2-R_a$ as shown in Fig. 2. In practice, using tubes of the 6AM6 type, a gain of about 1500 may be obtained with an output impedance of 9 K or less.

Andrew S. Williams, Electronics Engineer,
Stromberg Carlson Co., Rochester 9, N.Y.

World's Smallest Battery!



Here's the world's smallest commercially available battery . . . and it comes from Mallory, pioneer of mercury battery developments. This micro-miniature cell, the RM-312, measures only .305" in diameter by .135" thick, and weighs only .022 ounce. It is rated at 36 milliampere-hours, and has a no-load rating of 1.4 volts. Applications include the military's new micro-miniature module program, hearing aids, radiation detectors, missile systems, and other sub-miniature devices.

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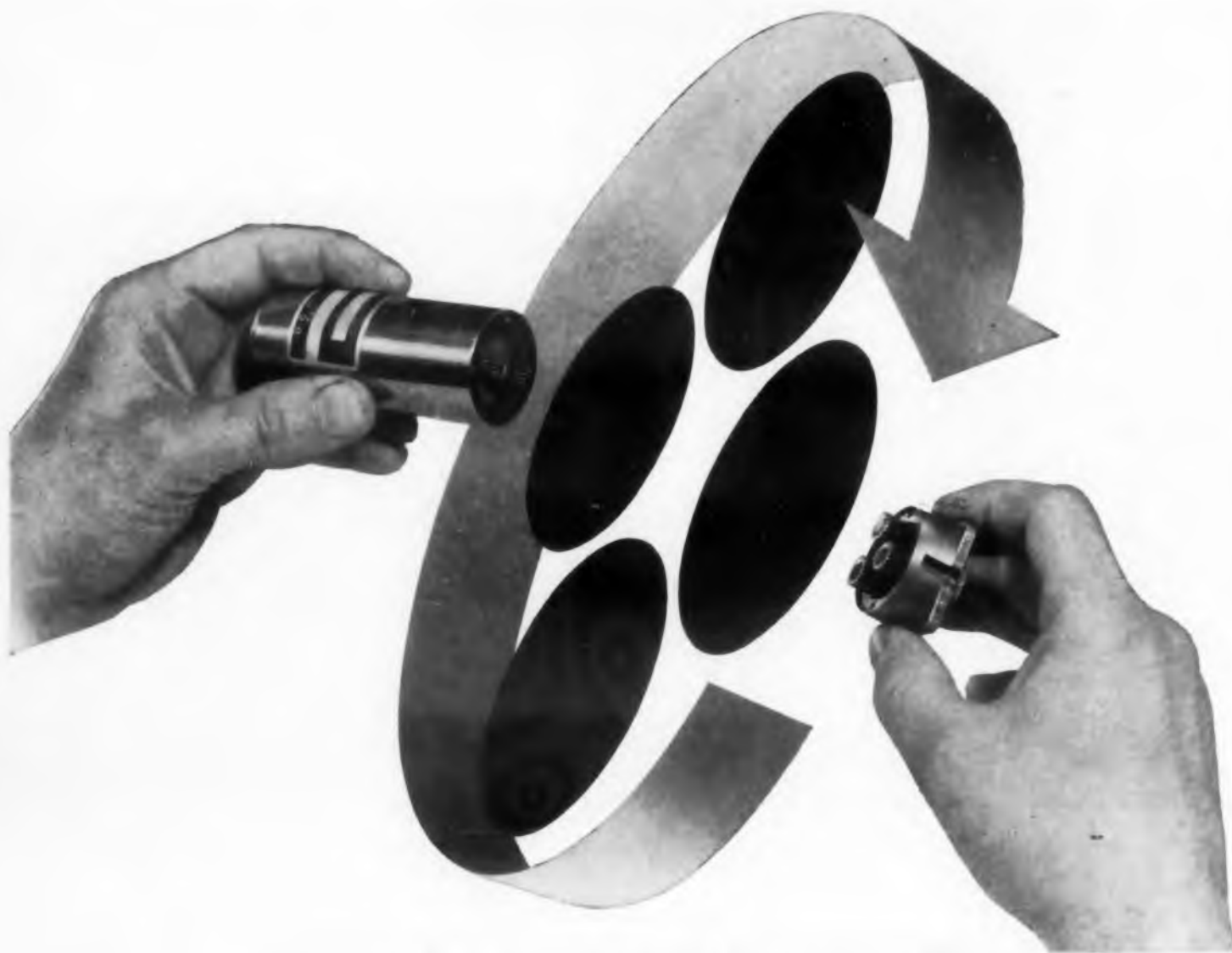


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In Canada, Mallory Battery Company of Canada, Limited, Toronto 4, Ontario

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motors for commercial applications

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And more and more designers are finding that these motors offer outstanding advantages for commercial applications as well. Universal, a.c., or d.c. types are available from $\frac{7}{8}$ " to $2\frac{1}{4}$ " in diameter. They can replace larger, ordinary motors at competitive cost, and deliver important bonuses too. They perform reliably under conditions that would soon ruin ordinary motors—high humidity and temperature, jarring shock and vibration, dust and fume-laden atmospheres.

Globe speed reduced motors are engineered to fit your specific application as no "off the shelf" motor can. Standard component design is the secret; for example, 83 even ratio planetary reducers are available to give the speed and torque you need. Many parts are inventoried. Design and production efficiency will save you money. If you have a commercial application that demands a smaller, more powerful, more reliable and competitively priced motor, then consult Globe first. Write for Bulletin ACG. Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio.

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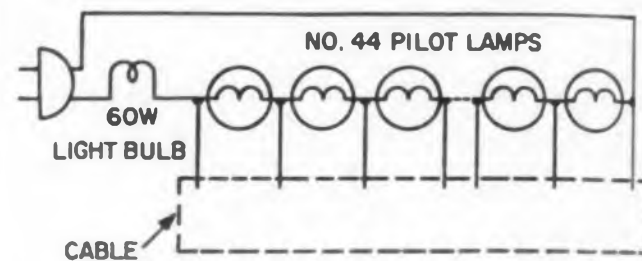
GLOBE

CIRCLE 37 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Cable Tester Uses Pilot Lamps and Light Bulbs

To short-test a cable it was decided to connect #44 pilot bulbs (6-8 v) between each wire and the next, and then connect the cable to the line. The problem was to connect these bulbs through some suitable element so that in case all bulbs lit (no shorts), they would be brilliant enough to see. On the other extreme, if only one bulb lit, the voltage would be limited so as not to turn the bulb out. Thirteen bulbs were involved.



Light bulb in cable tester protects pilot lamp indicators.

The dropping element chosen was an incandescent bulb. The resistance of this device varies with current. At a high current, the resistance is high and, conversely, when the current is low the resistance is low. By the proper choice of bulb the voltage across each bulb was maintained at about 5 v when all bulbs were lit. This provided adequate light. The voltage across a bulb when only one was lit did not exceed 9 v.

Arthur M. Goldschmidt, Moorestown, N.J.

Measure Gain of Operational Summer

Measuring the closed loop gain of an operational summing amplifier without the use of a digital voltmeter can be quite simple. The theoretical closed loop gain of the operational amplifier of Fig. 1, where K_o approaches infinity, is

$$K_f = Z_f/Z_i$$

Since K_o is actually finite, the actual closed loop gain differs from the theoretical.

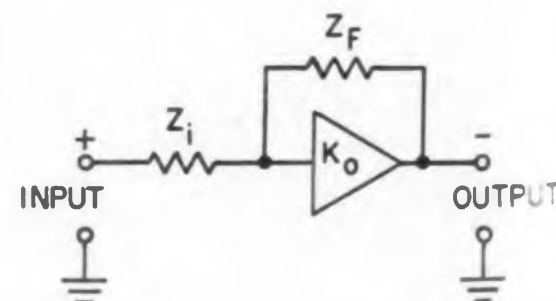


Fig. 1. A typical operational summing amplifier.

ELECTRONIC DESIGN • July 8, 1959

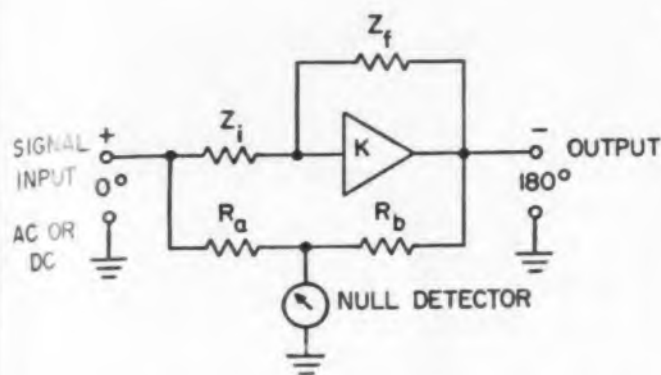


Fig. 2. The ratio of the decade resistors R_b/R_a gives the closed loop gain of the amplifier.

To measure the actual gain, a signal is fed into the amplifier as shown in Fig. 2. Use is made of a null indicator and two precision decades R_a and R_b . R_a is adjusted relative to R_b until a null is obtained on a null detector. The gain of the amplifier K_f is then given by $K_f = R_b/R_a$.

The method may be used for ac or dc summing amplifiers. The accuracy of the measurement depends on the precision of the decades used and the sensitivity of the null detector. The sum of R_a and R_b must not load the amplifier. This condition is easily met since the output impedance of this type amplifier is inherently very small.

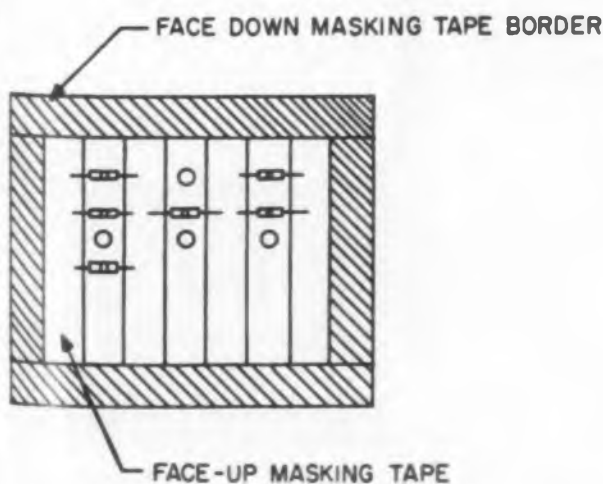
Irving Berner, Electrical Engineer, Radio Corp. of America, Camden, N.J.

Masking Tape For Small Parts Layout

Masking tape can save lots of time in small component layout. Strips of tape are laid, face up, on a sheet of cardboard. They are held down by face-down strips of tape serving as a margin.

The actual components, or pieces of cardboard cut to size, can be laid out on the masking tape and can be switched around readily to give a close approximation of the final layout.

Ray Antelman, ITT Labs., Nutley, N.J.



Masking tape strips serve as convenient layout board for small components.



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CIRCLE 38 ON READER-SERVICE CARD



How big is a dropout?

A dropout can be measured more than one way. Physically, the surface imperfection that causes a dropout is microscopic — often quite invisible to the naked eye. Financially, though, this molehill can become a mountain — may cost you thousands of dollars from a single error.

That's why our customers invariably demand perfection from our EP Audiotape, the extra precision magnetic recording tape. They just can't afford dropouts.

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EP Audiotape quality is so well verified by instruments like the Automatic Certifier that every reel is guaranteed to be defect-free! For more information write for free Bulletin T112A. Write Dept. TD, Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y.

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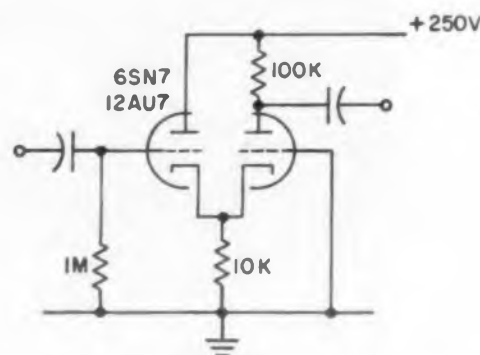
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CIRCLE 39 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Circuit Data for a Cathode Coupled Limiter

In your February 18, 1959 issue, you published this circuit configuration from a German Abstract. From my own experience, I can recommend the circuit as a clipper and square wave generator because it is efficient, simple, and extremely un-critical. I employed it frequently in new designs after I found it in pre-war U.S. Air Force equipment.



Cathode coupled limiter is independent of tube clamping effect. Limiting is always due to tube cutoff.

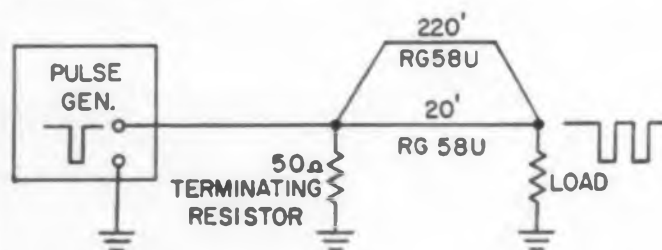
For readers who like to apply the circuit without calculations and experimenting, I am enclosing practical circuit data. With the values marked, amplification is approximately 6 times; clipping level (peak-to-peak amplitude of square wave) 90 v.

Klaus H. Jaensch, Stromberg-Carlson Co., Rochester, N.Y.

High Speed Pulser From Slower Generator

In testing pulse circuitry it is sometimes necessary to have a high speed pulse generator to check the operation of high speed multivibrators, diodes, and other fast circuits and components.

For instance, we recently had occasion to check the operation of a one-shot multivibrator at a five mc pulse rate. We were stymied because our generator only operates up to one megapulse per second. Looking over the industry we found that not only are five megapulse generators scarce but they are also costly. But we found a simple and inexpensive solution.



Paralleled coax delay lines deliver 5 mc pulses from 1 mc generator.

TUBE PROBLEM:

When the 6AF4 tube was replaced in UHF TV tuners, servicemen sometimes got a big surprise. Reason: the tubes were not standardized, and a replacement was likely to bring in one channel where another should have been.

SONOTONE SOLVES IT:

First, Sonotone set up extremely tight controls on all materials going into the 6AF4 components. Second, Sonotone used a more thorough exhaust process.

RESULT:

The Sonotone AF4 family of reliable tubes has been accepted by the industry as standard for initial production and replacement.

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CIRCLE 40 ON READER-SERVICE CARD

A SHORT SURVEY

We asked this question of the first four engineers we saw.

DID YOU EVER THINK OF BECOMING AN EDITOR?

Answer. **NO.**

This reply is not at all startling except for the fact that the four people asked are now **ELECTRONIC DESIGN** editors. Their answer was true right up to the time they read one of our help wanted ads. It never occurred to them there was a career in editing. There is.

If you have a BEE degree, a year or two of design engineering experience, and a flair for writing, why don't you inquire? Send resume to:

James A. Lippke
Managing Editor
ELECTRONIC DESIGN
830 Third Avenue
New York 22, New York

CIRCLE 917 ON CAREER FORM PAGE 57

ELECTRONIC DESIGN • July 8, 1959

We took two pieces of coax cable instead of one and connected them in parallel between the generator and load. Now we get pulses from both cables with the space between pulses equal to the difference in propagation time of the two cables.

Incidentally with RG58U the propagation velocity is approximately 600 feet per μsec . Oh yes, reflections are no problem and attenuation for a 0.1 μsec pulse over 220 feet (0.3 μsec delay) of cable is only about 10 per cent.

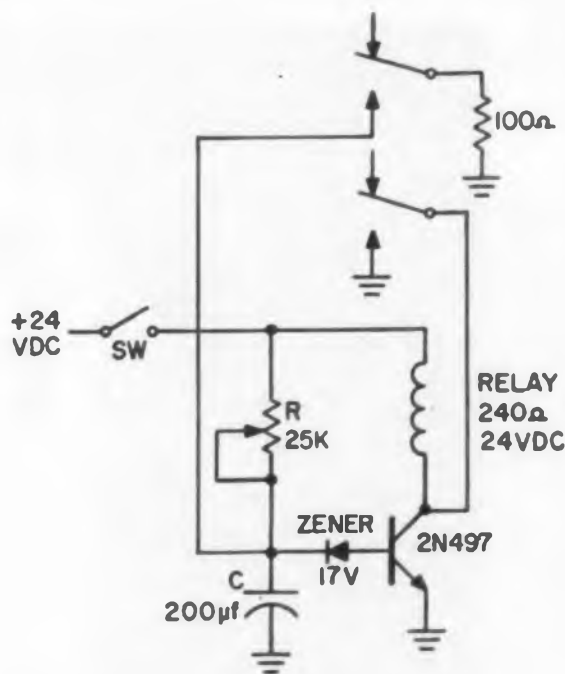
Gerald F. Dulin, Engineer, Applied Science Laboratory, Stromberg-Carlson Co., Rochester, N.Y.

Simple Circuit Delays Standard Relay

We had to delay a standard low-resistance-coil aircraft relay. Closing of the relay was to be delayed about a second. The relay was to be reset almost instantaneously.

The circuit shown in the figure solved the problem simply. The *C* and *R* elements provide the delay with the Zener diode providing further delay of the trigger signal to the base of the transistor.

The transistor does not turn on till the capacitor has charged to the Zener breakdown voltage. The variable resistance is used for fine adjustments of delay.



Relay delay circuit uses standard relay and combination of *R*, *C*, and the Zener diode.

Rapid reset is obtained by discharging the capacitor through the 100 ohm shorting resistor on one of the normally open relay contacts. The relay is held closed by another pair of contacts which serve as locking contacts.

W. L. Rumple, Senior Engineer, Ampex Corp., Redwood City, Calif.

Design Tips . . . on liquid cooling

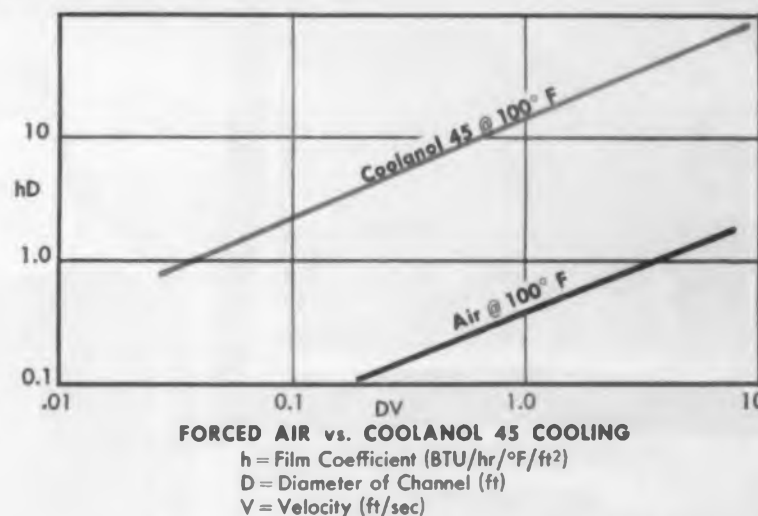
Monsanto

NO. 3: DESIGN MINIATURIZATION

PROBLEM: Increase heat dissipation capacity of cooling system and reduce its size and weight.

SOLUTION: Choose liquid cooling with Coolanol 45.

EXAMPLE:



This graph shows how liquid cooling with Coolanol 45 can make possible smaller, lighter, more efficient cooling systems than forced air. Coolanol 45 requires less heat-transfer area for the same heat load, a volume flow rate as much as 25 times lower, smaller cooling channels, and no bulky fins, fans or blowers. When you need to standardize, simplify or miniaturize a cooling system design, choose Coolanol 45 . . . efficient heat transfer coolant-dielectric and hydraulic fluid from -65° F. to 400° F.

SEND FOR NEW DESIGN BOOKLET

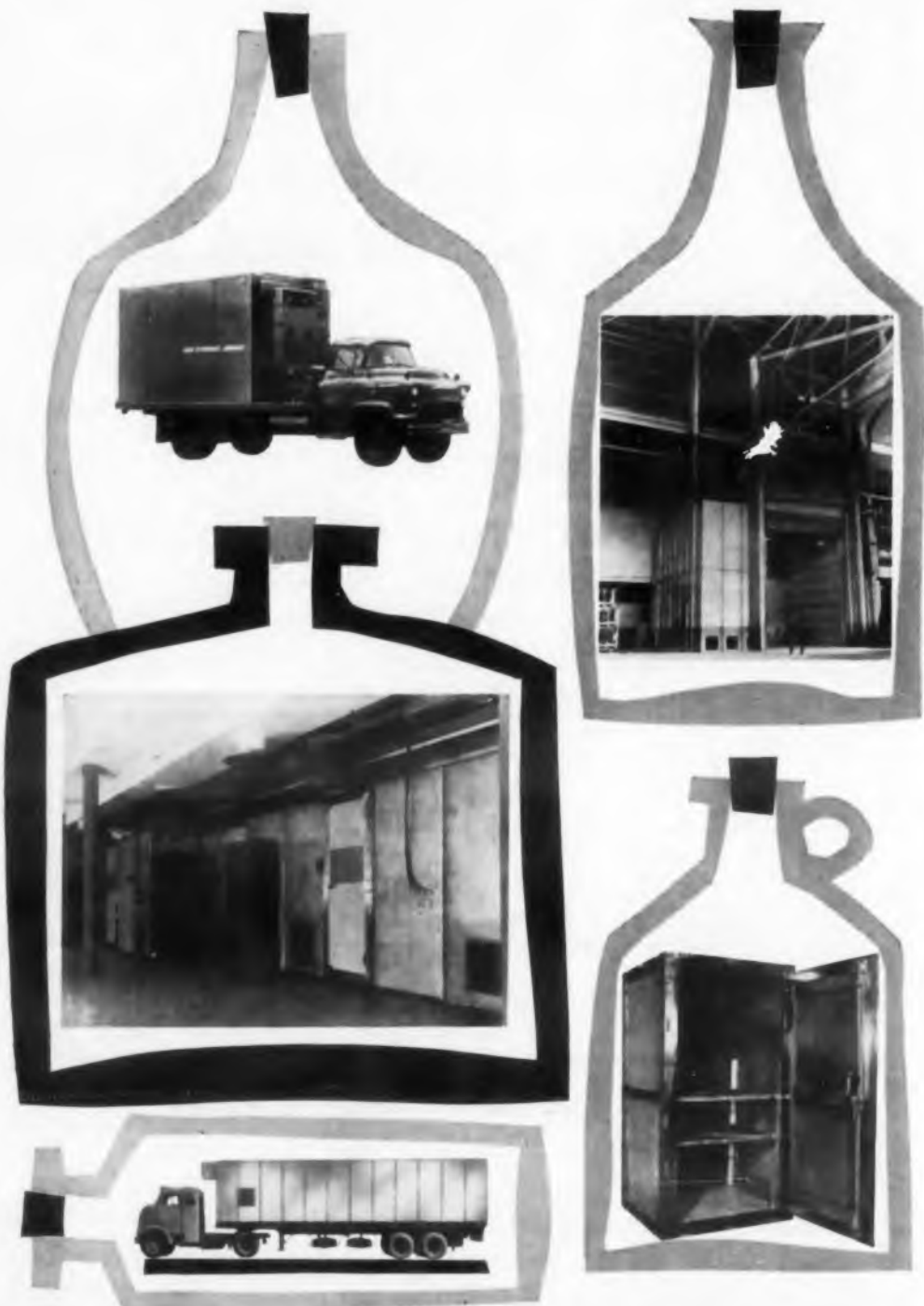
"Design Tips on Liquid Cooling with Coolanol 45" discusses static and dynamic cooling methods, how to apply the package concept to cooling design, how to simplify and standardize cooling and hydraulic units. It gives you a step-by-step solution of a typical cooling problem to show you how to apply principles of heat transfer in actual practice. For your copy of this new booklet, circle the reader-service number . . . or write direct:



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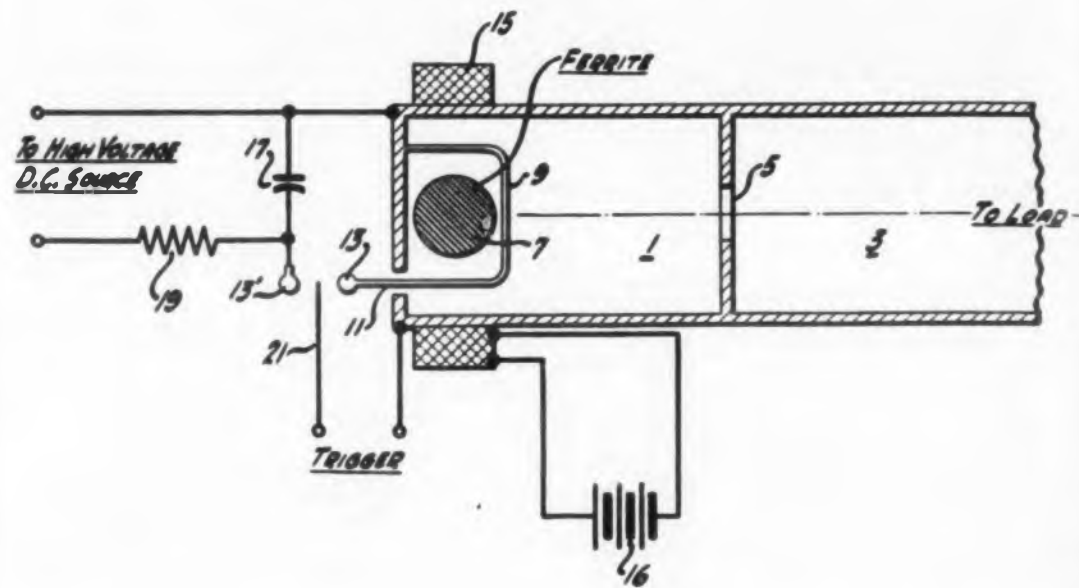
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*Exceeds attenuation requirements of MIL-E-4967A (ASG)



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CIRCLE 43 ON READER-SERVICE CARD

PATENTS



Microwave Pulse Generator

Patent No. 2,873,370. Robert V. Pound.
(Assigned to Levinthal Electronics Products, Inc.)

Impulsing a ferrite with a magnetizing field normal to the polarizing magnetic field generates, by magnetic resonance high peak power; this can be applied to radar transmission at millimeter wave-

lengths. The intensity of the applied pulsed field producing the processing magnetic vector is proportional to the frequencies in the pulse to be generated. At 1.0 mm (300 kmc) the applied field should be about 100,000 gauss. The requisite large applied field is generated by the discharge of a capacitor through a single turn coil of very low inductance.

PRINTED CIRCUITS

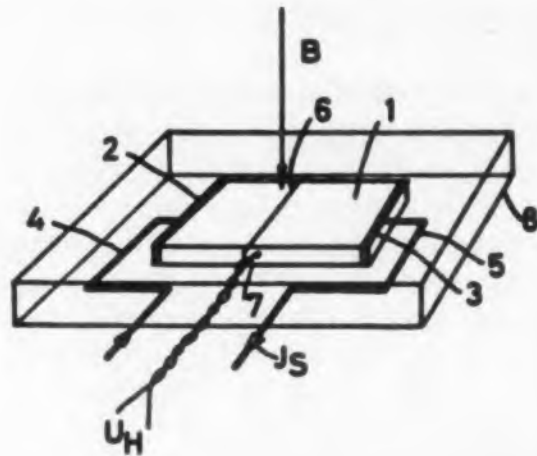
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A ferrite pellet, volume about $(\lambda/2\pi)^3$, is located in cavity 1 and the pellet is subjected to the polarization field produced by coil 15. Coil 9 is a single turn loop connected to capacitor 17 by means of spark gap 13 — 13'. After the capacitor is fully charged, the trigger breaks down the spark gap region and the capacitor rapidly discharges through loop 9.

The sample must be a dielectric since otherwise the processing fields would set up circulating currents and dissipate in I^2R losses the energy which should radiate.



contact with the resistance body.

The semiconductor 1, located with its plane surface normal to the field B , has current leads connected by contacts 2 and 3. Hall voltage U_H exists at the terminals of the twisted pair of wires connected at midpoints 6 and 7. An insulated section of wire continuously in contact with the center of the upper surface joins the output lead to terminal 6. By this means, unequal current surfaces on either side of the line joining the Hall electrodes are no longer possible and the difference reduces to zero.

Hall Effect Device

Patent No. 2,877,394. Friedrich Kuhrt.
(Assigned to Siemens, Berlin.)

Semiconductor compounds having high Hall constants (carrier mobility $\cong 6000$ $\text{cm}^2/\text{v sec}$) can be used to drive power devices directly since the component due to the time variable magnetic field is effectively cancelled. The design permits mass production of high-quality Hall effect devices with current electrodes in surface



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systems...on new or in-service
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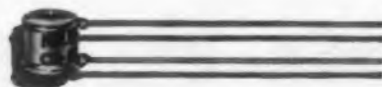
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newly developed Kelvin "RELAXED WINDING" techniques practically eliminate resistance drift with age and "shorts" or "opens" due to thermal shock.



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The 0.05W micro-miniature type EP-00 is .080" dia. x .325 long, 50K ohms max. resistance. Available with radial and axial lead wires. ALL CONNECTIONS ARE WELDED. High temperature epoxy plastic is used in an exclusive vacuum encapsulation process. Standard resistance tolerances to 0.1% (specials to 0.01%). Environmental temperature range: -65°C to $+125^{\circ}\text{C}$.



CERAMIC SERIES "CB"

The 0.15W miniature type CB-05 is $\frac{1}{4}$ " dia. x $\frac{1}{4}$ " long, 500 K ohms max. resistance. Available with radial and axial lead wires. Standard resistance tolerances to 0.1% (specials to 0.01%). Environmental temperature range: -55°C to $+85^{\circ}\text{C}$.



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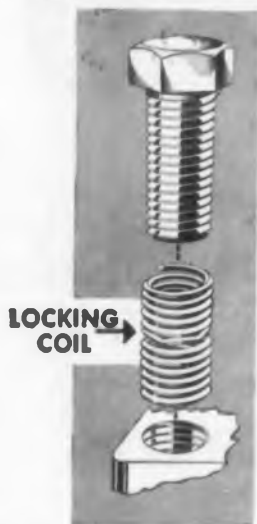
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Heli-Coil® Screw-Lock Inserts* lock screws against impact and vibration and permanently protect critical tapped holes in this transducer assembly.

Critical Electronic Controls Get Internal-Locking, Protective Threads

with **HELI-COIL** Screw-Lock Inserts



Principle of Heli-Coil Screw-LOCK Insert. Locking center coil grips internally, holds screw firmly.

Electronic control devices for aircraft and missiles, like this angle of attack vane transducer made by U. S. SCIENCE CORPORATION, LOS ANGELES, CALIF., have to withstand severe vibration, impact, corrosion and temperature change. They must be made of light materials and still have strong threads — able to hold fasteners tightly and stand frequent assembly and disassembly.

U. S. SCIENCE insures rock-solid screw assemblies by protecting vital tapped holes with one-piece internal-locking Heli-Coil Screw-LOCK Inserts. These precision formed, stainless steel wire inserts eliminate thread wear, lock screws securely — without resort to clumsy, external lock nuts and lock wiring.

Simple Installation Procedure

U. S. SCIENCE finds it easy to install Heli-Coil Screw-LOCK Inserts. Drilled holes are tapped with a Heli-Coil tap and the Inserts wound in with a prewinder inserting tool. Conventional screws are used in assembling the unit.

Heli-Coil Screw-LOCK Inserts

- positively lock fasteners against loosening under impact and vibration
- prevent thread wear, stripping, corrosion, galling and seizing
- eliminate lock nuts, lock wiring, other supplementary locking devices
- permit repeated disassembly and reassembly
- can be used in standard proportion bosses without need for redesign
- save assembly time, space, weight and cost
- meet government specs for locking torque and vibration

*Patented



HELI-COIL CORPORATION
DANBURY, CONNECTICUT

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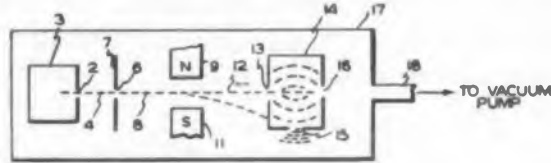
PATENTS

Production of Electromagnetic Energy

Patent No. 2,879,439. Charles H. Townes.

A magnetic or an electric field separates oscillating particles which normally exist in thermal equilibrium in at least two discrete energy states. The higher energy state induces oscillations in a high-Q cavity and the frequency stability of the output is about one part in 10^{10} . If there are fewer particles than necessary to sustain oscillations in the cavity, a signal from a separate source at the specified frequency will trigger the oscillations, and in effect, the signal will be amplified. When the cavity temperature is kept low, the amplifier noise figure is less than unity.

A typical working system is shown wherein, for example, ammonia molecules at 10^{-3} mm Hg stream through aperture 6 and the lower energy particles are deflected aside by the magnets 9-11. The higher energy molecules enter cavity 14



to induce oscillations at a frequency set by the molecular response and cavity geometry. Useful output couples through aperture 15.

As an amplifier, fewer ammonia molecules are allowed to enter the cavity but provision is made for inserting signals into the cavity to trigger and control the oscillations. This produces amplification of the control signal as useful output.

Microwave Frequency Discriminator

Patent No. 2,883,533. Clyde L. Ruthroff. (Assigned to Bell Telephone Labs., Inc.)

The discriminator comprises a single detector insensitive to ambient temperature change and the phase comparison is properly adjusted to avoid spurious modulation; adequate and fast response are provided. Operation of the device depends upon the $\lambda/8$ path difference in guide 11 compared to the length in guide 12 and also to the $\lambda/4$ phase shift resulting when ferrite 17 is excited by solenoid 19.

Initially both relay 22 and solenoid 19 are not excited. Microwave energy from the oscillator splits equally at the hybrid junction with half to resonator 14 and half

FROM JUST ONE HEAD... TO A COMPLETE



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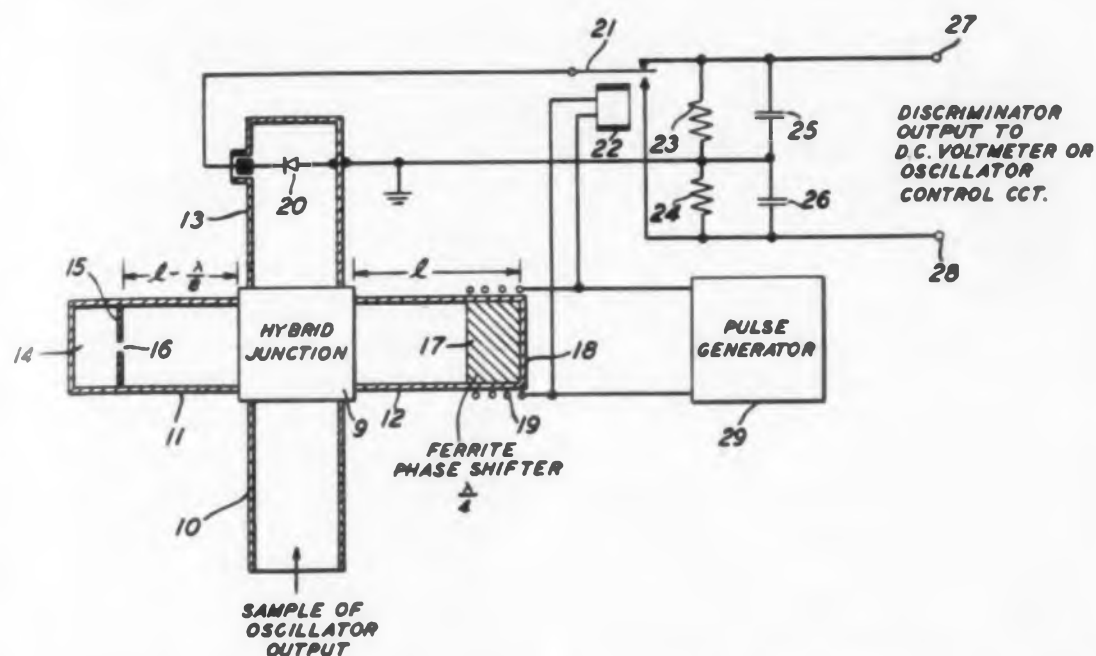


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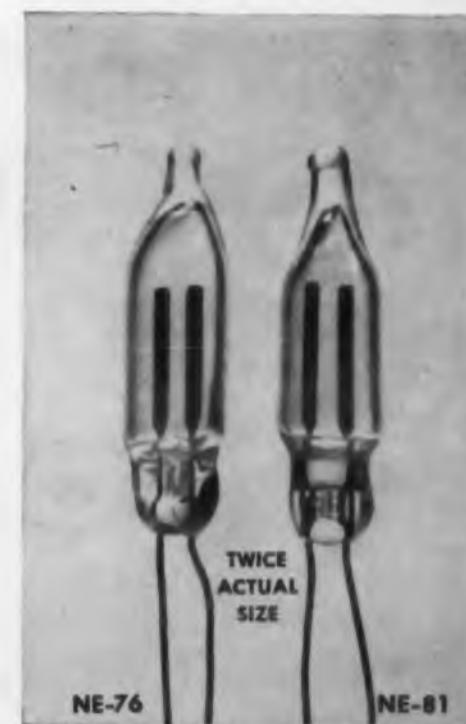
ELECTRONIC DESIGN • July 8, 1959



to the shorted terminal 18. After reflection, two signals, now $\lambda/4$ out of phase, drive detector 20 and charge capacitor 25. Subsequently generator 29 switches to excite solenoid 19 and to trip relay 22 connecting the detector output to capacitor 26. Microwave energy now reflected from shorting plate 18 is shifted an additional $\lambda/2$ and the detector output charges capacitor 26. As a result the voltage across resistors 23 and 24 follows in phase and

magnitude any frequency shift of the oscillator. Resonator 14 senses the frequency change in the oscillator. Thus the reactive component of the resonator impedance increases with frequency deviation being capacitive above center frequency and inductive above this frequency. This phase shifts the signal reflected from the resonant cavity 14 and thereby changes the magnitude of the resultant signal seen by the detector.

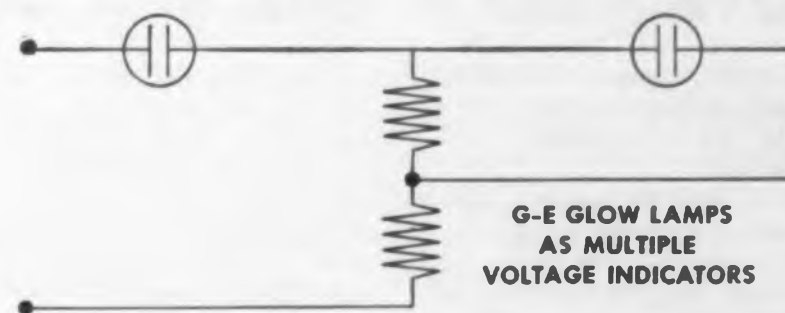
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| Operating Volts | 57 \pm 4-volts d-c | 50 to 60-volts d-c |
| Extinction Volts (in series with .25 megohm or more) | 50-volts d-c | 50-volts d-c |
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| Leakage Resistance (at high humidity) | 100 megohms | 100 megohms |
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| NE-81 Life Change in Starting and Operating Voltage At .3 m.a. | | + 5-volts in 6,000 hours |

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A technician probes radiated interference from an aircraft hoist in the Los Angeles laboratory of Sprague's Interference Control Field Service Dept.

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Once the equipment reaches the prototype stage, Sprague specialists will conduct tests either in the manufacturer's own plant or in one of Sprague's interference laboratories. Sprague will also direct compatibility tests on end equipment or complete weapons systems, and recommend solutions to any integration problems which might develop.

Sprague Interference Control Laboratories are located on the Pacific Coast, in the Mid-West, and on the East Coast. These laboratories are staffed by top interference and susceptibility control specialists, and are equipped with the most advanced instrumentation and model shop facilities.

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BOOKS

Principles of Direct-Current Machines
Alexander S. Langsdorf, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y., 363 pp., \$8.50.

This text presents a compact analysis of the operating characteristics of direct-current generators and motors based on the necessary relations between the magnetic and electrical circuits which constitute their structural design.

The basic principles of electromagnetism which are needed in developing the characteristics of rotating machines are presented in the opening chapter, together with a full discussion of the systems of units in which magnetic and electrical quantities are expressed. The remainder of the book is concerned with the properties and construction of the machines themselves. Design considerations which determine the dimensions of ma-

chines have been touched upon only to the extent necessary to answer questions that occur naturally to inquiring students.

There are outstanding line drawings—particularly those involving connection diagrams, which reduce crossovers to a minimum and can be easily followed by the eye without confusion and uncertainty.

Since the time now devoted to courses in dc machinery in electrical engineering curricula is in general limited, the length of this text has been correspondingly reduced. All line drawings are new, while halftone illustrations are based on new, up-to-date photographs supplied by various manufacturers. Illustrative problems, with solutions, have been inserted at various points in the text. The problem material at the end of the book is entirely new.

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The Audio Cyclopedia

Howard M. Tremaine, Howard W. Sams & Co., Inc., The Bobbs-Merrill Co., Inc., New York, N.Y., 1269 pp, \$19.95.

This comprehensive reference on audio and hi-fi covers every phase of the subject including the latest data on stereo. Although written by and for the audio engineer, this volume is clear enough to be appreciated by the amateur audiophile. More than 3400 topics are included and accompanied by over 1600 illustrations.

Organization of topics covers: Basic Principles of Sound; Acoustics and Studio Techniques; Constant-Speed Devices, Motors, and Generators; Microphones; Attenuators; Equalizers; Wave Filters; Transformers and Coils; Sound Mixers; VU and Volume Indicator Meters; Vacuum Tubes, Transistors, and Diodes; Audio Amplifiers; Disc Recording; Cutting Heads; Recording and Reproducing Stylis; Pickups; Magnetic Recording; Optical Film Recording; Motion Picture Projection Equipment; Loudspeakers, Enclosures, and Headphones; Power Supplies; Test Equipment; Audio-Frequency Measurements; Installation Techniques; General Information, Charts, and Tables;

Stereophonic Recording and Reproduction of Disc Records.

A unique indexing system, including chapter and paragraph numbering, facilitates the reference usage of this volume.

Molecular Science and Molecular Engineering

Arthur R. von Hippel, *The Technology Press of M. I. T.*, and John Wiley & Sons, Inc., New York, N.Y., 446 pp, \$18.50.

Third and final volume in a series on modern materials research, this book proceeds from classical to molecular science. The chapters advance in a unified way from the structure of the atoms and molecules and the behavior of charge carriers in gases to the formation and structure of condensed systems, and to dipoles and their spontaneous alignment in ferroelectrics and ferromagnetics. Final chapters are devoted to ions and electrons in liquids and solids.

Twenty-two contributing editors have written on a number of topics including molecular concepts producing masers and memory systems, transducers, transistors, parametric amplifiers, ion-exchange resins, etc. There are ample illustrations and tables to supplement the text.

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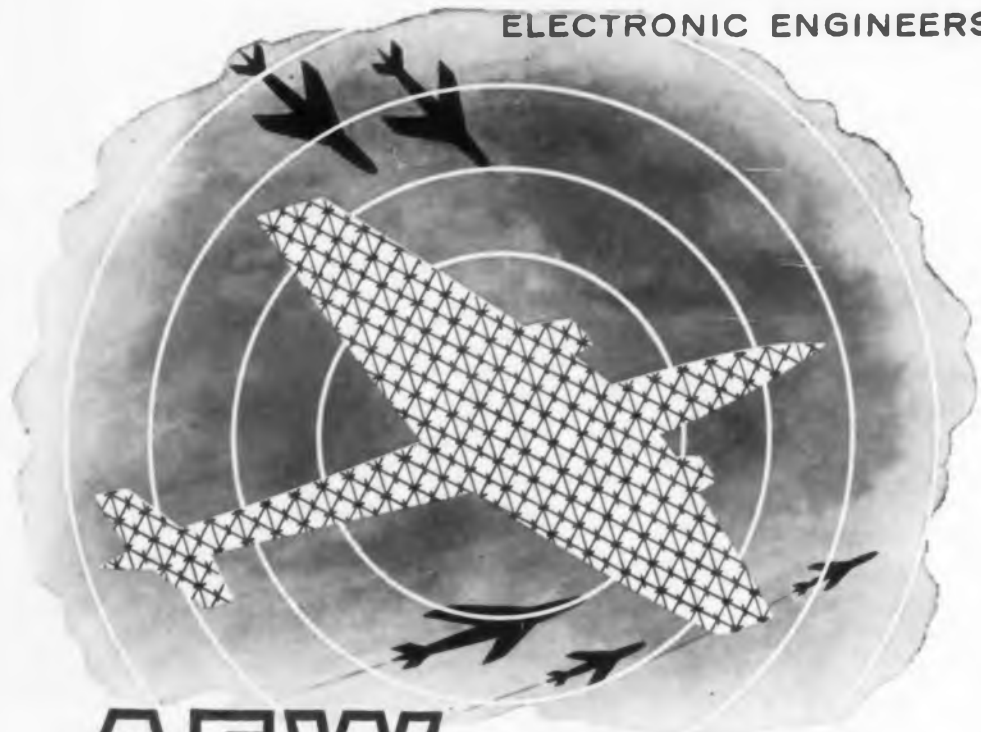
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ELECTRONIC ENGINEERS



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DESIGNING YOUR FUTURE

Wanted: Fewer Dreamers, More Doers in Engineering

Bernard M. Gordon, President
Epsco, Inc.

"Where are all the engineers?" asks Epsco's young president, Bernard M. Gordon.

Too many, he concludes, are floundering in ivory "systems" towers — and wastefully. What industry needs, he says, is not more theorists but more hardware engineers — fast-thinking, profit-minded, competition-conscious engineers to do practical design work. Train such men and give them responsibility. The result? Lasting dividends to both industry and the engineers.

To ease the engineering shortage, Mr. Gordon says, reclaim the "lost" talent in the massive academic-oriented laboratories.

EVERY DAY the engineering "shortage" appears more acute. Yet the nation's need for engineers to develop both industrial products and weapons for defense,

constantly grows. Where are all the engineers?

Some managers seriously doubt that there is, in fact, any real shortage. It has been estimated, for example, that within a 100-mile radius of Boston there are almost 10,000 electronic engineers. What are they doing? An answer to this will help unravel the riddle of the so-called engineering shortage.

Serious engineering has always involved a wide spectrum of capabilities. Essential are the talents of the brilliant, mathematically inclined, searching-for-knowledge engineer; the creative development engineer; the methods engineer and many supporting engineering personnel. But not all engineers are capable of original concepts. Nor need they be.

Few Scientists Needed

Relatively few scientists are needed to keep a large number of practical, resourceful engineers working to produce products and machines for industry and defense. However, a major problem is that the excitement of the new technology coupled with "delusions of academic

At 32, Bernard M. Gordon, president of Epsco, Inc., can look back on what—for someone else—might easily pass for a lifetime of achievement. He has crammed his business success so far into five short years. His horizon is unlimited.

He co-founded Epsco in January, 1954, with Joseph H. Davis Jr., now senior vice president of the company. Their first company address was the basement of Mr. Davis' home.

Orders have built up in a steadily rising wave since Epsco opened shop—from \$150,000 in 1954 to \$4 million last year. The current backlog is \$7.5 million. Sales of \$8.5 are anticipated before the year is out.

Epsco claims 40 "firsts" in data-control engineering. Its prescription for engineers is Mr. Gordon's credo: "Hard work and individual responsibility . . . practicality and reliability."

The executive holds two degrees from the Massachusetts Institute of Technology: a B.S.E.E. and an M.S.E.E. He also has done graduate work at Tufts, Harvard and the University of Pennsylvania.

Last year he received national recognition when Esquire magazine named him an outstanding young business leader.

grandeur," as one educator has put it, have created an atmosphere in which a large proportion of engineers are assigned to advance, or "systems" thinking. And this is done whether or not their major talents can, in fact, be directed toward original concepts.

As more engineers are attracted to the massive academic-oriented laboratories operating on a cost-plus-fixed-fee basis, fewer are available to do the practical design work. In short, there is not balanced high-level engineering, directed toward both innovative thinking and practical design.

Theory Overemphasized

The situation has been brought about by a combination of factors. In military laboratories, the job description "electronic scientist" now defines what used to be called an engineer. Leading academic technical institutions are emphasizing theoretical studies to the extent that some of their potentially best students are being shunted from practical engineering. Many students are being taught that the reduction of a theoretical design to practicality can be done by lesser-schooled technicians.

Regardless of the conceptive brilliance of our leading scientists (and the nation does appear to have an adequate number), if our engineers do not devote their full experience and knowledge to the practical problems of equipment design and production, we will fail in the international race for scientific supremacy.

The solution to the engineering problem lies primarily in a "back to engineering" movement for engineers—and particularly for our most creative and competent engineers.

Epsco's approach has been to seek engineers who have an excellent record of accomplishment but who, more often than not, have recently become involved in activities not fully utilizing their true talents and experience. We try to convince these men to assume practical responsibility once again, including all phases of analysis, invention, fundamental design, reduction to practice and production engineering.

At the same time the company has attempted to motivate junior engineering personnel by assigning them to senior men as apprentices.

The approach we are taking is based on our experience on building advanced

telemetry, air-traffic control and automatic checkout systems; nuclear-process monitors; analog-digital conversion systems and many instrumentation systems, along with the basic components and equipment for these systems. Nearly all of the work involves accomplishment of specifications and development techniques in advance of the known state of the art.

The company has had many successes, but there also have been a few real problems. However, nearly every major engineering problem at Epsco can be traced to a case in which academically oriented personnel were assigned to tasks requiring practical experience, competence and drive. The lessons learned have resulted in a formal program, under a central engineering directorship, for the motivation of creative thinking and a "finish the job" attitude.

We attempt to teach our engineers that they are truly valuable to the company only when the customer—either military or industrial—is satisfactorily using the equipment as originally conceived. We attempt to teach them that the time they take to accomplish a job is a primary factor in the company's evaluation of them.

Pitfalls Complicate Task

Engineering is the art of combining knowledge with imagination and creating, through hard work and skill, solutions to existing or foreseeable needs. The solutions are in the form of practical and economically justifiable products. However, the road to successful engineering, particularly in the relatively new electronics industry, is often blocked by many practical factors. If these are not anticipated and overcome, complete frustration may result. Epsco aims to eliminate these factors through the education of newer engineers by those who have been through the school of hard knocks.

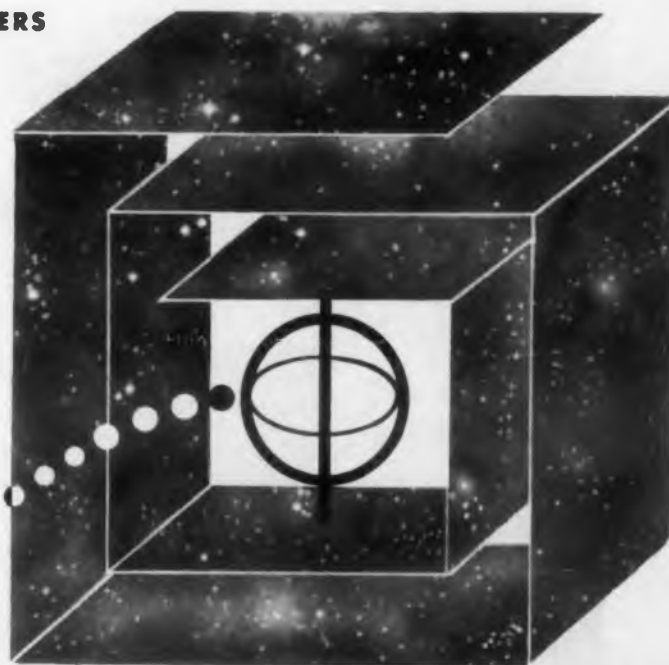
Newer engineers are taught that their skill is the lifeblood of the company and that if the concern is to maintain technical leadership and create increasing opportunities for them and other employees, they must meet both the needs of customers and the challenge of competitors.

It is our view that an engineer must be taught to:

- Produce products that can be sold at a profit.
- Contribute to national defense.

(Cont. on following page)

ELECTRONIC ENGINEERS



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"This personal growth typifies Motorola's policy of expanding activities and promoting from within to keep pace with the rapid industry development. It is also very gratifying to be part of an organization that operates in a spirit of friendly teamwork, where even top officers are addressed by their first names; a company that appreciates and encourages ingenuity and capability. Throughout Motorola I have found everyone takes a keen, enthusiastic interest in his work and feels a strong pride in the company's commanding position in the field and in its products.

"Living in the Chicago area is also very enjoyable. I bought a home in a small western suburb only a half hour drive from the plant, yet still well out into the fresh country air. It's only one of dozens of pleasant, well planned communities surrounding the city. Fine schools, shopping and recreation facilities are convenient everywhere.

"Motorola is continually growing, and every day I see this development opening constant advancement opportunities for individuals with talent and willingness. I'm proud to be a part of it."

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DESIGNING YOUR FUTURE

- Contribute to society.
- Achieve creative satisfaction.

We believe that the successful engineer is endowed with creativity, imagination, and drive and that when these traits are combined with education and experience, the combination produces the complete engineer.

Responsibilities Listed

Becoming an engineer leader takes years of experience and industrious work. An engineer has many responsibilities. To name a few:

- Customers to satisfy.
- Products to conceive.
- Circuits and mechanisms to design and invent.
- Schedules to meet.
- Budgets to beat.
- Procedures to write.
- Technical papers to present.
- Test equipment to design and devise.
- Production drawings to approve.
- Support personnel to supervise.
- Sales matters to attend to.
- Reports to prepare.
- Theoretical analysis to carry out.

The more of these an engineer can do

well, the more likely he is to advance, both professionally and with the company.

To develop correct attitudes and competence in engineers, a company should organize its engineering divisions into vertical project groups.

Full responsibility for all phases of a project, including development and management must be placed in the hands of the project engineer. It is our belief that the departmentalized, service group type of organization now becoming common in the electronics industry kills both the will to create and the desire to succeed—and particularly removes the needed sense of responsibility.

We believe, then, that the solution to the so-called engineering shortage lies primarily in motivating the nation's engineers to be "real engineers" and to derive creative satisfaction from true achievement. Once engineers have been "re-created" by a process of learning by doing, the solution to the engineering "shortage" will manifest itself.

It is probable that if only 10 per cent of the country's would-be electronic scientists can be motivated to return to the true purpose of engineering, the productive engineering force can be tripled. ■ ■

ENGINEER'S SUCCESS STORY

That opportunity awaits the ambitious in practical engineering is supported by this case history from the files of the Epsco Systems Division:

Richard Ferrero, 26, four years out of college with a B.E.E., was disgruntled. A member of a group of engineers in a large electronics organization, he was responsible for the design of a small section of a large communications system. He had little or no contact with other phases of the project, such as purchasing of materials, customer liaison and packaging.

He felt he wasn't advancing professionally. He wanted increased responsibilities.

When he joined Epsco, he was assigned to a senior project engineer. He became apprentice head of data-logging system projects, utilizing digital voltohmmeter input devices and paper tape perforator output mechanisms.

After six weeks of apprenticeship, he was designated full-fledged project engineer, assuming complete responsibility for completion of the systems. His duties included technical liaison with the customer, purchasing of components and materials, supervision of technicians, and design and engineering of all circuitry. The systems were delivered on schedule four weeks after he took full charge.

Two weeks prior to this, he had been assigned to a new project for a military data-logging system. This, too, was delivered on schedule.

He received full responsibility for the design and production of a digital data-monitoring system for a movie-film process control application.

He designed, wrote the technical proposal and sold a data-acquisition system for medical research on psychopathological behavior. As project engineer on this system he is now completing it on schedule.

All this in less than a year with Epsco.

In spare moments, he writes technical articles, one of which was recently published.

And recently he became a guide at Epsco, instructing new engineers on how to assume responsibility. ■ ■

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

14

(Please print with pencil or type.)

Name _____ Telephone _____

Home Address _____ City _____ Zone _____ State _____

Date of Birth _____ Place of Birth _____ Citizenship _____

Position Desired _____

Educational History

| College | Dates | Degree | Major | Honors |
|---------|-------|--------|-------|--------|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Recent Special Training _____

Employment History

| Company | City and State | Dates | Title | Engineering Specialty |
|---------|----------------|-------|-------|-----------------------|
| | | | | |
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Professional Societies _____

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Minimum Salary Requirements (Optional) _____

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Circle Career Inquiry numbers of companies that interest you

- 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924
 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

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Your Goal?
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Speeds Action**

ELECTRONIC DESIGN's new Career Inquiry Service form is designed to help engineers advertise themselves. This new service will speed applications to the jobs they seek. It is the first such service offered in the electronics field.

To present your qualifications immediately to the personnel managers of companies that interest you, simply fill in the attached standardized short resume.

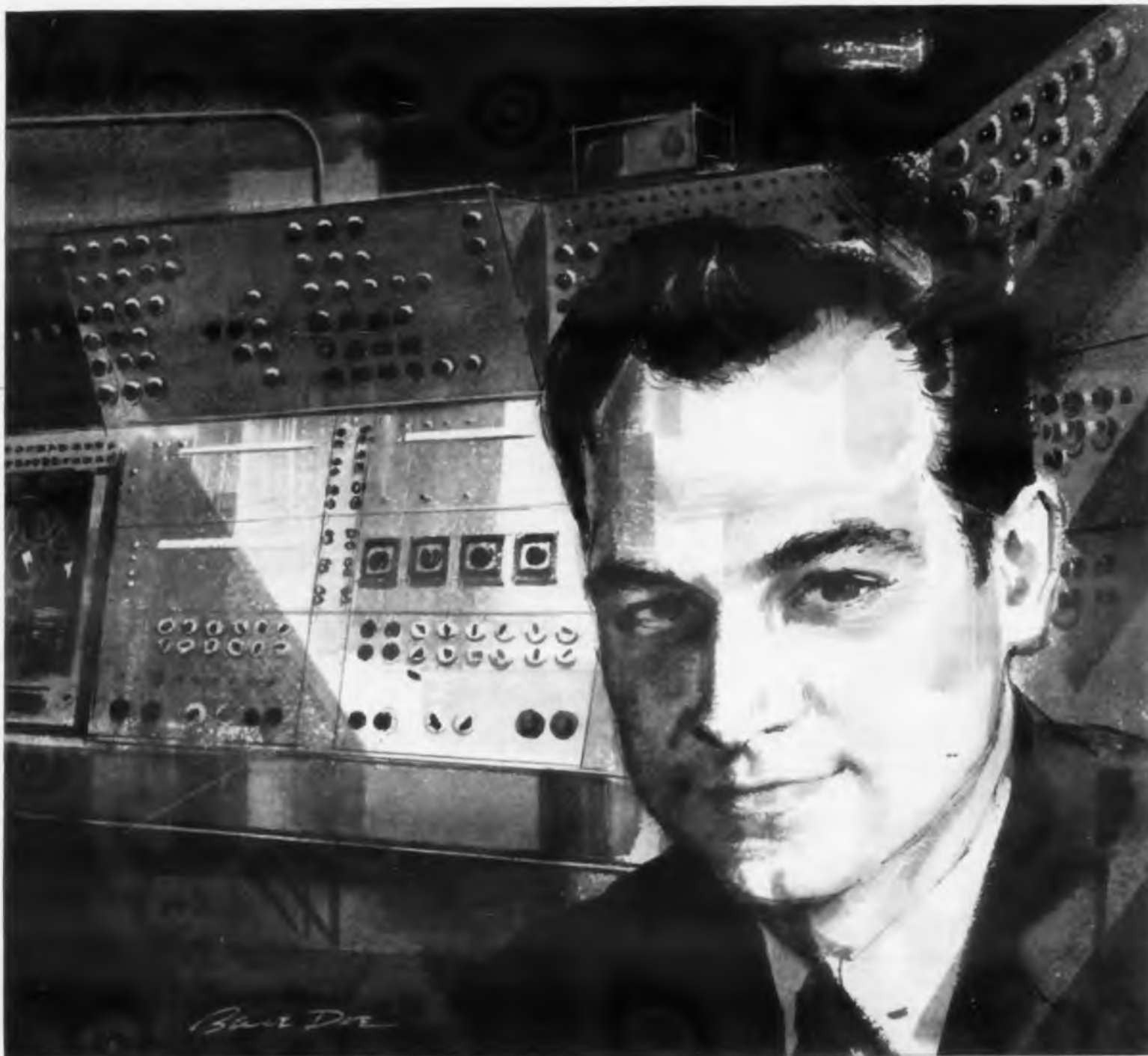
Study the employment opportunity ads in this section, and circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN's Reader Service Department will make photocopies of your standardized resume and send it to all companies you select . . . *the same day the resume is received.* (ELECTRONIC DESIGN will detach the circle number portion of the form, so that no company will know how many numbers you circled.)

The standardized resume will permit personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you directly. In the past much time has been lost through personnel-manager requests for resumes from applicants who proved ineligible.

Readers who desire only company brochures should use the regular Reader Service card.

Mail Career Inquiry Service form to Reader Service, ELECTRONIC DESIGN, 830 Third Ave., New York 22, N. Y.



C. L. Hampton

Computer expert Chuck Hampton is a man with problems.

As head of our Avionics Division's Computer Applications section, Hampton pits his analog and digital computers against the mathematical intricacies of infrared research, optics, spectral background studies, feedback control, and weapon system design.

At thirty, with a BSEE from the University of Illinois,

Chuck Hampton is a Senior Engineer. He typifies the progress made at Aerojet by younger men of technical distinction, in electronics and many other areas.

We think the challenge is imposing, the opportunity impressive. May we see *your* resume? AEROJET-GENERAL CORPORATION, Box 296S, Azusa, California or Box 1947S, Sacramento, California. Attn: Director of Scientific and Engineering Personnel.

AEROJET-GENERAL CORP.

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CIRCLE 902 ON CAREER INQUIRY FORM

YOUR CAREER NEWS, NOTES, NOTIONS

Look for that new job right now if you want to show up well against other applicants. Reason: the job market is slow; most employed persons are sticking with present positions until they get their vacations.

Small- and medium-sized companies offer engineers opportunities equaling those found among the giants and "blue chips." Young engineers frequently don't realize this, because smaller outfits don't advertise or comb the campuses the way large employers do. Employment agents can often give applicants up-to-the-minute information on opportunities with many small companies.

Take plenty of resumes if you register for a job with an agency. According to *Jobs in New York*, applicants often don't leave enough to permit the agent to hit all likely employers. Have 6 to 12 resumes for each agency.

Demand for new electronic grads is greater than last year, according to the same publication. Starting salary for EE's is \$500 to \$550 a month.

The heavy demand for electronic engineers is certainly not news to anyone exposed to the help-wanted ads. Other engineers do not enjoy this same popularity. Construction engineers, for example, are in poor demand.

Heavy bidding for EE seniors has lived up to predictions made last winter by the Engineering Manpower Commission of the Engineers Joint Council. The long-term outlook for engineers is exceptionally bright, according to the EMC; industry anticipates the demand for graduates to rise 29 per cent by 1962 and 40 per cent by 1965.

Demand is being further accentuated by a decreased enrollment of freshman engineers (11 per cent in 1958). If this trend continues in 1959, the manpower shortage may be extremely serious.

The Federal Government is not lessening its engineering recruitment effort, although it did well in 1958. As the No. 1 employer of engineers and scientists, it has much at stake.

Federal agencies have been told to stress premium job features found only in Government scientific and technical programs. This advice was given by several prominent scientists, engineers, and personnel officials in speeches to the Government-wide Conference on Scientific Manpower held recently in Washington.

Speakers stressed that Federal scientific and technical programs offered new and challenging opportunities and that the Government should spotlight its superior attractions. Among the "plus

features" cited in the Government's career scientific service were opportunities to:

- Do research on a wide variety of exciting and challenging problems.
- Engage in basic research without production-related pressures.
- Work in the most modern and fully equipped facilities, without worry about the adequacy of research funds.
- Participate in pioneering work in science and technology.
- Publish research results without fear of compromising the employer's competitive position.
- Gain public recognition of professional achievements.
- Participate in work vitally important to national security and progress.

Although it is unlikely that Government pay for scientists and engineers can be made fully competitive with that offered by industry, the gap is in large part offset by the attractions that only Federal service can offer.

Some of the problems that need solving:

- Making the Government's career scientific service flexible enough to permit advancement to top rungs for scientists who wish to stay in creative work rather than transfer to administrative duties.
- Minimizing reliance on outside laboratories for new work, so that the morale of Government scientists will not be impaired.
- Correcting erroneous concepts of public service.

Universal licensing of all engineers in the State of Washington has been proposed by the Seattle Professional Engineering Employees Association. They ask that all engineers making design and other critical decisions be registered. At present, engineers employed by a corporation which does not sell engineering services (as contrasted to products) are exempt from registration. SPEEA thinks licensing would increase the stature of the profession as it would indicate that engineers possess certain qualifications.

Overworked or underworked? Being underworked can create anxieties, according to William E. Henry, associate professor of psychology at the University of Chicago. He commented on the cause of anxieties in executives in the May issue of the University magazine. Excessive stress, he said, may result if an executive [or engineer] is in a position beyond his skill and has to push hard to accomplish the job. But a more deep-seated anxiety, the psychologist reported, can stem from an executive's dissatisfaction with a job beneath his level of responsibility and intelligence. Conclusion: pushing a little harder to measure up is better than not having enough to push at all. ■ ■

3-D Radar...Leus... Distance, Altitude

(Pictures on Page 3)
A revolutionary new 3-D radar capable of detecting enemy air attackers at extreme range and revealing their distance, bearing and altitude to military ground units was revealed today by the Army. The new system, called Frescanar and developed by Hughes Aircraft Company, also sees its target more clearly than ordinary radar. It increases the number of targets which can be detected at the same time.

Army Shows Radar With 3d Dimension

By JACK RAYMOND
Special to The New York Times
WASHINGTON, Oct. 14.—The Army demonstrated a new "three-dimensional" radar device today and called it "one of the most important advances made in electronic detection." The new radar gives simultaneous readings of bearing, distance and altitude; it is designed to be hauled on truck trailers.

Called Great Advance Army Unveil Hughes Radar

Electronically, 'Frescanar' Can See 50% Further Than Previous
WASHINGTON, Oct. 14.—The Army Tuesday unveiled a field radar system that simultaneously detects bearing and altitude. It employs a single antenna housed in an inflatable frame. The device is designed to become the electronic eyes of ground forces.

New Radar Improves Air Defense for Army

WASHINGTON.—Field armies now are needed to have a truly effective missile defense against any kind of attack except that from ballistic missiles within a year, Army officials said last week. A statement came at the unveiling of a new type of radar as a key element of the Monitor system, will save men, training time, and ease the mobility and effectiveness of air defense in tactical operations. An additional feature is that the entire mobile radar equipment used for the same job. The move at good speed will set up and be ready in minutes.



ADAR ANTENNA—A mobile radar system, developed and manufactured by the U. S. Army by the Hughes Aircraft Company, detects targets in three dimensions: height, bearing and distance. On the left is the antenna which obtains the information and transmits it to a control van on its right. Other trailers contain diesel generators which power the system in the field. One generator is on a standard Army trailer.

Army Unveils A Faster Radar System

WASHINGTON.—A radar system that is faster, more reliable and more rugged than present equipment was unveiled by the Army here Tuesday. Nicholas A. Gerovich of Hughes Aircraft Co. said a single antenna does the job.

J.S. Reveals New Radar Instrument

Los Angeles, Tues. Oct. 14, 1958
A "3-D" radar that for the first time automatically computes distance, bearing and altitude of far-away targets was unveiled today by the Army in Washington.

Army Unveils Revolutionary Radar Device

BY VERNON I. CHAPMAN
Washington
The Army new radar device spots enemy aircraft

Hughes Radar

THE WALL STREET JOURNAL
Wednesday, October 15, 1958
Army Tests Improved Radar Device Originally Developed for Navy

3-D Radar by Army

WASHINGTON—The Army said today that a new radar device that spots airborne targets at extreme range and simultaneously computes distance and altitude. The device is called Frescanar. It is a major breakthrough in radar technology. The new radar system is called frequency scanning. The position of the radar beam is changed by varying the frequency of electromagnetic energy applied to the antenna. Thus the beam can move at lightning speed to handle more targets with greater accuracy than with conventional radar.

A new field... a new future... for the forward-looking engineer!

The first radar system capable of simultaneously detecting range, bearing and altitude from a single antenna, transmitter, and receiving channel... Frescanar is a major breakthrough in radar technology.

Developed by Hughes Fullerton, the Frescanar antenna operates on a new electronic principle called frequency scanning: The position of the radar beam is changed by varying the frequency of electromagnetic energy applied to the antenna. Thus the beam can move at lightning speed to handle more targets with greater accuracy than with conventional radar.

This unique concept opens entirely new fields for radar... including a great many as yet unexploited. Hughes Fullerton needs creative engineers who can step in and help develop these new military and civilian applications.

While Hughes Fullerton places emphasis on advanced development, it is a completely integrated engineering and manufacturing organization... whose activities cover a wide range of electronic and electromechanical applications.

Now expanding rapidly, Hughes is offering imaginative engineers a number of new positions. If you are interested in stimulating work with solid opportunity for personal and professional growth, we invite your inquiry. Please contact Mr. L. V. Wike at address below.



GROUND SYSTEMS
PERSONNEL SELECTION AND PLACEMENT
HUGHES AIRCRAFT COMPANY
FULLERTON 12, ORANGE COUNTY, CALIFORNIA

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3-D Radar Developed by Hughes

Computes Bearing, Range, Altitude in Single Operation

Three-dimensional, hemispherical radar detection developed by Hughes Aircraft is now in use on Navy ships.

Army Gets Improved Field Radar

WASHINGTON, Oct. 14.—The Army today unveiled a new field radar system that simultaneously computes distance, bearing and altitude. The device is called Frescanar. It is a major advance over the old radar system.

3-Dimensional Radar Is Displayed by Army

By JAMES W. BRADY
Special to The Tribune

Please write direct to advertiser mentioning ELECTRONIC DESIGN

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AVIATION

To the engineer who wants to get out of the traps, Link - Binghamton offers a clear shot at a good career and good living.

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If your qualifications include experience with radar simulators, automatic checkout equipment, optical systems, electronic packaging, analog or digital computers, contact us at once.

Write to Mr. A. F. Darrah
Link Aviation, Inc., Binghamton, New York

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Precision
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CIRCLE 903 ON CAREER INQUIRY FORM

**CAREER
OPPORTUNITIES
BROCHURES**



**Bendix Aviation
York Division**

"Guided Missile Electronics and More" is designed for use at the college placement offices for the junior engineering candidate. The most commonly asked questions of applicants are featured in interview form, stressing growth opportunities and challenges at this company for the young engineer. Type of assignments available and project groups, operational activities, competitive advantages and disadvantages and the major engineering objectives are covered. Facilities, on-the-job photos, and living condition within the York, Pa., community are illustrated and outlined.

Bendix Aviation Corp., York Div., Dept. ED,
York, Pa.

CIRCLE 870 ON READER-SERVICE CARD



**Hughes Aircraft
Company**

The integrated organization of administration, engineering and manufacturing, keynotes the illustrated, 10-page brochure, "Key Man in Electronics Manufacturing: The Engineer". The interrelationship of projects at Hughes is emphasized and a profile of the engineer and his work are described and illustrated. General facilities and overall advantages for the engineer are delineated. The story is completed by notes on the active present and sound future with this company.

Hughes Aircraft Co., Dept. ED, P.O. Box 5426,
Airport Sta., Los Angeles 45, Calif.

CIRCLE 871 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1959

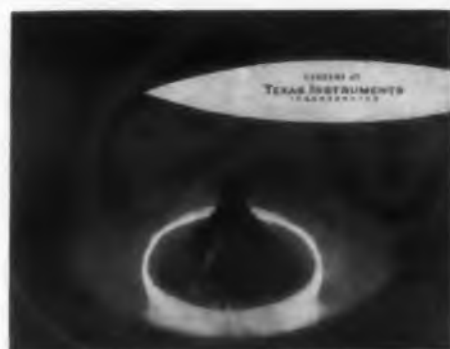


Westinghouse Electric Corporation

A collection of categorized flip cards comprise this brochure which presents "A Detailed Guide to Current Job Opportunities at Westinghouse, Baltimore". The breakdown of openings separates fields of interest, and discusses within each alphabetically listed section job titles, and brief job descriptions. Offers a quick survey of current positions to the interested applicant.

Mr. A. M. Johnston, Employment Manager,
Westinghouse Electric Corp., Dept. ED, P.O.
Box 746, Baltimore 3, Md.

CIRCLE 872 ON READER-SERVICE CARD



Texas Instruments Incorporated

Particularly helpful for the applicant to Texas Instruments Inc. is a series of career charts that list all positions available according to divisional breakdowns. Detailed career charts for each autonomous division spell out the nature of the career, detailed functions, and qualifications. The Products divisions include: Apparatus, Semiconductor-Components, Industrial Instrumentation, Geophysical Service, and Engineering Supply. The broad scope of opportunities in each of the Product divisions, Industrial Engineering, Manufacturing, and Quality Control are discussed. In addition, the overlapping opportunities that co-exist in the Product divisions and company staff functions include: Marketing, Research and Engineering, Control and Finance, and Personnel.

Applicants will also obtain guidance to company benefits, a photographic description of the Dallas and Houston areas, a brief analysis of company sales growth, facilities and employee expansion in this 24-page illustrated brochure.

Texas Instruments Inc., Dept. ED, 6000 Lemmon Ave., Dallas 9, Tex.

CIRCLE 873 ON READER-SERVICE CARD

Power Through Solid State Physics

Delco Radio is a world leader in automotive radio engineering and production. And, since our beginning in 1936, we have grown steadily, keeping pace with the rapidly expanding electronics industry.

Today, with this world of experience and knowledge accumulated through the years, it's only natural that Delco would become deeply involved in the important missiles and allied fields.

NOW Delco Is Offering Engineers and Scientists Opportunities in Space Age Devices:

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- STATIC INVERTERS
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- POWER SUPPLIES

We have immediate requirements for:

ELECTRONIC ENGINEERS to design transistor circuits . . . communication circuits . . . radio circuits . . . servo-systems . . . antennas . . . or to do component and material specifications.

COMPUTER ENGINEERS for development of control type, special, or general purpose units. Experience in digital to analog and analog to digital converter design. Or magnetic core or drum type memory. Mechanical engineers for package design. Electronic engineers for test design, servo-analysis, and circuit design.

PROCESS ENGINEERS—Electronic and Mechanical for transistor and electronic production planning and follow-up.

SEMI-CONDUCTOR SALES ENGINEERS—Also customer assistance engineers. Prefer semi-conductor applications or similar experiences.

DRAFTSMAN—Minimum of 3 years experience in making complicated, detailed drawings and minor layouts.

If you are interested in becoming a part of this newly-established GM team of specialists, send your resumé today to the attention of Mr. Carl Longshore, Supervisor—Salaried Employment.

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DELCO RADIO DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

CIRCLE 904 ON CAREER INQUIRY FORM

CAREER OPPORTUNITIES



**Sylvania
Electronic
Systems**

Research and development work of the Reconnaissance Systems Laboratory is sketched along with a brief account of company location and organization. Emphasis is placed on a list of opportunities in applied mathematics and physics, physical design, electronic development, and project engineering. Professional advancement and benefits are discussed and the general living area is described.

Sylvania Reconnaissance Systems Lab., Dept. ED, P.O. Box 1296, Mt. View, Calif.

CIRCLE 874 ON READER-SERVICE CARD

**Boeing Airplane
Company**



Amplly illustrated with photographs, Boeing's brochure, "Environment for Dynamic Career Growth," emphasizes detailed descriptions of achievements in pace-setting products and in research and development. Engineers are photographed in on-the-job assignments covering every phase of technical project. Boeing, today and tomorrow, sets the theme of environmental image, enhancing the applicant's ability to picture himself in one of these settings. Facilities of the company in Seattle and Renton, Wash., Wichita, Kan., and Cape Canaveral and Elgin Air Force Base, Fla., are indicated. Career advantages are presented in terms of professional environment, graduate study, management development, recognition for advancement, and specific company benefits.

Mr. Stanley M. Little, Dept. RB-1, PO Box 3822, Boeing Airplane Co., Dept. ED, Seattle 24, Wash.

CIRCLE 875 ON READER-SERVICE CARD

*Explore new areas
at IBM in*

MXATHEMA

At IBM, creative mathematicians are discovering important, new applications of mathematics in the electronic computer field. Long before actual construction of IBM's unique Magnetic Character Sensing Machine, for example, mathematicians were at work on a mathematical model, testing both the over-all design and the logic circuitry needed for character recognition. In another project, mathematicians employed large-scale computers to simulate, in a matter of weeks, eight years of engineering work which have yet to begin. Currently under study are vehicular penetration problems involving thousands of variables. Projects of this sort demand keen, discerning minds. If you have a flair for creative mathematics, you're the man we want to talk to.

You will enjoy unusual professional freedom and the support of a wealth of systems know-how. Comprehensive education programs are available, plus the assistance of specialists of many disciplines. Working independently or as a member of a small team, your contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

CAREERS AVAILABLE IN THESE AREAS...

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| Analog & digital computers | Experimental techniques | Probability theory |
| Applied mathematics | Field theory | Reliability |
| Circuit design | Human factors engineering | Scientific programming |
| Communications theory | Logic | Solid state |
| Computer system design & analysis | Mathematical & numerical analysis | Statistics |
| Control system research | Operations research | Switching theory |
| | | Theoretical physics |

Qualifications: B.S., M.S., or Ph.D. in Mathematics, Physics, Statistics, Engineering Science, or Electrical Engineering — and proven ability to assume important technical responsibilities in your sphere of interest.

ASSIGNMENTS NOW OPEN INCLUDE . . .

MATHEMATICIAN: to handle mathematical analysis of advanced scientific computer programming for solution of systems problems, differential equations, probability-type problems, photogrammetry problems.

STATISTICIAN: to solve analysis-of-variance and multiple-regression type problems; to design experiments for various engineering applications and select form of statistical analysis of greatest value; to give statistical support to engineering departments in such areas as reliability analysis and human factors engineering by developing statistical programs for the IBM 704. Statistical experience in engineering problems and thorough knowledge of statistical distribution functions necessary.

RESEARCH MATHEMATICIAN: to investigate statistical problems in control system research on digital computer; to study control problems of analog to digital conversion, with particular reference to matrix problems; to apply experience with networks, statistics, or communications theory to problems in computer design; to solve problems involving switching theory, probability and information theory, and coding.

MATHEMATICS

APPLIED MATHEMATICIAN: to undertake assignments involving knowledge of feedback control theory, data systems theory, servomechanisms, information theory, statistical models, heat flow, circuitry, magnetics, probability.

MATHEMATICIAN-PROGRAMMER: to specify and program elements of a sophisticated automatic programming system. Must have considerable experience in automatic programming research.

OPERATIONAL PROGRAMMER: to develop computer program techniques for real-time military applications, using game theory and systems simulation.

OPERATIONS RESEARCH MATHEMATICIAN: to evaluate closed loop systems consisting of computers, radar displays, and inertial equipment; to simulate advanced weapons systems in order to evaluate alternate design concepts; to analyze and design electromechanical systems, studying targets, tactics, and operational effectiveness. Experience in applying advanced mathematical techniques to weapons systems analysis and evaluation. Knowledge of probability and linear programming techniques.

For details, write, outlining background and interests, to:
Mr. R. E. Rodgers, Dept. 555 G-1
IBM Corporation
590 Madison Avenue
New York 22, N. Y.

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

CIRCLE 905 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • July 8, 1959

Collins Radio Company



"A Career With Collins" is an illustrated brochure describing the development of this company and outlining careers in three fields. Engineering opportunities exist in research and development, production and manufacturing, or industrial engineering. Formal training programs are available for new engineers as well as engineering students still in school. A background in physical sciences could lead to career in research and development, analytical work, planning or administration. Business management positions are also described. Itemization of employee benefits is included. Many on-the-job photographs show engineers in various project activities.

L. R. Nuss, Collins Radio Co., Dept. ED, Cedar Rapids, Iowa.

CIRCLE 876 ON READER-SERVICE CARD



The National Cash Register Company

The National Cash Register Company brochure "Where Will You Work?" indexes a variety of answers: opportunities, assignments, advancement, research, company history, engineering, benefits, recreation, Dayton area and how to apply. Of interest to the applicant particularly is a listing of typical assignments in the fields of physics, electrical engineering, mechanical engineering, and chemistry, as well as a listing of typical current fields of research interest. Within the engineering section, a structural diagram shows the relationship of various engineering projects. Company facilities and community facilities are fully illustrated.

Director of Scientific Placement, The National Cash Register Co., Dept. ED, Dayton 9, Ohio.

CIRCLE 877 ON READER-SERVICE CARD

Communication Engineers

Immediate Staff Build-Up on New, Integrated

COMMERCIAL & MILITARY PRODUCT DESIGN PROGRAMS

at General Electric's Communication Products Dept. in Lynchburg, Virginia

Serving both industrial and military customers, the Communication Products Department offers engineers a unique type of professional stimulation—through participation in *integrated* design and production programs in advanced communication systems.

Industrial products of Microwave Radio Relay, Mobile and Powerline Carrier Current communication systems comprise the major portion of Department sales. These are often related to other projects for the Department of Defense, such as our contract for design and manufacture of a 24 channel tropospheric scatter system.

Engineers here frequently have the opportunity to contribute to both types of programs.

Immediate openings for men with Project Engineering or Group Leading experience in these areas:

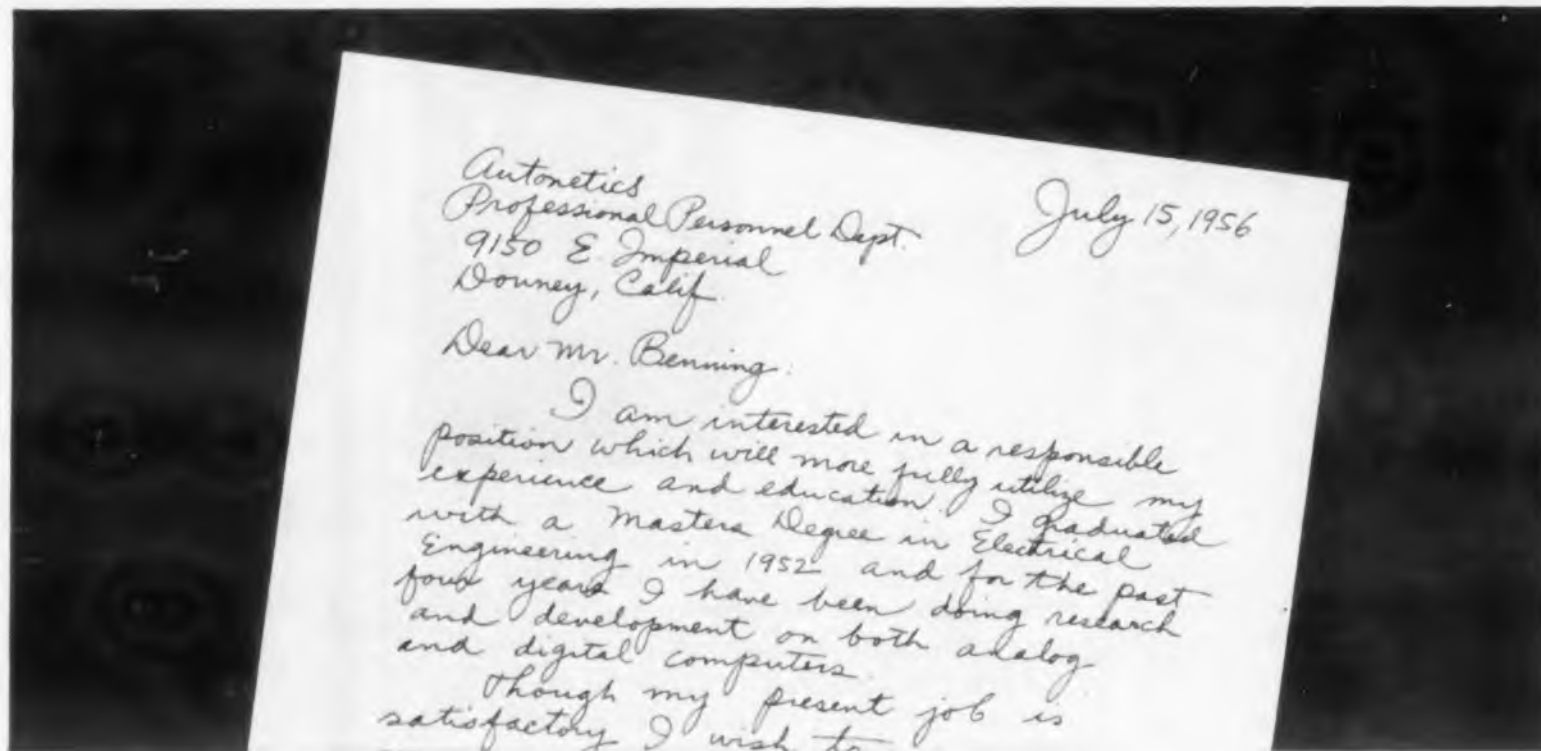
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Write for data sheets on the Department and literature describing the attractive residential city of Lynchburg. Address Mr. Arthur Guy, Section 76-MB.

COMMUNICATION PRODUCTS DEPT.
GENERAL ELECTRIC

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Lynchburg, Virginia

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This letter moved an engineer ahead 5 years

Two years ago a man took 10 minutes to write this letter. Today he enjoys the responsibility and professional standing in the Autonetics Division of North American that might have taken 5 years to achieve elsewhere.

THE 20TH CENTURY'S MOST INTERESTING OPPORTUNITIES FOR THE CREATIVE ENGINEER

Now under way at Autonetics are over 100 projects—military and non-military—involving some of the most arresting and advanced work to challenge the engineering mind today.

WHERE IS YOUR FIELD OF INTEREST?

Inertial Navigation Systems—for aircraft and naval vessels with the organization that successfully flew all-inertial autonavigators more than eight years ago—and whose many-generation family of ever-improved inertial systems for manned and unmanned vehicles have made over 800 successful flights.

Radars—like the lightweight, monopulse type that guides aircraft to targets through fog and darkness and provides all radar functions for both high and low level missions—air-search, automatic tracking, ground-mapping and terrain-avoidance.

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Information Processing Equipment—including airborne magnetic tape recorders, transistorized analog or digital computers for both the military and industry, and pace-setting numerical control systems for three-axis position and path control of machine tools for industry.

At finger-tip nearness Autonetics has unique experience, advanced tools and techniques plus precision machine shops turning out work to millionths of an inch tolerances in both developmental and volume quantities.

Opportunities have never been better—at every level of creative engineering from Preliminary research and design to Performance test—because **Autonetics is one of the few companies in the world designing and quantity-producing systems within the complete spectrum of electronics, electro-mechanics, control engineering and data processing.**

Write today and tell us what kind of creative engineering interests you (please include highlights of your education and experience).

Write V. G. Benning, Manager, Employment Services.
9150 E. Imperial Highway, Downey, California

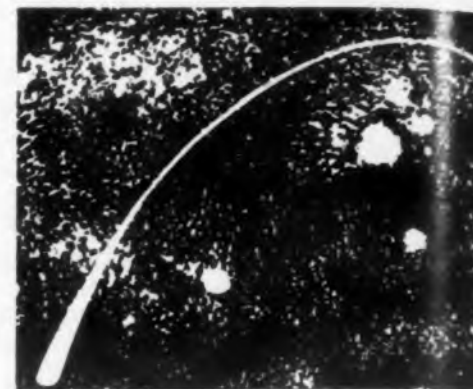
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NERVE CENTER OF THE NEW INDUSTRIAL ERA

CIRCLE 907 ON CAREER INQUIRY FORM



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Here is your chance to prove your ability doing *important* work on missile fuzing, beacons, guidance, packaging and related test equipment. We have key openings that offer you the opportunity to move ahead rapidly in your profession. At Bendix York, you benefit from the advantages of a small company atmosphere in a growing division of one of the nation's largest engineering and manufacturing corporations. Also, you'll enjoy the "good life" in our beautiful suburban community. Good salaries, all employee benefits.

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York Division
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CIRCLE 908 ON CAREER INQUIRY FORM
ELECTRONIC DESIGN • July 8, 1959

CAREER OPPORTUNITIES

Link Aviation Inc.



"There's a Place For You at Link" historically interprets this company for the new job applicant, points out engineering positions available in addition to research and development, manufacturing, field service, sales or finance. Benefits to all personnel are summarized. A pictorial view of life in Binghamton, New York is given.

Link Aviation, Inc., Dept. ED, Binghamton, N.Y.

CIRCLE 878 ON READER-SERVICE CARD



U. S. Civil Service

The United States Civil Service Commission announces examinations to fill top positions with the Army Ordnance Missile Command. Highly qualified applicants for the positions of electronic scientist, metallurgist, physicist, and engineer, are invited to apply. Aeronautical, electrical, chemical, electronic, mechanical, general and industrial engineers are needed. Positions to be filled are located in Huntsville, Alabama with the Redstone Arsenal, headquarters for the Army Ordnance Missile Command, the Army Ballistic Missile Agency, the Army Rocket and Guided Missile Agency, and the Ordnance Guided Missile School. The organization is concerned with research, development, and industrial activities of rocket, missile, and satellite programs, plus support of missile systems in the field.

Check your requirements against Announcement No. 5-35-7(59) which lists salaries, educational, physical and experience requirements for the positions noted above. Bulletin free from:

U. S. Civil Service Commission, Bureau of Departmental Operations, Dept. ED, Washington 25, D. C.

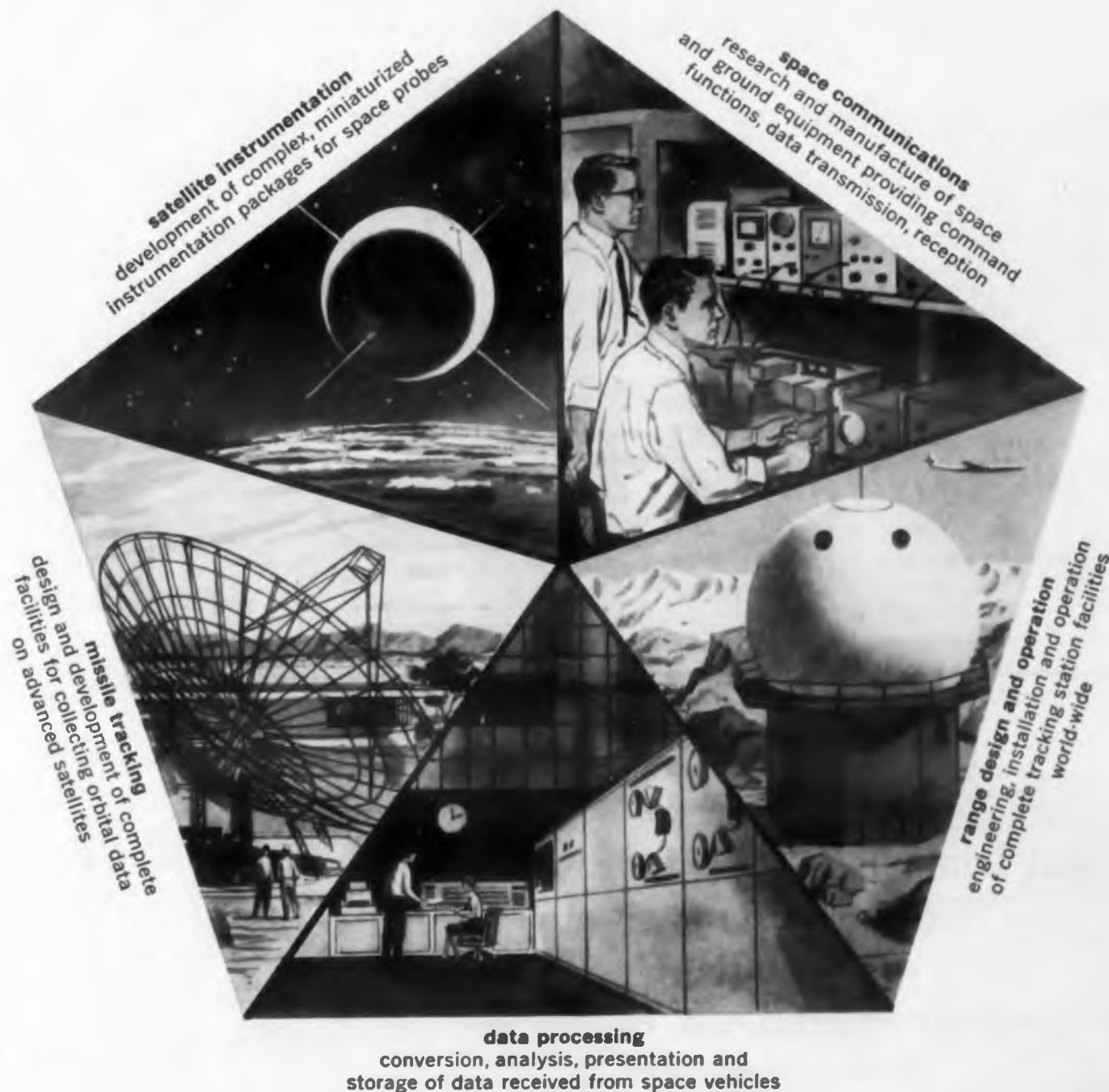
CIRCLE 879 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1959

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FIVE FACETS OF PHILCO IN CALIFORNIA

CAREERS



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A part of the Government and Industrial Division of Philco Corporation

CIRCLE 909 ON CAREER INQUIRY FORM

6518

65

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Have you had two or more years experience in the design of VHF or UHF transmitters?

... in airborne packaging?

... in transistor circuitry?

If you have, we want to talk to you.

Please send resume to **W. C. WALKER**
ENGINEERING EMPLOYMENT MANAGER



NORTH HOLLYWOOD, CALIFORNIA

Other High-Level Electronic Engineering Positions Available

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PHILCO

FAMOUS FOR **QUALITY** THE WORLD OVER

has immediate opportunities for
**Electronic Engineers
& Scientists**

IN PHILADELPHIA, PA.

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Transistorization, Microwave Development, Telemetering
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Missile Fuzing, Aerodynamics, Applied Mechanics

ELECTRONIC DATA PROCESSING

Product Planning, Systems Analysis, Memory Development
Input and Output, Test & Evaluation, Production Engineering
Programming, Field Service Engineers, Instructors & Writers

Send Confidential Resume to Mr. J. R. Barr, Engineering Employment Manager

PHILCO Government and Industrial Division
4780 Wissahickon Avenue, Philadelphia 44, Pa.

CIRCLE 911 ON CAREER INQUIRY FORM

ENGINEERS

ADVANCED CELESTIAL NAVIGATION SYSTEMS

Senior Project & Staff Positions. Qualifications should include previous responsible experience in analog and digital computers, advanced electronic techniques and navigation concepts.

AIR DATA INSTRUMENTS

Expansion of air data engineering department has created vacancies for engineers and designers (EE & ME) at all levels including Senior positions for especially qualified men in 1. pressure switches, 2. altitude and mach controllers, 3. ground support equipment for air data instruments—for advanced programs in supersonic and other classified instrument and control projects, as well as civil jet programs.

FIELD SERVICE ENGINEERS & TECHNICAL REPRESENTATIVES

For field service work on flight instrumentation. Requires electronic background with knowledge of electro-mechanical systems. Must be able to travel and/or relocate.

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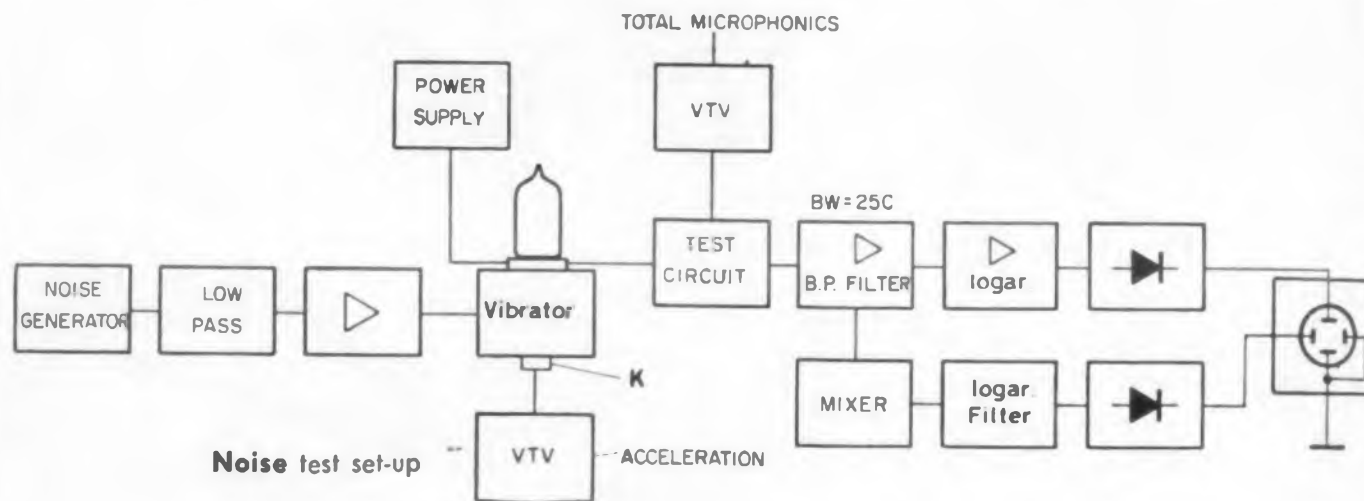
GERMAN ABSTRACTS

E. Brenner

Noise Acceleration For Tube Microphonics Measurements

THE SPECTRUM of tube microphonic noise is often obtained by first subjecting the tube to sinusoidal vibrations of adjustable frequency and then recording the output. Since the mechanical

elements in the tube generally have high Q, the peaks of the spectrum are often within narrow bands so that this type of analysis may consume up to 15 minutes per tube. When coupled with



Frequency Modulation With Control Inductance

IT IS well known that a saturable inductor in the tank circuit of an oscillator can be used to construct a frequency modulated signal source. The large modulating current and power requirements which powdered core coils demand, to-

gether with the associated biasing circuits, have placed this method in the realm of academic curiosities. The development of ferrite core coils which require lower control current amplitude, less space and can be biased with small permanent

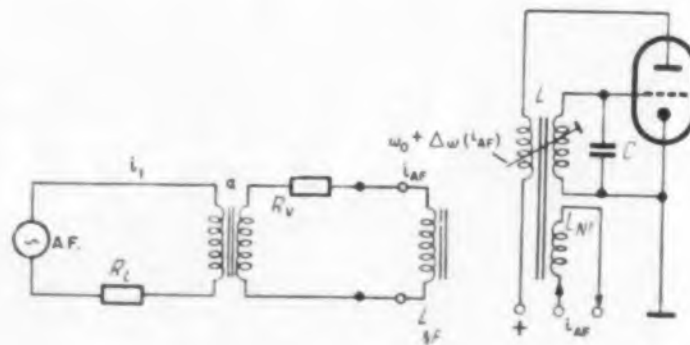


Fig. 1. "Principle of Inductance Control."

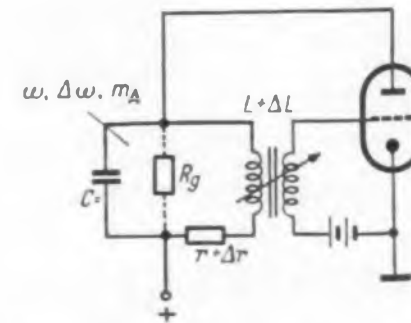


Fig. 2. "The movement of inductance produces frequency survey and amplitude modulation."

stroboscopic observation of the tube elements, good insight into the microphonic noise can be obtained by this method, especially if the data is supplemented by shock excitation tests.

The time required to carry out the spectrum analysis can be greatly reduced if acceleration due to uniform (white) noise is used since in that case all frequencies in the band of interest are applied at the same time.

The block diagram of a test system in which a noise source is used is shown in the figure. A noise source—low pass filter (10 kc)—power amplifier combination excites the vibrator. A transducer, K (Barium titanate), furnishes a signal which is proportional to the total acceleration. The tube under test is connected to a standard test circuit and the total microphonic noise is measured. In addition, the microphonic noise signal is passed through a band pass filter (bandwidth 25 cps) whose center frequency is adjustable (e.g. motor drive). The selected portion of the spectrum is logarithmically amplified and the frequency response curve is displayed on the screen of an oscilloscope. Experimental results show that reproducible spectrograms are obtained when the frequency band is covered in 15 sec.

Abstracted from an article by H. Hellmann, *Frequenz*, Vol. 13, No. 3, March 1959, pp 83-89.

magnets motivate a "new look" in inductance variation for fm signal generation.

Using inductance control, permeability variations of 30 per cent, corresponding to frequency swings of 15 per cent, can be achieved with ferrite core toroids. The basic circuit of such an oscillator is shown in Fig. 1.

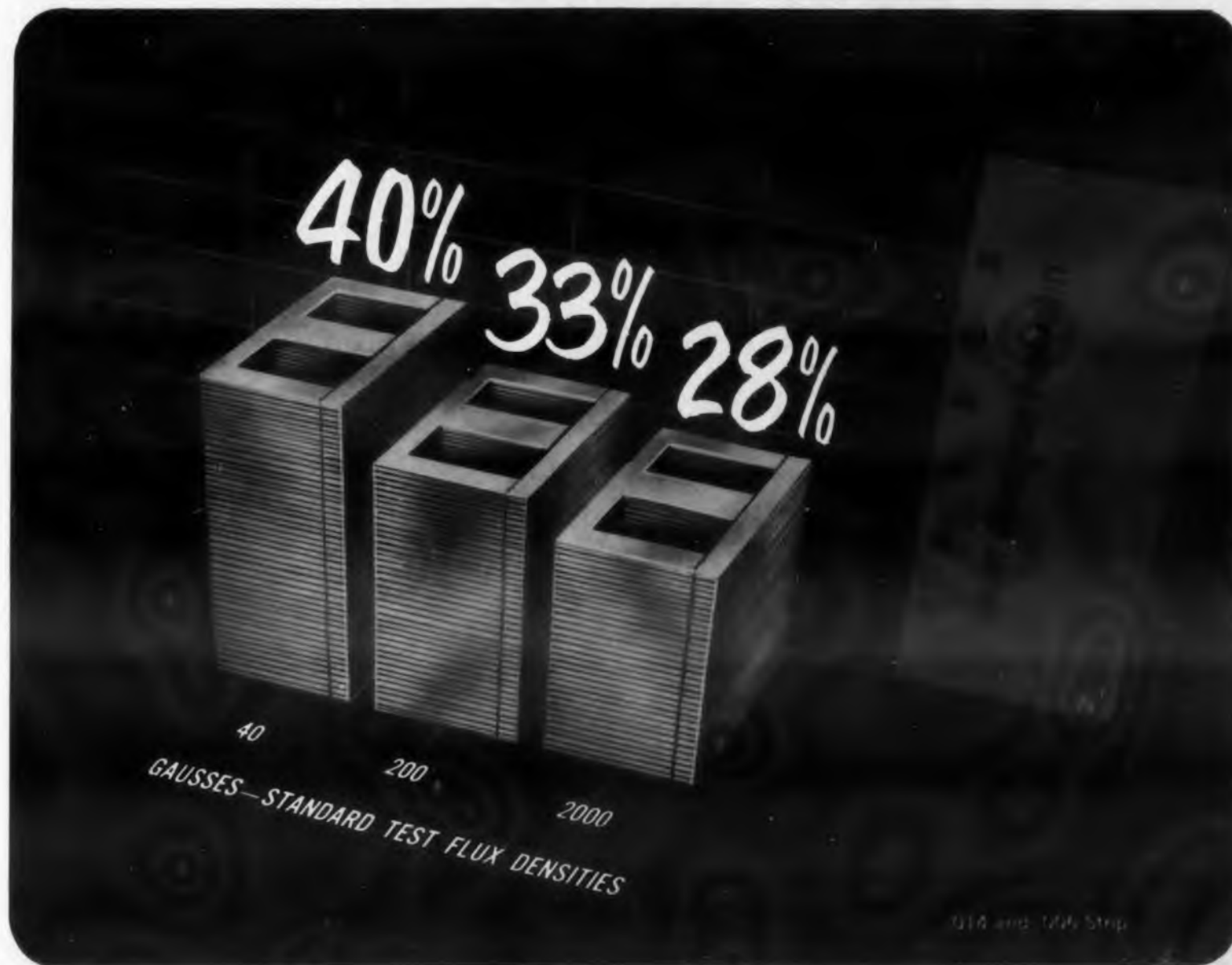
In Fig. 2 a constant amplitude is produced if C/rC is independent of frequency. For small fractional changes in frequency, $d = \Delta f/f$, the amplitude modulation produced is given by the index

$$m_A = d^2/(1+d^2)$$

Thus for 75 kc deviation, the amplitude modulation index is 47 per cent at 250 kc, 3.5 per cent at 1 mc and only 0.8 per cent at 20 mc. In the original paper, methods of minimizing am as well as the frequency limits of inductance-controlled modulated fm sources are treated. On the basis of analytical and experimental results it is concluded that ferrites are well suited for miniature and control signal generators and compare favorably with reactance tube circuits.

Abstracted from an article by W. Moortgat-Pick, *Frequenz*, Vol. 13, No. 4, April 1959, pp 117-120.

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TAPE WOUND CORES of High Permeability Materials Arnold tape wound cores are available made of Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750 Electrical Metal, Silectron, or the new rectangular-loop material, Supermendur. All except Supermendur cores are available in standard tape thicknesses of 1/2, 1, 2, 4 or 12-mils.

Toroidal cores are made in 30 standard sizes with protective nylon or aluminum cases. Special sizes of toroidal cores are produced to individual requirements. Write for Bulletin TC-101A. (TC-113A for Supermendur Cores.)

BOBBIN CORES Arnold bobbin cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps to suit the ultimate use of the core in electronic computer assemblies. Magnetic materials usually employed are Deltamax and Square Permalloy in standard thicknesses of 1, 1/2, 1/4 and 1/8 mil. Bobbins are supplied in ceramic or stainless steel. Write for Bulletin TC-108A.

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MO-PERMALLOY POWDER CORES Available in a wide range of sizes, from .260" OD to 5.218" OD. They are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.

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IRON POWDER CORES A wide selection of cores is available, from simple cylinders to special cores of complicated design. The line includes all standard types of threaded cores, cup, sleeve, slug and cylindrical insert cores: for use in antenna and RF coils, oscillator coils, IF coils, perm tuning, FM coils, television coils, noise filter coils, induction heating and bombardier coils, and other low frequency applications. Preferred sizes are carried in warehouse stock for quick shipment. A standard series of iron powder toroids is also manufactured, conforming to the standard sizes proposed by the Metal Powder Industries. Write for Bulletin PC-109.

SENDUST POWDER CORES Available in a wide selection of sizes, ranging from .800" OD to 3.346" OD, and in permeabilities of 10, 13, 25, 30, 50 and 80, although not all sizes are available in all permeabilities. They possess magnetic properties generally superior to iron powder cores, but inferior to Mo-Permalloy powder cores in the audio and carrier frequency range. Write for Bulletin SDC-110.

celerometers, phono pickups, microphones, ultrasonic grinding and cleaning devices and underwater signaling devices. For more information, write for Bulletin CM-116.

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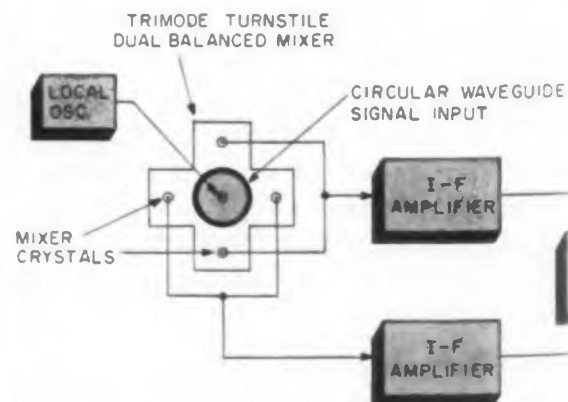
ABSTRACTS

Microwave
Polarimeter
Displays
Polarization Directly

Instantaneous viewing of microwave polarization achieved with trimode turnstile.

INSTANTANEOUS viewing of the polarization of an input signal is possible with a simple microwave polarimeter technique. Using a trimode turnstile junction in a precision dual balanced mixer for circular waveguide, the polarimeter is capable of high accuracy over a wide frequency band, achieved through symmetry of the plumbing. Amplitude errors of less than 2 percent over a 12-percent band are possible.

Used as a precision dual balanced mixer with circular waveguide input, the trimode turnstile waveguide junction is the key to a simple microwave polarimeter technique which permits in-



Block diagram of the microwave polarimeter.

ELECTRONIC DESIGN • July 8, 1959

stantaneous viewing of input polarization. Through linear mixing, the relative phase and amplitude of orthogonal components of an arbitrarily polarized input signal are preserved in the i-f outputs of the two mixers. After amplification, these two i-f signals are applied to orthogonal deflection planes of a cathode-ray tube to obtain an accurate, instantaneous picture of input polarization. Circular polarization generates a circle; elliptical polarization, an ellipse; and linear polarization, a line which indicates the plane of polarization. In certain applications, a variation of the method permits direct i-f recording of the polarization information. The polarimeter technique has application in microwave communication, radar, countermeasures, radio astronomy, antenna studies, and in laboratory measurements of polarization.

Under conditions of linear mixing, the phase and amplitude relationships of the orthogonal components of the input signal to the circular waveguide will be accurately preserved in the i-f signal outputs of the two balanced mixers, regardless of the i-f chosen. The high degree of accuracy of this conversion operation, which can be achieved because of symmetry of the trimode turnstile mixer, is most important in its application to a precision polarimeter. The simple manner in which these i-f signals are utilized to make visible the polarization characteristics of the input signal is illustrated by the block diagram. Typically, the two i-f signals are applied to orthogonal deflection planes of a cathode-ray tube, after the necessary amplification, to obtain a Lissajous figure which is a pictorial representation of the input signal polarization.

Use Commercial Oscilloscopes

The commercial availability of high-gain, direct-coupled, "X-Y" type oscilloscopes with wide-band amplifiers providing identical phase and gain characteristics in both x and y planes, simplifies the presentation problem for many applications. Two types of commercial oscilloscopes may be used, a Weston model 983, and a Tektronix type 536. The Weston instrument has identical x - and y -axis amplifiers with a 3 db bandwidth of 4.5 mc and relative phase shift within 2 deg to 1 mc. The Tektronix 536 employs identical plug-in amplifiers for both axes. For the polarimeter application, type 53/54B, wide-band, high-gain amplifiers is used. Bandwidth is greater than 10 mc, with less than 1 deg of phase error. Excellent presentations have been obtained using separate reflex klystrons for signal source and for L.O. These are tuned to produce an i-f beat which is within the passband of the scope amplifiers.

Abstracted from U. S. Naval Research Laboratory, NRL Report 5214, *An Instantaneous Microwave Polarimeter Technique* by P. J. Allen and R. D. Tompkins.

1 1/2

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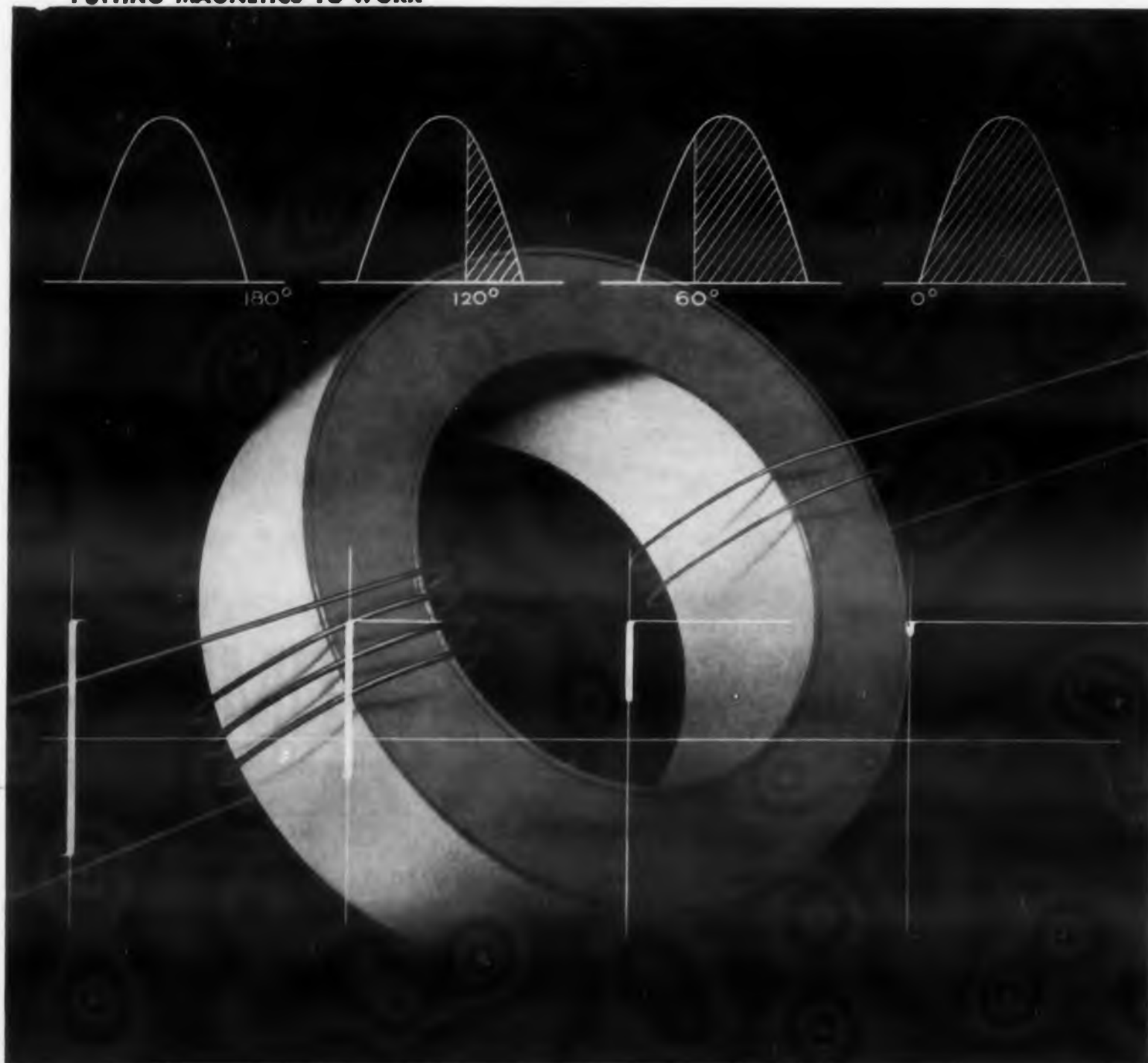


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REPORT BRIEFS

Electron Tube Shorts and Discontinuities

This investigation concerns the problem of short-testing electron tubes. In the past, repeatability of short detectors was evaluated with tubes. This was not satisfactory because most temporary shorts, are by nature, not repeatable. A Simulated Short Generator was developed and an evaluation of different detectors was made. The Simulated Short Generator was also used to study the levels at which shorts become objectionable in electronic equipment. *Study of Electron Tube Shorts and Discontinuities, William A. Barrows and Clarence L. Reynolds, General Electric Co., Owensboro, Ky., June 58, 188 pp, \$3.00. Order PB 151489 from OTS, Washington 25, D.C.*

Reliability Prediction and Ground Equipment

A progress report on the development of a prediction technique which will enable a designer to predict the quantitative reliability his equipment will achieve in the field. It is felt the results to date are sufficiently significant to be reported, and indicate the technique is valid enough to be used by engineers and scientists for analyzing and increasing the reliability of their equipments. The report describes the development of a technique for predicting ground electronic equipment reliability. *Reliability Prediction and Test Results on USAF Ground Electronic Equipment, Joseph J. Naresky, Rome Air Development Center, Griffiss AFB, N. Y., July 58, 25 pp, \$0.75. Order PB 151041 from OTS, Washington 25, D. C.*

Transistor IF and RF Amplifiers

Miniaturized transistorized if amplifiers which can withstand shock, vibration, and temperature conditions between 0 C and 70 C have been designed and constructed and have the following characteristics: Center Frequency, 1 mc, 15 mc; 6 db Bandwidth, 8.8 kc, 13.0 kc; 60 db Bandwidth, 21.2 kc, 25.0 kc; Power Gain, 80 db, 76 db. A 30 mc if amplifier breadboard with a 51.7 db gain, a 6 db bandwidth of 150 kc, and a 60 db bandwidth of 500 kc has also been constructed. Three permeability-type miniature rf tuners to track three tuned circuits in the frequency range of 1.5 to 5.0 mc, 5.0 to 15.0 mc, and 15 to 45 mc have been designed and constructed. A technique of temperature compensating high-Q ferrite-cored coils have been discovered. *Radio Frequency Tuners and IF Amplifiers for Transistors, Edward A. Abbott, Emerson Radio and Phonograph Corp., Jersey City, N.J., Oct. 58, 28 pp, \$0.75. Order PB 151545 from OTS, Washington 25, D.C.*

Improved Guns for Cathode Ray Tubes

This contract calls for the development of a tube directly interchangeable with the 10UP14A, but improved with respect to focus quality and change of focus with drive. Line widths much better than those specified for the 10UP14A were attained, but difficulty was encountered in focusing screen currents of the order of one ma. The chief causes were focus lens distortion and space charge defocusing. *Development of Improved Guns for Cathode Ray Tubes*, D. W. Clark, Radio Corp. of America, Harrison, N.J., Oct. 58, 21 pp, \$0.75. Order PB 151503 from OTS, Washington 25, D. C.

High-Power Traveling-Wave Tubes

In the cloverleaf traveling-wave tube project, the most recent tube built, after some modification, operated at a small-signal gain approaching 40 db without serious instability. A maximum power output exceeding 3 megawatts was obtained, with an efficiency of approximately 33 per cent, and a gain of almost 35 db. The observed bandwidth under these conditions was 9 to 10 per cent. In the high-power, broadband tube structures project, a tube is now in design and construction of some components has started. This tube uses the 24-loop section of the "centipede" design as the basic structure. *Development of High-Power Traveling-wave and Hybrid Tubes*, M. Chodorow, Microwave Lab., Stanford U., Calif., May 58, 29 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 136050 from Library of Congress, Washington 25, D. C.

Radio-Isotope Thermoelectric Generator

This report consists of five sections, each of which is part of a predevelopment feasibility study of the radio-isotope thermo-electric generator. The program is described in general, and thermoelectric design considerations, radio-isotope source design and shielding are examined in detail. The design of a handling facility is described and a typical electronic application of the device is discussed. The conclusions of this feasibility study are that it is possible to build a practical model of the radio-isotope thermoelectric generator and that such a device will have certain unique and desirable performance characteristics not presently attainable by conventional methods. *Design Considerations for the Radio-isotope Thermoelectric Generator*, F. B. Brauer, J. L. Briggs and others, Rome Air Development Center, Griffiss AFB, N.Y., Jan. 57, 87 pp, Microfilm \$4.80, Photocopy \$13.80. Order PB 135315 from Library of Congress, Washington 25, D. C.

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Electronic Engineering

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REPORT BRIEFS

Reduced Reflections in Phosphors

The theory and process are given for preparation of cathode-ray tubes with reduced phosphor reflection obtained by incorporation of the phosphor in a glaze of close refraction index match. Resulting tubes provide an improvement of two and a half times in ambient light reflection. *Reduced Reflections in Phosphors: Theory and Experiment*, John F. Dreyer, Polacoat, Inc., Blue Ash, Ohio, Oct. 58, 12 pp, \$0.50. Order PB 151486 from OTS, Washington 25, D. C.

Power Transformer Design

A new and improved method for the design of certain types of electronic power transformers is described. Satisfactory designs can be obtained with little or no repetitive trial procedures. The following types of transformers have been investigated during the current contract: (1) Transformers with unbalanced magnetization; (2) Current-limiting or high-reactance transformers; (3) Current-limiting transformers with unbalanced magnetization; (4) Vibrator-supply transformers; (5) Low-capacitance transformers; (6) Instrument transformers. *Research and Development of New Design Method for Power Transformer*, G. Forster, Armour Research Foundation, Chicago, Ill., Mar. 56, 305 pp, \$5.00. Order PB 131968 from OTS, Washington 25, D.C.

Punch-Thru Diode

The punch-thru diode is a planar junction diode with a very narrow base width. Three techniques which have been used to manufacture punch-thru diodes are described. The current-voltage relationship of this diode is a function of the degree of imperfection of the ohmic contact. Because of its narrow base width, the diode is a high-frequency device both for small-signal applications and for switching applications. Small signal applications at uhf are discussed. In switching applications the reverse recovery time is limited as much by junction capacitance as by hole-storage effects. A switching-diode design that switches at speeds up to 5 M cps is described. The low forward-voltage drop and high-frequency capacity make this switching diode unique. *Punch-Thru Diode (Operation As A Narrow-Base Diode)*, R. H. Rediker and D. E. Sawyer, Lincoln Lab., MIT, Lexington, Mass., 27 Nov. 58, 28 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 130878 from Library of Congress, Washington 25, D. C.

Teflon Hook-Up Wire

The object of this program is the evaluation of commercially available Teflon insulated hook-up wire to enable the establishment of specification requirements for the procurement of such wire. The physical and electrical properties within the temperature range of -65 to $+250$ C have been evaluated in accordance with prescribed test procedures. *Evaluation of Teflon Hook-Up Wire*, LeRoy Allen Mullin, Research Inst., Syracuse U., N.Y., June 56, 269 pp, Microfilm \$11.10, Photocopy \$40.10. Order PB 136002 from Library of Congress, Washington 25, D.C.

Rapid Response Magnetic Amplifiers

Development of rapid response magnetic amplifiers and their associated supplies are reported. The successful development of two static magnetic power supplies is described: that of a 64.8-kc five-stage cascaded unit and that of a 6-kc single-stage unit. A rapid response magnetic amplifier with a power gain of 20,000 and a time response of 140 μ sec was constructed. *Rapid Response Magnetic Amplifiers*, Peter H. Sawitz, American Research and Mfg. Corp., Rockville, Md., Sept. 58, 54 pp, \$1.50. Order PB 151458 from OTS, Washington 25, D.C.

Accelerometer Shake Tests

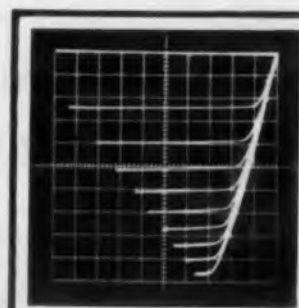
Data are presented for operational investigation of specified manufacturer's characteristics for two types of acceleration transducers. The test data presented indicate that the performance of the transducers tested only approximates that specified by the manufacturer. The great desirability of vibrational calibration of accelerometers just prior to use is clearly indicated. *Results of Accelerometer Shake Tests*, Max I. Rothman, Air Force Missile Development Center, Holloman AFB, N. Mex., Aug. 58, 11 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 136055 from Library of Congress, Washington 25, D.C.

Industrial Preparedness Study on Power Transistors

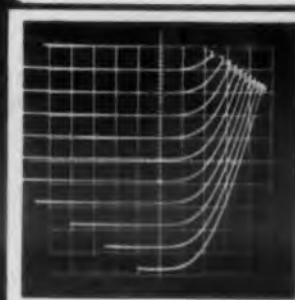
A study has begun on the low voltage operation of present power transistor types with a view to changing designs slightly to improve performance at low voltages. Equipment has been set up for making silicon alloy junctions. This equipment is now in operation and initial results on the few transistors and transistors made so far look promising. *Industrial Preparedness Study on Power Transistors*, P. W. Erickson and J. F. Battey, Transistor Products, Inc., Waltham, Mass., July 55, 27 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 136090 from Library of Congress, Washington 25, D.C.

Displays 4 to 12 curves
per family
with input current
from

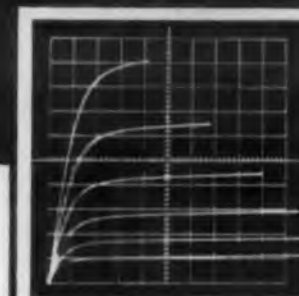
1 MICROAMP/STEP
to
200 MILLIAMPS/STEP



HIGH COLLECTOR CURRENT
PNP transistor, collector current vs collector voltage with constant-current base steps. Collector sweep is 0 to 5 v with a 0.25-ohm load, base current is 1000 ma/step. Vertical deflection is 1000 ma/div, horizontal 0.5 v/div.



HIGH INPUT CURRENT
PNP transistor, collector current vs collector voltage with base grounded and constant-current emitter steps. Collector sweep is 0 to 1.5 v, emitter current 200 ma/step. Vertical deflection is 200 ma/div, horizontal 0.1 v/div. Zero voltage is at center scale.



LOW INPUT CURRENT
NPN transistor, collector current vs collector voltage with constant-current base steps. Collector sweep is 0 to 1.5 v, base current 1 microamp/step. Vertical deflection is 10 microamp/div, horizontal 0.1 v/div.

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Dissipation limiting resistors—0 to 100-kilohms in 17 steps.

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Collector current, 16 steps from 0.01 ma/div to 1000 ma/div.
Pushbuttons are provided for multiplying each current step by 2 and dividing by 10, increasing the current range to 0.001 to 2000 ma/div.

Horizontal axis—

Collector volts, 11 steps from 0.01 v/div to 20 v/div.

Both axes—

Base volts, 6 steps from 0.01 v/div to 0.5 v/div.
Base current, 17 steps from 0.001 ma/div to 200 ma/div.
Base source volts, 5 steps from 0.01 v/div to 0.2 v/div.

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Select either common-emitter or common-base configuration.

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REPORT BRIEFS

Ferroelectric Devices

An investigation of ferroelectric crystals and their utilization in ferroelectric second-harmonic amplifiers has demonstrated that such amplifiers are impractical unless much better materials become available. Amplifiers using barium titanate crystals and having power gain-bandwidth products of 56,000 have been constructed. The principal limitation for successful operation is crystal heating due to hysteresis losses at high fields. *Ferroelectric Devices*, Richard A. Fotland and Edward F. Mayer, Horizons, Inc., Cleveland, Ohio, Oct. 58, 75 pp, \$2.00. Order PB 151484 from OTS, Washington 25, D.C.

Gas-Filled Clipper Tube

The investigation clearly indicates that a gas tube clipper in an end of line matched impedance clipper circuit offers most advantageous operation at all power levels up to the 5948/1754 level. Included in this report is information necessary for a designer to compute the desired ratings of a clipper tube from the design data of the modulator circuit. The results of this report will be used to design an optimum clipper tube for service at the 5948/1754 power level. *Research Study and Development of Clipper Tube*, Arthur J. Moses, Chatham Electronics, Livingston, N.J., 30 Sept. 56, 208 pp, Microfilm \$9.30, Photocopy \$31.80. Order PB 136040 from Library of Congress, Washington 25, D.C.

Saint Computer

The Saint computer is a Semiautomatic Analog Intercept computer, the word intercept being used as a general term to include the interdiction and return-to-base functions. The Saint computer has the capability of directing an attack at any heading relative to the target. The computer predicts the entire intercept path and displays this prediction on a PPI; the prediction is an integral part of the computation. *Saint Computer, An Analysis*, John A. Lyden, Jr., Air Force Cambridge Research Center, Boston, Mass., May 58, 56 pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 136045 from Library of Congress, Washington 25, D.C.

Sensitive Phase Meter

This meter is capable of measuring the very small time difference that exists between corresponding pulses of two nearly coincident pulse chains. This method utilizes electronic switching techniques that periodically reverse the two input connections to a phase indicator. The output of

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ELECTRONIC DESIGN • July 8, 1959

the phase indicator is integrated and the resulting waveform is an ac signal, at the switching rate, whose amplitude is directly proportional to the time difference between the input signals. *Sensitive Phase Meter*, Frank Vratovic, *Diamond Ordnance Fuse Labs.*, Washington, D.C., 20 June 58, 11 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 136027 from Library of Congress, Washington 25, D.C.

Crystal-Controlled S-Band Exciter

A crystal-controlled S-band exciter designed and developed for application in the transmitter of a high-performance MTI radar has proved that crystal control of S-band radar transmitters is feasible and results in greater frequency stability than obtainable with triode and klystron stalos. Construction and measurement techniques, technical data, and a derivation for frequency stability are presented. *Crystal-Controlled S-Band Exciter*, R. Allen and H. Whitney, *Air Force Cambridge Research Center*, Bedford, Mass., May 58, 25 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 136048 from Library of Congress, Washington 25, D.C.

15-Channel Transistorized Commutator

Evaluation of a 15-channel transistorized multi-plexer designed for use in a new PAM-FM telemeter or as a commutator in conjunction with existing systems. Tests were made to determine linearity, sensitivity, zero-signal offset, channel uniformity, and the effects of changes in power supply voltage, signal-source impedance, and output loading. The packaging was designed to minimize the effects of temperature, humidity, vibration, and shock. *Evaluation of NOLC 15-Channel Transistorized Commutator*, T. Burr Jackson, *Naval Ordnance Lab.*, Corona, Calif. Apr. 1958, 20 pp, microfilm \$3.60, photocopy \$9.30. Order PB 135339 from Library of Congress, Washington 25, D.C.

Antennas For Scatter

Unlike the signal received over a line-of-sight path, scatter signals arrive at the receiving site from a continuum of directions with intensities that may be described by a directional pattern similar to an antenna pattern. This report shows how the mean signal power available at the terminals of a receiving antenna may be expressed in terms of the antenna pattern and of a pattern of incoming power density. Methods of measuring the power-density pattern at the receiving site are discussed. *Topics in the Design Antennas for Scatter*, John Granlund, *Lincoln Lab.*, MIT, Lexington, Mass., 23 Nov. 56, 120 pp, Microfilm \$6.00, Photocopy \$18.30. Order PB 130880 from Library of Congress, Washington 25, D. C.

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CASE HISTORIES



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STANDARDS AND SPECS

Sherman H. Hubelbank

Drawings

MIL-D-8510B(ASG), PREPARATION OF DRAWINGS, AND PHOTOGRAPHIC AND CONTACT REPRODUCIBLES, 18 DECEMBER 1958

Reproducibles of undimensioned drawings are of two types. Type I are reduced size reproducible photographic negatives of full size undimensioned drawings. Type II are full size reproducible duplicates of full size undimensioned drawings.

MIL-M-8857(ASG), REQUIREMENTS FOR MICROFILM OF ENGINEERING DRAWINGS AND RELATED DATA, 1 NOVEMBER 1958

This spec requires the furnishing of microfilm, electric accounting machine cards, and a microfilm index. Microfilm shall be furnished for end-article drawings and support equipment drawings, in addition to contractor's standards and specs. Electric accounting machine cards shall be submitted for each repairable vendor item applicable to the end article.

Repair Parts

MIL-E-17362C(SHIPS), ELECTRONIC REPAIR PARTS REQUIREMENTS, PROCEDURES FOR STOCK NUMBERING AND ASSIGNMENT OF GOVERNMENT NOMENCLATURE, 20 JANUARY 1959

Detailed procedures, terms, and conditions governing the selection and furnishing of repair parts are covered in this spec. In addition, the requirements for the preparation and submission of provisioning technical documentation are established. Also covered are the procedures for obtaining Government assigned nomenclature for electronic equipment and for obtaining Federal stock numbers for items furnished under the contract.

MIL-P-15137B(SHIPS), PROVISIONING AND TECHNICAL DOCUMENTATION FOR REPAIR PARTS FOR ELECTRICAL AND MECHANICAL EQUIPMENT (NAVAL SHIPBOARD USE), 20 JANUARY 1959

Covered in this spec are procedures for identifying, cataloging, assigning stock numbers and determining requirements for repair parts test equipment, and support equipment. Additionally, procedures are established for stock number assignment and the preparation of provisioning documentation.

Harnesses

MIL-H 15362B(AER), GENERAL SPECIFICATION FOR AVIONIC EQUIPMENT TEST BENCH HARNESSSES, 15 SEPTEMBER 1958

The general requirements for the design and fabrication of test bench harnesses for maintaining avionic equipment are covered in this spec. This spec is intended for use as the basic spec for developmental and initial production contracts where a detail spec does not exist.

Materials

NBS CIRCULAR 552, STANDARD MATERIALS ISSUED BY THE NATIONAL BUREAU OF STANDARDS, 8 APRIL 1959

This circular lists the standard materials issued by the Bureau and their prices. Information on certified compositions, properties, and purchase procedures are given. About 250 of the samples are of certified composition; some 100 of these have been prepared specifically for use in spectroscopic analysis. Copies of this publication are available from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., for 35 cents.

Magnetic Core

ASTM A 346058, STANDARD METHOD OF TEST FOR A-C MAGNETIC PROPERTIES OF LAMINATED CORE SPECIMENS

This standard provides a method of test and a description of the proper type of instrumentation which should reduce errors to below 5%. Copies of this standard are available from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

Copper Magnet Wire

Four new ASA standards for copper magnet wire used in the manufacture of electrical apparatus have been published. Sponsored by NEMA, the new standards cover products designed and manufactured to coordinate with performance requirements of AIEE for insulating material in a variety of classes. The new standards are:

C9.8-1958, SINGLE AND HEAVY NYLON-COATED ROUND COPPER MAGNET WIRE (NEMA MW6-1957)

C9.9-1958, SINGLE-PAPER-COVERED ROUND COPPER WIRE (NEMA MW31-1956)

C9.10-1958, PAPER-COVERED RECTANGULAR AND SQUARE COPPER MAGNET WIRE (NEMA MW33-1957)

C9.11-1958, GLASS-FIBER-COVERED RECTANGULAR AND SQUARE COPPER MAGNET WIRE (NEMA MW42-1957)



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These resistors are now available in three sizes:

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|------|----------|------------|
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| N-70 | 1/2 watt | 1.0 megohm |

All ratings at 70°C., derating to 150°C.

Even after a full 1,000 hours of load-life tests, change in resistance of these

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Here are typical data for other performance characteristics:

| | |
|---------------------|-----------|
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| Effect of solder | 0.02% |
| Shelf life (12 mo.) | 0.2% |
| Voltage coef. | 0.001%/v |
| Temp. coef. | 0.02%/°C. |
| Hot spot (max.) | 150°C. |
| Short-time overload | 0.03% |

For more complete information on these resistors and other Corning miniature components, write to Corning Glass Works, 540 High Street, Bradford, Pa. Or contact our sales offices in New York, Chicago, or Los Angeles.



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STANDARDS AND SPECS

Materials Handbook

MILITARY HANDBOOK H1B, CROSS INDEX OF CHEMICALLY EQUIVALENT SPECIFICATIONS AND IDENTIFICATION CODE (FERROUS AND NONFERROUS ALLOYS)

A single five-digit code number is established for ferrous and nonferrous alloys of similar compositions covered by a variety of specs. The handbook makes it easier to prepare raw material requirements for bills of materials. The publication also permits ready comparison of material compositions. Copies are available from the Government Printing Office, Washington 25, D.C., for \$1.75. Order this 366-page edition by specifying Catalog No. D7.6/2:1B.

Electron Tubes

ELECTRON TUBES, TECHNIQUES FOR APPLICATION OF IN MILITARY EQUIPMENT

This handbook is intended to provide guidance to design engineers in the application of electron tubes in military electronic equipment. Tube properties and statistical concepts are discussed in Part I. These properties and concepts are discussed in Part II with circuit design. Part III contains numerical and graphical information and special design data. Manufacturer's life test data on the tube property behavior of these specific types are presented in Part IV. This 684-page publication is available from the Government Printing Office, Washington 25, D.C., for \$3.25.

Units and Symbols

ISO R31, PART 2, QUANTITIES AND UNITS OF PERIODIC AND RELATED PHENOMENA

The second part of an international agreement on units and on symbols for quantities and units used in various fields of science and technology has been published by the International Organization for Standardization (ISO). It includes the following basic units of measurement: meter for length, kilogram for mass, second for time, ampere for electric current, degree Kelvin for thermodynamic temperature, and candela for luminous intensity. It also has standard international symbols, abbreviations, definitions, and conversion factors for these basic units, as well as for many other widely used units, such as the inch, the fathom, the gallon, the bushel, and the barrel. The conversion factor for the inch is established at exactly 25.4 millimeters. This is the same as the conversion factor which will become legal in the U.S., England, and Canada this year. Part 1 and Part 2 are available from American Standards Association, 70 E. 45th St., New York 17, N.Y., for \$1.80 and \$1.20 respectively.

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ELECTRONIC DESIGN • July 8, 1959

Nomenclature and Nameplates

MIL-N-18307C(ASG), NOMENCLATURE AND NAMEPLATES FOR AERONAUTICAL ELECTRONIC EQUIPMENT, 1 OCTOBER 1958

This spec establishes the requirements and procedures for obtaining assignment of "AN" (also known as "JCENS") and "ANA" nomenclature. In addition, it covers approval of nameplates or marking methods. Procedures outlined in this spec are to be used for equipment used by the Bureau of Aeronautics, Department of the Navy, and the Air Force.

Capacitors

IEC PUBLICATION 103, ALUMINUM ELECTROLYTIC CAPACITORS FOR GENERAL PURPOSE USE

Polarized electrolytic capacitors with aluminum electrodes are covered in this standard. These capacitors are intended for general purpose application in telecommunication equipment and in electronic devices where the ambient temperature is not below -25°C . Established are requirements for judging the mechanical, electrical and climatic properties of these capacitors. Copies of this publication are available from the American Standards Association, 70 E. 45th St., New York 17, N.Y., for \$3.20 per copy.

MIL-C-21720(SHIPS), CAPACITORS, FIXED, SOLID ELECTROLYTE, TANTALUM, 29 DECEMBER 1958

Capacitors covered by this spec are polarized, tantalum, solid electrolyte, fixed types. These capacitors are intended for use in coupling, by-pass, and other applications where the ac component does not exceed 5% of the dc voltage rating. Low-voltage applications are the primary intended use for these capacitors where stability, size and shelf life characteristics are important factors. Transistor circuits are typical applications. A typical type designation is CS12BB2R2K.

MIL-C-18312A(NAVY), CAPACITORS, FIXED, PAPER (MYLAR) DIELECTRIC CONSTRUCTION, DIRECT CURRENT, HERMETICALLY SEALED METALLIC CASE, 25 NOVEMBER 1958

These capacitors are intended for use in power supply filter circuits, by-pass applications and other applications where the ac component of the voltage is small with respect to the dc rating. In addition, they may be used where high values of insulation resistance are not essential and where occasional momentary breakdown can be tolerated. Momentary breakdown is defined as one or a series of rapidly succeeding capacitor discharges evidenced by abrupt decreases in insulation resistance of values below the limits specified and followed by restoration of the resistance to a value above this point. Typical designation of capacitors meeting this spec is: CH70B1NF605M.



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Nickelonic News

VOL. 1 DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS NS 7

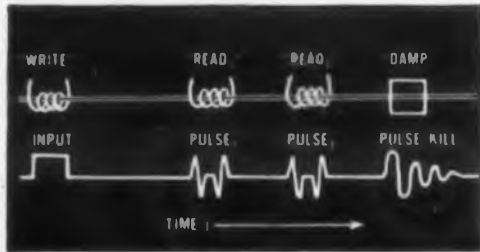


Magnetostriiction of Nickel drives Delttime data storage unit. With these units some 15 million bits of data could be handled in a 3x7x7 foot space, engineers estimate.

Shock waves in Nickel "store" 1500 bits of information

MAMARONECK, N. Y.: Magnetostriiction produces shock waves in Nickel that travel one foot in about 63 micro-seconds. Delttime, Inc. uses this property of Nickel to build electronic delay lines. Their latest is a data storage unit that packs eleven 300-microsecond delays in a small space. Ten lines "store" 150 bits of data each, the other "clocks."

Center rod of unit (shown with plastic cover to reveal detail) is structural. Nickel delay lines are concentrically located around rod. Diagram below shows schematic of a single line with associated pulses.



Delay lines are Inco Electronic-Grade "A" Nickel, drawn fine and stranded to reduce eddy currents. Delttime engineers say Nickel combines large and efficient magnetostriiction response, minimum corrosion, excellent mechanical properties.

Pertinent Literature: Write for Inco Bulletin 127B: "Magnetostriiction".

CIRCLE 563 ON READER-SERVICE CARD

5 new Inconel-protected instruments retain accuracy at missile speeds, heats

... point the way to more reliable high temperature parts design

CHICAGO, ILL.: Striking through the air on mile-a-second missile nose cones ... fixed in hot, corrosive fluid streams ... the five new instruments described below operate reliably at glowing temperatures. Aero Research standardizes on Inconel* nickel-chromium alloy for parts of these instruments that bear the brunt of this demanding service.

(1) Total temperature probe — withstands 1740° F generated by friction during flight on missile nose cones. (See photos below.) For maximum reliability, its Inconel sheathing also withstands oxidation and thermal shock.

(2) Wide-range thermocouple — measures temperatures from as low as -320° up to +1900° F in high-velocity

fluids. Inconel sheathing effectively resists these severe erosive-corrosive conditions.

(3) High-accuracy, high-temperature probe—measures temperatures between 0° and 1800° F. Again, Inconel sheathing assures reliability, protecting its accuracy in supersonic jet exhausts, high-temperature furnaces.

(4) Jet thrust measuring rake, water-cooled — operates in 3500° F jet afterburner gases. Inconel alloy construction provides essential high strength at high temperature, plus corrosion resistance.

(5) Sonic-speed, 4430° F, wind tunnel, water-cooled — Inconel alloy forms all major components, gives tunnel the backbone needed to stand up under terrific velocity and heat.

You, too, can give parts high temperature stamina with Inconel alloy. It retains useful strength through 2000° F, and can be easily welded and formed into intricate shapes.

Pertinent Literature: Write for Bulletin T-7: "Engineering Properties of Inconel and Inconel X", and "Inco Nickel Alloys for Electronic Uses".

CIRCLE 564 ON READER-SERVICE CARD



Inconel-sheathed total temperature probe mounted on Redstone missile nose cone — assures high strength at high temperatures and readily withstands oxidation, erosion and thermal shock at extreme velocities. Probe (shown at right) is product of Aero Research Instrument Company, Inc., Chicago, Illinois.



Sensitive transducer measures minute changes of pressure in human body

... Monel fluid chambers withstand corrosion, do not affect saline purity

WALTHAM, MASS.: This sensitive pressure transducer measures a wide range of physiological pressures — from 400 mm Hg down to less than 1 mm Hg.

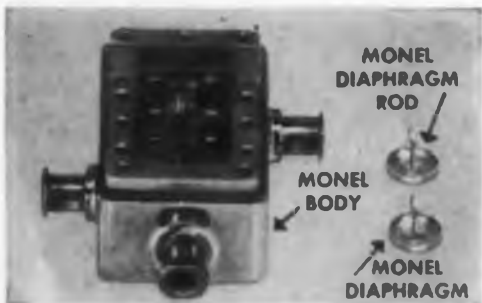
Absolute and differential pressures travel from source (needle or catheter) through a saline-filled tube to actuate two small Monel* nickel-copper alloy diaphragms. Monel diaphragm rods pivot a tiny differential transformer core, producing a signal which is fed

to amplifiers for quick reading.

Monel alloy was chosen for the parts above because it withstands corrosive attack from all common saline and sterilizing solutions. As a result, Monel alloy does not affect saline purity. In addition, Monel alloy is easy to form, machine, to braze, solder and weld.

Pertinent Literature: Write for Bulletin T-5: "Engineering Properties of Monel and R Monel".

CIRCLE 565 ON READER-SERVICE CARD



Monel transducer body and diaphragms resist corrosive saline solutions for long, reliable service. Transducer is made by Sanborn Company, 175 Wyman St., Waltham, Mass.



THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street • New York 5, N. Y.

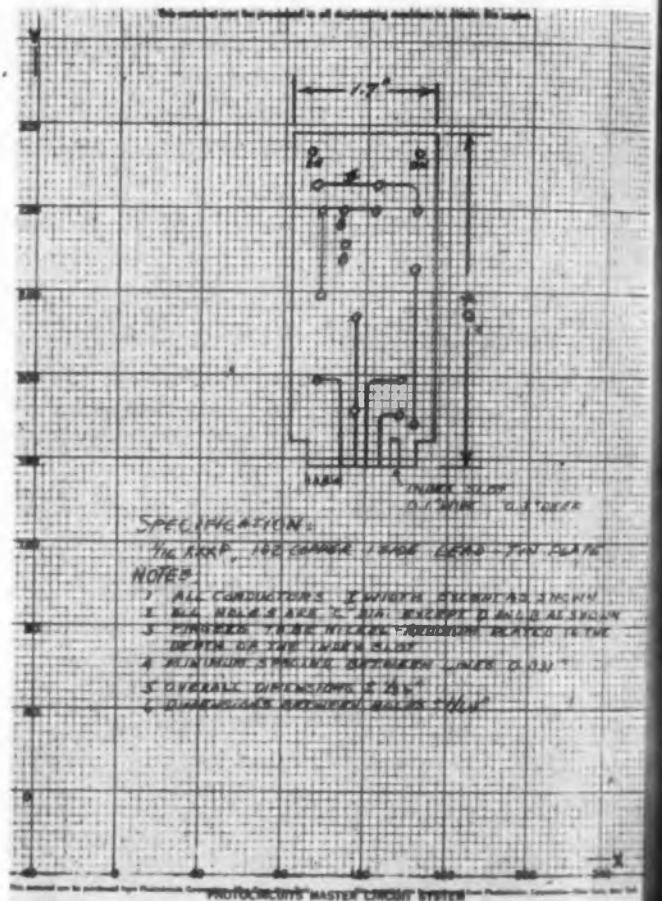


CIRCLE 563, 564, 565 ON READER-SERVICE CARD

SERVICES FOR DESIGNERS

Custom Made P-W Boards

Photocircuits Corporation has reduced printed-wiring boards to a catalog item. Designers, using a kit supplied by the company, may sketch out any reasonably-sized board, the pattern and hole configuration. Supplied with this information on an 8 x 10 in. 0.1 in. grid mylar sheet, Photocircuits offers drilled quantities of the piece, with a choice of base materials and platings. All this without a tooling charge, without need of artwork, and at a competitive piece price.



Enclosed in this kit "Master Circuit System" is a sheet of gridded mylar printed with x and y coordinates over a 0.1-in. grid matrix. The grid lines are not photographically reproducible. A sample sketch and a set of instructions are included. Also included are the standard dimensions to which the designer is to make up his sketch.

Artwork is the starting point in making up these panels. First the designer sketches the circuit full size on the mylar sheet with a sharp pencil. Then holes and lands are indicated and dimensioned according to the standards supplied. Hole tolerance can be held to $\pm 1/64$ -in. without tool charges. Edge tolerances of the board are held to within $\pm 1/32$ -in. without tool charges.

Three sizes of conductors are provided. Line width tolerances and registry depend upon conductor size. Printed legends on finished circuits are marked in color on the mylar sheet. One size of a

two-sided board is shown in dotted lines.
Additional 8 x 10 in. mylar sheets are available from Photocircuits for \$1.00 each. Sheets 10 x 16 in. sell for \$2.00 and 20 x 16 in. sheets sell for \$4.00.

Photocircuits Corporation, Dept. ED, 31 Sea Cliff Avenue, Glen Cove, N.Y.

CIRCLE 77 ON READER-SERVICE CARD

Computing Center

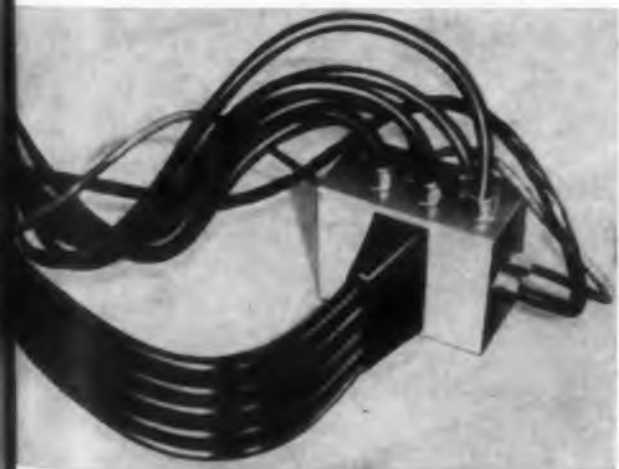
High-speed electronic data processing applied to the customer's application in business, military, or government, is offered by the 6-month old Computing Services Center of the Computer Department of the General Electric Company, located on the campus of Arizona State in Phoenix. The Center features a skilled personnel core of almost 200 with backgrounds in many areas—from civil engineering to physics.

General Electric Co. Computer Dept., Dept. ED, 1103 N. Central Ave., Phoenix, Ariz.

CIRCLE 78 ON READER-SERVICE CARD

Custom Cables

Custom electrical and electronic cable and cable assemblies designed to help solve aircraft and missile cable problems are being manufactured by this company. Cables are custom designed to meet customer's specific requirements and can be manufactured to nearly any length or gauge. The company will assume complete responsibility for design, fabrication and testing to actual installation requirements, if desired by the customer. A large inventory of wire and jacket mate-



is maintained at the plant to meet unusual functional or environmental requirements. Cables are manufactured on special planetary cabling machines designed by the firm. These unique machines are capable of completing the most precise and complex cables to meet the ever increasing demand for specialized cable configurations.

Aeronautical and Instrument Division, Dept. ED, Robertshaw-Fulton Controls Co., 911 East Broad St., Richmond 19, Va.

CIRCLE 79 ON READER-SERVICE CARD

DELCO POWER TRANSISTORS

NEW TYPES



**MILITARY
COMMERCIAL**

TYPICAL CHARACTERISTICS AT 25°C

| EIA | 2N297A* | 2N297A | 2N665** | 2N553 |
|----------------------------------|---------|--------|---------|---------------|
| Collector Diode Voltage (Max.) | 60 | 60 | 80 | 80 volts |
| HFE ($I_c = 0.5A$) (Range) | 40-100 | 40-100 | 40-80 | 40-80 |
| HFE ($I_c = 2A$) (Min.) | 20 | 20 | 20 | 20 |
| I_{co} (2 volts, 25°C) (Max.) | 200 | 200 | 50 | 50 μa |
| I_{co} (30 volts, 71°C) (Max.) | 6 | 6 | 2 | 2 ma |
| F_{ae} (Min.) | 5 | 5 | 20 | 20 kc |
| T (Max.) | 95 | 95 | 95 | 95°C |
| Therm Res. (Max.) | 2 | 2 | 2 | 2° C/W |

*Mil. T 19500/36 (Sig. C.)

**Mil. T 19500/58 (Sig. C.)

NOTE: Military Types pass comprehensive electrical tests with a combined acceptance level of 1%.

Delco Radio announces new PNP germanium transistors in 2N553 series—the 2N297A and 2N665, designed to meet military specifications. These transistors are ideal as voltage and current regulators because of their extremely low leakage current characteristics. All are highly efficient in switching circuits and in servo amplifier applications, and all are in volume production! Write today for complete engineering data.

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Division of General Motors • Kokomo, Indiana

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Newark, New Jersey
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Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

CIRCLE 80 ON READER-SERVICE CARD



SPECTROL PRECISION POTENTIOMETERS

Meet the SPECTROL METAL MULTI-TURN



New type
construction
provides
**150°C.
OPERATION**

The Spectrol Model 590 ten-turn precision potentiometer features all metal construction of machined aluminum with the helical coil placed directly against the case for maximum heat dissipation. Aluminum case provides excellent dimensional stability, is non-hygroscopic and will operate in a relative humidity of 95%. The 1" diameter 590 is available in ranges from 25 to 120,000 ohms with a standard linearity tolerance of $\pm 0.3\%$. Tolerances to $\pm 0.025\%$ on special order.

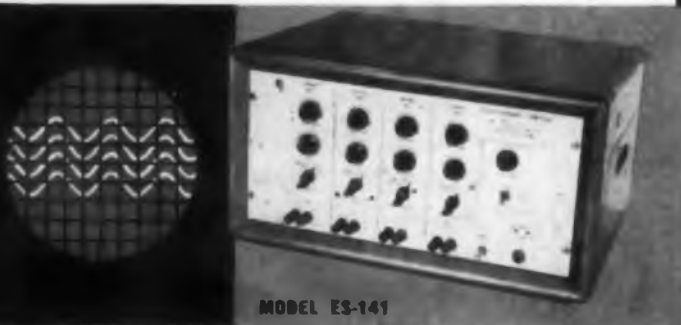
For complete technical information call your local Spectrol representative or write directly to the factory. Please address Dept. 197

SPECTROL ELECTRONICS CORPORATION
"precision electronic components"

1704 South Del Mar Avenue, San Gabriel, Calif.

CIRCLE 81 ON READER-SERVICE CARD

DISPLAY 4 WAVE FORMS SIMULTANEOUSLY ON A SINGLE CHANNEL OSCILLOSCOPE



MODEL ES-141

NEWTON MULTI-CHANNEL ELECTRONIC SWITCH

The NEWTON ELECTRONIC SWITCH (Model ES-141) accepts 4 independent signals and sequentially connects them to a single output in a four way display on a single channel oscilloscope. Variations of the basic unit can be made to provide for simultaneous display of any number of positions — the number limited only by total sampling time available.

Compact, light-weight transistorized model for air-borne applications. FOR COMPLETE INFORMATION, WRITE TODAY FOR DATA SHEET



ANOTHER ACHIEVEMENT IN OPERATIONAL DIGITAL BY NEWTON Transistorized model 10 times smaller than Model E S-141

THE NEWTON COMPANY | MANCHESTER, CONNECTICUT

CIRCLE 82 ON READER-SERVICE CARD

NEW LITERATURE

Microwave Test Equipment

Two page Bulletin No. 100 describes a variety of microwave test equipments from the company's Pacemaker line. Featured is the standing wave amplifier, Type 277A, with a frequency of 1000 cps ± 2 per cent; bandwidth selection of 15, 50 or 550-2500 cps; sensitivity of 0.1 μ v full-scale deflection at 15 cps bandwidth. Specifications are included for laboratory power supply, universal power bridge, precision heterodyne frequency meter, spectrum analyzers, and klystron power supply. An attached business reply card will enable the reader to obtain the new 160-page PRD Microwave Catalog. Copies of Bulletin No. 100 can be obtained by writing Polytechnic Research & Development Co., Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N.Y.

Environmental Testing

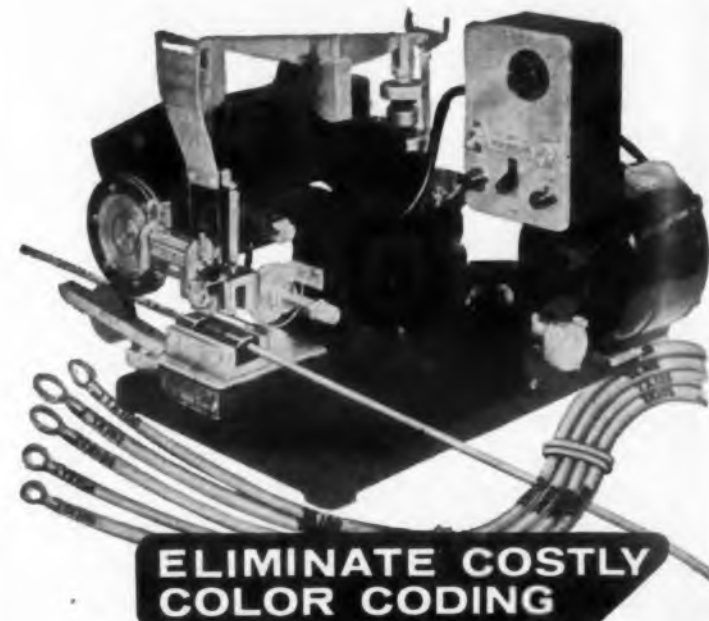
83

Facilities and functions of an electronic and electromechanical environmental test facility, said to be the most completely equipped facility for both performance and environmental testing in the West, are explained and illustrated in a 6-page technical bulletin. The bulletin describes the complete testing laboratory which is operated as an independent facility within the Santa Ana, Calif., establishment. The laboratory is said to offer extensive facilities for tests of product performance under precisely simulated environmental conditions. According to BJ Electronics, both industry and government agencies have access to the latest commercially available test facilities, as well as specialized engineering talent, for the testing of individual instruments and components, or complete electronic and electromechanical systems. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

Shipping Containers

84

This 4-page, 2-color bulletin describes the three basic types of reusable shipping containers in the line—standard padded, dunnage board and shock cradle—and tells how they insure the damage-free arrival of such delicate equipment as radar units, gyroscopes, scientific instruments, electronic apparatus and other shock-sensitive components and equipment. Illustrated with photographs and line drawings, the bulletin also describes how the containers meet all Air Transport Associations Specifications for Category I containers. Tables list specifications and recommend container types for various classifications of equipment. National Vulcanized Fibre Co., 1059 Beech St., Wilmington 99, Del.



**ELIMINATE COSTLY
COLOR CODING**

with a

KINGSLEY Wire-Marking Machine

The Kingsley Machine will permanently mark each wire or piece of plastic tubing with its own individual circuit number, at any desired spacing... at a speed of 11,000 stampings per hour!

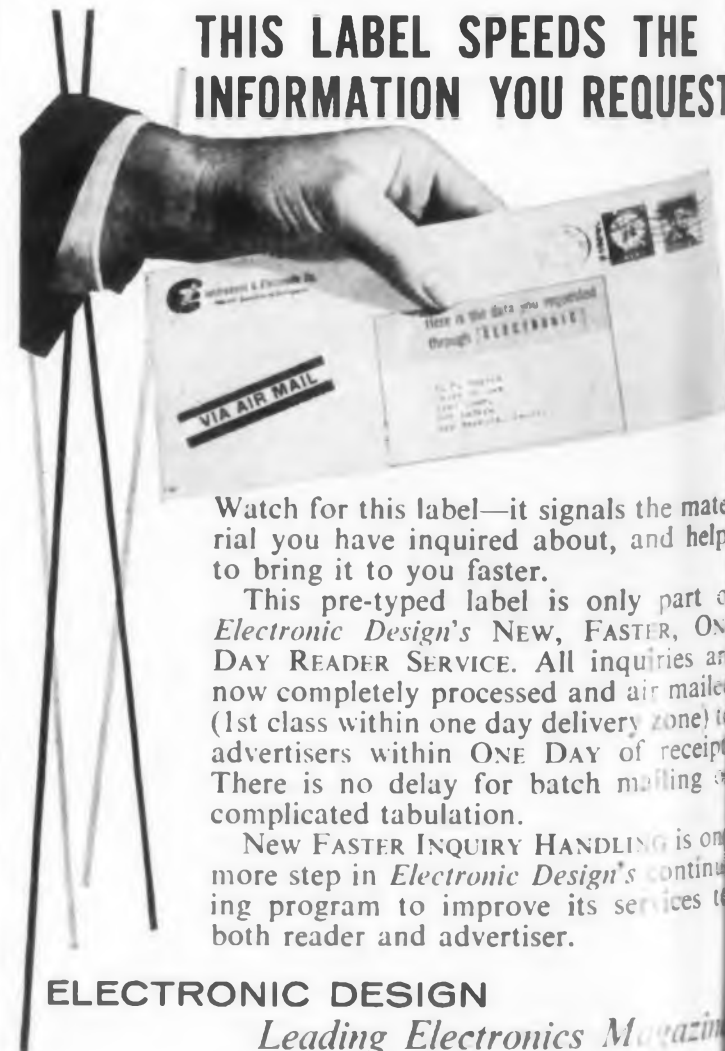
You need only one color of wire for as many codes as necessary. Simplify your assembly methods and speed your production time with the same machine that has proven so successful in the entire aircraft industry.

Write for complete information

KINGSLEY MACHINE CO. • HOLLYWOOD 38 • CALIFORNIA

CIRCLE 85 ON READER-SERVICE CARD

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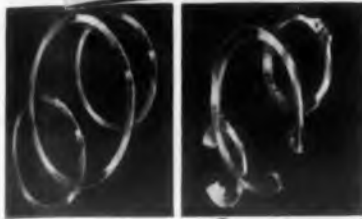
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Shows you how to determine which Ring Gives You the **ONE BEST ANSWER** to Problems of

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ONLY RAMCO MAKES BOTH
MODERN TYPES OF RETAINING RINGS

40 pages of latest information on both types of modern retaining rings. Explains when and how to use Spirolox, the full 360° "gapless" ring, and when to use the modern conventional CircOlox ring. Shows special adaptations, such as the new "Self-Locking" and "Single-Turn" Spirolox Rings, as well as many other specialized rings, materials and finishes available. Write for FREE copy TODAY!

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CIRCLE 86 ON READER-SERVICE CARD

Control Components 88

Bulletin 1300 describes electric actuators, 28 v and 400 cps motors, screwjacks, gear boxes and control equipment for aircraft, missile and industrial applications. A brief technical description of each unit is given, together with general design and operating parameters. Hoover Electric Co., 2100 S. Stoner Ave., Los Angeles 25, Calif.

Inertia And Impact Switches 89

A general description, applications and basic design considerations of inertia and impact switches are included in this four-page brochure. Also mentioned are calibration of the units, response time, switch mounting and a tabular listing of the switches available. Inertia Switch Div., Safe Lighting, Inc., 527 Lexington Ave., New York 17, N.Y.

Strain Gage Equipment 90

This four-page bulletin describes a new line of strain gage instrumentation and input conditioning equipment. The Bulletin 106, includes information on strain indicator, millivolt per volt standards, switching units, regulated power supplies and amplifiers for strain gage use. Bytrex Corp., 294 Centre St., Newton 58, Mass.

Digital Voltmeter 91

This two-page data sheet describes model 502 ac/dc digital voltmeter. The unit is one of a new line of digital instruments featuring a fifth digit for dc overranging. A description, block diagram of the circuit and electrical specifications are provided. Kin Tel, Cohu Electronics, Box 623, San Diego, Calif.

Potentiometer Catalog 92

Details of all production model precision potentiometers, associated Duodial and Digidial turns-counting dials, Helidel delay lines, Helitrim trimming potentiometers and lab model pots are contained in this 20-page catalog. Single-turn and multi-turn potentiometers are grouped separately and arranged for quick comparison of specifications. Technical data is presented in a format that includes complete electrical mechanical and environmental specifications, coil data, photos and outline drawings. The catalog is index-tabbed and all vital statistics are arranged for fast reference. Beckman Instruments, Inc. Helipot Div., Helipot Technical Information Service, 2500 Fullerton Rd., Fullerton, Calif.

Feeds, stakes and fuses Eyelets in PRINTED CIRCUIT Boards

WITH 100%
RELIABILITY



EDWARD SEGAL
MODEL NR-ESSM
automatic eyelet
attaching machine

In every environmental test!

This revolutionary machine, supplied as a complete installation, is obsoleting manual eyelet attaching and soldering. Leading manufacturers, in many cases using batteries of them, find Segal's new Model NR-ESSM is a completely dependable automatic method of making continuous electrical circuits of the printed elements on opposite sides of a board — or a single side if desired. Stakes and fuses 30 eyelets or more a minute, top and bottom, with never a reject.

There are other models for cold staking flat and funnel type eyelets, and for feeding and staking tube pins and turret terminals with equal reliability. All are highly economical. Segal can improve your eyelet attaching production. Write section ED-7,



Manufacturers of eyeleting machinery,
special hoppers and feeding devices
132 LAFAYETTE STREET, NEW YORK 13, N. Y.

CIRCLE 93 ON READER-SERVICE CARD

New ROLLPIN APPLICATION DATA!



Esna's latest Rollpin booklet gives you valuable information on where to use and how to install these versatile, all-purpose fasteners. A slotted, chamfered, cylindrical spring pin, Rollpin locks securely in place—yet can be drifted out and used over and over again. Write for it today and see how Rollpins can simplify design and production operations. Address Dept. R55-757.



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CIRCLE 94 ON READER-SERVICE CARD

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Shaft Retention FASTENERS CATALOG TODAY!

Featuring **Fastex® Springrip Fasteners**
Springrip Fasteners simply slip on shaft or stud. Biting teeth resist dislodging movement. Full story told in new catalog containing data on Springrip Fasteners, **Plasti-Rings®**, Push On Fasteners and "C" Rings.

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CIRCLE 87 ON READER-SERVICE CARD



SHIELDED CABLES

designed for



**STEREO
HI-FI**



These low capacity cables are especially designed for use as leads between amplifiers, speakers and record changers of Stereo HI-FI units. Standard Two Conductor and Single Conductor cables are available and, where required, modifications of these cables can be developed to satisfy specific requirements.



LOW CAPACITY RECORD CHANGER TO AMPLIFIER EXTENSION CABLE

Two Stranded Conductors with clear polyethylene insulation extruded in parallel with a spiral wrapped tinned copper shield and a black extruded plastic jacket. Two styles available, with .030" wall insulation, 24 uuf per foot shield to conductor capacity and .017" wall insulation, 39 uuf per foot shield to conductor capacity.

LOW CAPACITY HI-FI AMPLIFIER INTERNAL SIGNAL CABLE

Two Solid Conductors in parallel with red and clear polyethylene insulation and spiral wrapped tinned copper shield with black extruded plastic jacket with 24 uuf per foot shield to conductor capacity.



STEREO RECORD CHANGER TO SPEAKER CO-AXIAL SINGLE CONDUCTOR LOW CAPACITY CABLE

Single Stranded Copper Conductors with polyethylene insulation, tinned copper full coverage shield and black or gray plastic insulation. Three styles available with shield to conductor capacities of 28, 31 and 33 uuf per foot respectively.

For complete specifications for these and other Lenz Wires and Cables write today for the new Lenz Catalog.



WIRES

and

CABLES

In Business Since 1904

LENZ ELECTRIC MANUFACTURING CO.
1753 No. Western Ave., Chicago 47, Ill.

CIRCLE 105 ON READER-SERVICE CARD

NEW LITERATURE

Components 106

New lines of connectors, potentiometers and thermocouple switches are described in this 4-page, illustrated catalog. Issued as catalog supplement 154 this data has been issued as an addition to the firm's basic 24-page brochure covering regular lines of thermocouples, harnesses, extension leads, pressure probes and test kits. Harco Laboratories, Inc., 77 Olive St., New Haven, Conn.

Electronics Directory

Available free to engineering departments, this Electronics Directory and Buyers' Guide is devoted to the electronics industry in the eleven Western States only. Included in the 50-page guide are: manufacturers and laboratories; associations and societies; distributors; surplus dealers; division, field and sales offices; representatives; products and services. Write to: Western States Electronics Directory & Buyers' Guide, 2404 W. Seventh St., Los Angeles 57, Calif.

Transformers and Reactors 107

This data sheet covers transformers and reactors ranging from subminiature units to those rated at 5 kva in output power. Provided is table that gives power rating, case dimensions and mounting dimension specifications. Among the units illustrated are encapsulated signal transformers and low phase shift power transformers. Coil Winders, Inc., New York Ave., Westbury, L.I., N.Y.

Antenna Measurements

This 77 page booklet is a review of some of the factors associated with measuring the radiation characteristics of antennas. Basic theory, practical aspects of the problem, description of equipment, and review of basic antenna measurements are covered. The Appendix contains a list of symbols, a bibliography containing all references to the text, nomographs, decibel conversion chart, and selection of commonly used antenna equations. Write on company letterhead to: Scientific-Atlanta, Inc., 2162 Piedmont Rd., N.E., Atlanta 9, Ga.

ELECTROCRAFT Connectors and Switches

TELEPHONE SWITCHBOARD JACKS



Ruggedly built long frame telephone switchboard jacks in 3 frame designs and all standard circuits. Welded steel frames assure rigidity. Nickel silver alloy springs supply greater service life and resistance to corrosion. Made in commercial types with fine silver contacts — military types to Mil-J-641 specifications. Special contacts and circuits as required.



All items in the entire line of Connectors and Switches are soundly engineered, sturdily constructed of high grade materials and designed to require minimum space. Design changes for other than standard applications readily supplied. Our engineering department will work with you on any such desired variations from standard items. Write for complete catalog.

ELECTROCRAFT, INC.
4426 N. Kedzie Avenue
Chicago 25, Illinois

CIRCLE 108 ON READER-SERVICE CARD

WAVEGUIDE COMPONENTS for microwave applications



FOR efficient use of your antenna, let Kennedy engineers design your feed system. Kennedy's line of waveguide components includes dual and linear polarization horns, transitions, duplexers, straight sections and bends. All of the components are designed for high-power use.

ANTENNA EQUIPMENT

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COHASSET, MASSACHUSETTS Evergreen 3-1200

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Down-to-earth SOLUTIONS to out-of-this-world PROBLEMS
Tracking Antennas-Radio Telescopes-Radar Antennas
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CIRCLE 115 ON READER-SERVICE CARD

NEW LITERATURE

Transmitting Tubes

116

Four-page application notes AN-178 presents a chart designed to simplify the selection of a transmitting tube made by the firm. The chart covers power-output requirements up to 2000 mc. It is divided into power frequency areas, each of which is labeled with the tube designation of the transmitting tube which will deliver optimum performance over that area. Radio Corp. of America, Commercial Engineering, Harrison, N.J.

Microwave Insulators

117

Microwave insulators of Teflon styrenes, Kel-F and other high dielectrics, machines to tolerances of 0.001 in. and less are described in Bulletin 2895, two pages. The bulletin gives reasons for choice of machining versus molding to obtain the close tolerances required, and illustrates several representative custom insulating and structural parts produced. Tri-Point Plastics, Inc., 175 I. U. Willets Rd., Albertson, L.I., N.Y.

Drafting Equipment

118

New products and important improvements in established lines are covered in this 1959 general catalog, 24 pages. Included in the catalog are the Staktube roll file, "file and find" storage system for large rolled blueprints, charts, drawings, and tracings, flat drawer files, as well as drafting tables and equipment. All equipment is constructed of steel and selected woods. Stacor Equipment Co., 295 Emmet St., Newark, N.J.

Readout Lamps

119

"Rayescent Readout Lamps," a four-page pamphlet, discusses the phenomenon of electroluminescence and its application in lamps now available for display of continually changing numerical or alphabetical information. The publication describes construction of readout lamps, indicates the capabilities and advantages of the various lamp types, and summarizes their principal mechanical, electrical, and visual characteristics. Westinghouse Electric Corp., Lamp Div., MacArthur Ave., Bloomfield, N. J.

SOLUTION DISSOLVES GLASS BUT DOESN'T AFFECT AUTRONEX GOLD PLATE!

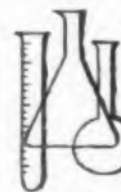
Autronex Gold Plated transistor headers were suspended in C.P.—4 solution (nitric, acetic and hydrofluoric with bromine) for several hours... the header's glass seals dissolved, the Gold Plate remained intact.

This dramatic experiment, carried out by one of the country's prominent manufacturers of semiconductor products, demonstrates some of the superior metallurgical properties of electroplate produced with the AUTRONEX ACID GOLD PLATING PROCESS—for all industrial applications.

The simple to prepare bath is mildly acidic (pH 3.5—4.5), operates at room

temperature, and produces deposits which are mirror-bright in any thickness. AUTRONEX electroplates also offer approximately 75% greater resistance to abrasive wear over conventional Gold plate.

For complete details on uses, bath preparation, equipment required, etc., ask for #EG-1.



AUTRONEX EASILY PASSES ALL RIGID PERFORMANCE-ACCEPTANCE TESTS

- SALT-SPRAY TEST
- MANDREL-BEND TEST
- BOILING WATER TEST

PRECIOUS METALS DIVISION



SEL-REX CORPORATION

NUTLEY 10, NEW JERSEY

Manufacturers of Exclusive Precious Metals Processes, Metallic Power Rectifiers, Airborne Power Equipment, Liquid Clarification Filters, Metal Finishing Equipment and Supplies

CIRCLE 120 ON READER-SERVICE CARD

Switches 121

The four-page catalog describes eight high temperature thermal and seven waterproof switches typical of this custom line. Photographs, dimension drawings, specifications and characteristics are included in these plug, probe, and surface types of thermal controls for critical government and industrial applications and waterproof conformance to government standards or military specifications. Control Products, Inc., 306 Sussex St., Harrison, N.J.

Flight Simulators 122

Detailed specifications, diagrams, and application data on a series of compact, high response simulators are described in bulletin TC-591. The flight simulators are available in one, two and three axis models for testing missile or aircraft navigational systems and associated components. Components are subjected to real angular velocity and acceleration programs, equivalent to those experienced during in-flight maneuvers. Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.

Printed Circuit Connectors 123

This 24-page catalog covers connectors designed for use with printed circuits. Connectors for 1/16, 3/32 and 1/8 in. printed circuit cards are described. Also included in the illustrated catalog are complete specifications, outline dimensions, general information and suggested applications. DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N.Y.

Environmental Testing 124

In eight pages this brochure describes temperature-vibration test chambers and temperature-altitude-vibration experimental rooms. The brochure covers small portable units with "Hi-Lo" lift for accommodating various heights of shakers and to permit both horizontal and vertical planes of vibration. The sizes pictured also include walk-in size chambers. A new type chamber is shown for testing aircraft and electronic equipment under conditions simulating the Chemosphere, which is an altitude between 100,000 and 200,000 feet. Conrad, Inc., Conrad Square, Holland, Mich.

ENCAPSULATED RADIO FREQUENCY CHOKES

The following series of R.F. chokes range in value from 0.1 uh to 50 mh. Basically identical to our standard series of axial lead R.F. chokes bearing the equivalent number, these coils are encapsulated in epoxy resin and conform to MIL-C-15305A.



| Part No. | Inductance ± 5% |
|----------|-----------------|
| 4580-E | 0.1 uh. |
| 4582-E | 0.15 uh. |
| 4584-E | 0.22 uh. |
| 4586-E | 0.33 uh. |
| 4588-E | 0.47 uh. |
| 4590-E | 0.68 uh. |
| 4592-E | 0.75 uh. |
| 4594-E | 0.82 uh. |
| 4602-E | 1.0 uh. |
| 4604-E | 1.5 uh. |
| 4606-E | 2.4 uh. |
| 4608-E | 3.9 uh. |
| 4609-E | 5.5 uh. |
| 4610-E | 6.2 uh. |
| 4611-E | 8.2 uh. |
| 4612-E | 10.0 uh. |
| 4622-E | 10.0 uh. |
| 4624-E | 15.0 uh. |
| 4626-E | 24.0 uh. |
| 4628-E | 39.0 uh. |
| 4629-E | 55.0 uh. |
| 4630-E | 62.0 uh. |
| 4631-E | 82.0 uh. |
| 4632-E | 100.0 uh. |
| 4642-E | 0.10 mh. |
| 4644-E | 0.15 mh. |
| 4646-E | 0.24 mh. |
| 4648-E | 0.39 mh. |
| 4649-E | 0.55 mh. |
| 4650-E | 0.62 mh. |
| 4651-E | 0.75 mh. |
| 4652-E | 1.0 mh. |
| 4662-E | 1.0 mh. |
| 4664-E | 1.5 mh. |
| 4666-E | 2.4 mh. |
| 4668-E | 3.9 mh. |
| 4669-E | 5.5 mh. |
| 4670-E | 6.2 mh. |
| 4671-E | 8.2 mh. |
| 4672-E | 10.0 mh. |
| 6302-E | 2.5 mh. |
| 6304-E | 5.0 mh. |
| 6306-E | 10.0 mh. |
| 6308-E | 25.0 mh. |
| 6310-E | 50.0 mh. |

Send for the MILLER industrial catalog

It lists over 1300 chokes, filters, transformers and coils, available for immediate delivery. Includes 260 new coil items—many conforming to military specifications. Request Miller Catalog No. 60.

J. W. MILLER COMPANY
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CIRCLE 125 ON READER-SERVICE CARD

GENERAL ELECTRIC VOLTAGE REGULATION IDEA FILE

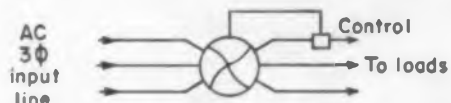
By C. A. NEUMANN



FOR RADAR ENGINEERS

General Electric Inductrol* regulators keep radar systems on the air effectively and accurately

Automatic control requirements for correcting voltage fluctuations are encountered in all portions of a radar system. Control can be handled by Inductrol regulators at the input to each component of the system, at the input of a group of components, or at the input to the entire system. Inductrol voltage regulators can also supply run-up voltage or current where required.



AN INDUCTROL REGULATOR controlling incoming voltage fluctuation in a three-phase circuit is shown in the above diagram. The three-phase regulator corrects each phase of the system concurrently and by the same amount.

Where phase voltage unbalances create operational difficulties by introducing ripple in the d-c power supplies, individual line control with single-phase regulators will correct these unbalances. They can be installed on any portion of the system.

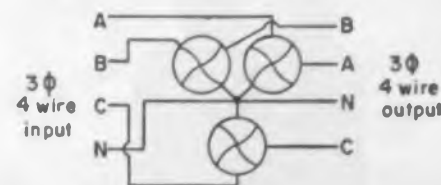
THREE SINGLE-PHASE INDUCTROL VOLTAGE regulators are connected line-to-neutral on a four-wire, three-phase system in the diagram below. Each regulator will control a phase of the system independently of the others—thus making available a balanced three-phase voltage output regardless of existing load unbalances.

As an example, power feeding a radar system requires regulating equipment to correct for incoming voltage variations of $\pm 15\%$, and maintain a constant input voltage to the system within a bandwidth of $\pm 1\%$. Load—500 kva, balanced three-phase; system voltage—480 volts, 60 cycles. Requirements: maintain a constant voltage

*Registered Trademark of General Electric Co. for Induction Voltage Regulators.

output of 480 volts, $\pm 1\%$. Installation is at a remote location. Regulating equipment must not require maintenance and its controls must be "drift-free."

To meet this requirement, the General Electric Inductrol regulator will correct for incoming line variations from 408 volts to 552 volts. Using basic formulae, we determine the load current to be 600 amps and that the regulator will have an 87.5 kva rating and a range of $\pm 17.5\%$.



PHASE UNBALANCE REQUIREMENTS are not involved in this example so a three-phase regulator will be sufficient.

The Inductrol regulator has no sliding contacts to wear, is of rugged construction, and will perform its intended function with the greatest degree of reliability. Its associated controls are drift-free, and are temperature and frequency compensated. They require no attention after the original setting has been made.

The regulator selected for this example is a dry-type suitable only for indoor service. Liquid immersed units are available for outdoor service.

OTHER INDUCTROL REGULATOR USES: power supply voltage control, control of filament power supplies, focus coil control, and grid voltage control in radar systems; variable speed antenna drives, computers, and many other electronic equipments.

For more information write to Section 425-21, General Electric Company, Schenectady 5, New York.

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GENERAL ELECTRIC

CIRCLE 126 ON READER-SERVICE CARD



**ACCURATELY
REPEATABLE
TIMING**

**WITH
INSTANTANEOUS
RESET**



**HEINEMANN'S
NEW
TRANSISTORIZED
TIME-DELAY RELAY**

If your products call for reliable, accurately repeatable timing or sequencing . . . and if cost is a consideration (when isn't it?), then have a look at the new Heinemann Trans-O-Netic* Time-Delay Relay.

Built around a transistorized control circuit, this new type of relay offers exceptional performance capabilities at a surprisingly low cost. Time delay is adjustable from 0.5 to 30 seconds, with repeatability at any set delay better than $\pm 5\%$. Reset is instantaneous. These three features, alone, place the Trans-O-Netic way out in front of the field.

But there's more. The relay is inherently stable, so that there is only a negligible temperature effect on time delay over a tested operating range of 32° to 130°F. Single-pole, double-throw switching is fast and clean; wiping action assures long contact life. The entire unit is enclosed in a phenolic case to protect it from dust and dirt.

More information? Certainly. Send for Bulletin 5300; it gives pertinent details and specifications.

HEINEMANN ELECTRIC COMPANY 156 Plum Street, Trenton 2, N. J.

*Trans-O-Netic is a trade name of the Heinemann Electric Company. S.A. 1002

CIRCLE 127 ON READER-SERVICE CARD

NEW LITERATURE

Transistors 128

Power switching resistors are discussed in these three, four-page data sheets. Labeled 2N1136, 2N1137 and 2N1138, they are high gain units. Absolute maximum ratings, electrical characteristics, dimensional data and graphs are included. Bendix Aviation Corp., Red Bank Div., Semiconductor Products, 201 Westwood Ave., Long Branch, N.J.

Connectors Catalog 129

This illustrated catalog describes the firm's complete line of electrical connectors. Catalog B 73 illustrates nomenclature of terms and references used in the description of electrical connectors, and lists electrical current ratings for cable, as based on wire gauges and number of wires. The line includes such connector styles as oval push-pull, round push-pull, round push-latch, "quik-loc," straight pin bigun, round push-lock, and change-out. Joy Manufacturing Co., Electrical Products Div., 1241 Macklind Ave., St. Louis 10, Mo.


Seals and Fasteners 130

Catalog 359, 12 pages, illustrates and describes complete line of single-unit, high-pressure seals and fasteners suitable for military, commercial and industrial applications. Included are material on toggle switch boots, rotary shaft seals, pushbutton switch boots and indicator light seals in a wide range of sizes. A. P. M. Sales Corp., 252 Hawthorne Ave., Yonkers, N.Y.

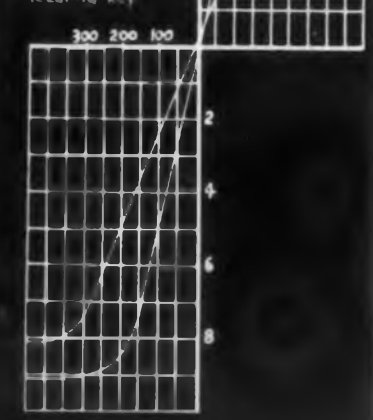
Systems and Components

Bulletin AV-100, 40 pages, describes the firm's systems and components. Included in the illustrated bulletin are static time delays, standard time delays, missile fuses and programmers, voltage and frequency sensors, meter relays, power supplies and inverters, automatic check-out equipment and specialty devices. Also covered are descriptions of the application of these products in complete systems developed by the firm. Write on company letterhead to Electronic Specialty Co., Dept. ED, 5121 San Fernando Rd., Los Angeles 39, Calif.

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- 11 pin plug with locating key

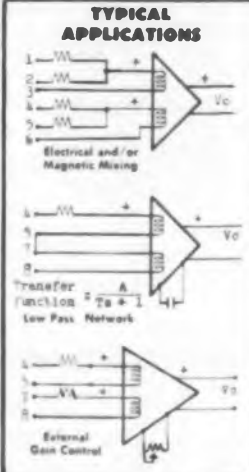


TOROTEL

MAGNETIC AMPLIFIER

The 02-type magnetic amplifier is a lightweight D.C. amplifier operating from a 115V, 400-cps source. The linear, gain stability and null characteristics of the amplifier make it very adaptable to use in Analog Computer and instrumentation.

TYPICAL APPLICATIONS



TOROTEL, INC.
5512 EAST 110th STREET KANSAS CITY, MO.

CIRCLE 131 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1959

Insulating Washers

132

Washers that are designed to electrically insulate semiconductors from the chassis but allow operating heat to dissipate rapidly are described in Bulletin 2965. The bulletin provides dimensions and hole spacing for major types of washers used with semiconductors. Ford Radio & Micro Corp., 536 63rd St., Brooklyn 20, N.Y.

Switch Catalog

Catalog 359, 28 pages, contains information on the firm's expanded line of snap-acting precision switches. Data on new sealed switches for severe environments, and low-cost switches for automatic devices have been added to the catalog. Other switches described are: general-purpose; low-force; high sensitivity; open-blade; AN and JAN, and reset switches. Data on bases, terminals, circuit arrangements and NEMA standard definitions on sensitive switch terms are also covered. Write to The W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Lees Rd., Wallingford, Conn.

Technical Data

133

This brochure contains conversion charts and technical data covering altitude pressure and temperature from -500 to 1,800,000 ft in accordance with the ARDC model atmosphere. Also included are temperature conversion factors from absolute 0 to 1000 deg and several conversion factors for materials, heat, velocity, and vacuum. Two other charts list dry bulb and temperature differential for relative humidity. Conrad Inc., Conrad Square, Holland, Mich.

Bandpass Filters

134

A line of miniature ceramic if bandpass filters is described and illustrated in this eight-page brochure. The brochure lists a wide range of bandpass characteristics and includes attenuation curves for narrow and wideband applications in military and commercial equipment. Insertion loss, shape factor and impedance transformation are discussed. Clevite Corp., Clevite Electronic Components Div., 3311 Perkins Ave., Cleveland 14, Ohio.

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laminates that accepts all
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Taylor

LAMINATED PLASTICS VULCANIZED FIBRE
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CERAMASEAL
sapphire-to-metal
seals
stay gas-tight
even at 450 c
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Do you need windows for radar equipment wave guides? Or for high-temperature, high-vacuum furnaces or infra red detection equipment?

CERAMASEAL has solved the problems involved in bonding synthetic sapphire to metal parts — is the country's leading producer. Sapphire discs or tubes are readily sealed to tubular type metal parts of kovar, nickel-iron or platinum. The seals are mass spectrometer-tight and the assemblies can be soldered, brazed or welded in place without damaging the seal.

FOR COMPLETE INFORMATION, write CERAMASEAL, INC., New Lebanon Center, N. Y. or phone: West Lebanon 3-5851.

Hermetic Ceramic Terminals, Magnetron Wells, Sapphire-to-Metal Seals

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CIRCLE 135 ON READER-SERVICE CARD



New precision Hallgenerators reliable magnetic test equipment

SIEMENS HALLGENERATORS — ten different types available from stock.

GAUSSMETERS — portable and stationary technical instruments, laboratory precision meters—no amplifier.

COERCIMETERS — for instant indication of H_c , between 200 and 5000 oersteds.

GRH Halltest Company

157 S. Morgan Blvd., Valparaiso, Indiana

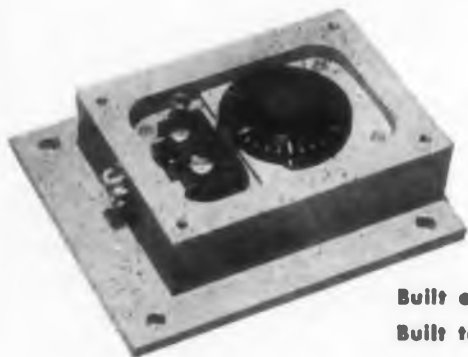


CIRCLE 137 ON READER-SERVICE CARD

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• SPECIALISTS IN MINIATURIZATION •

- TIMERS, (Mechanical or Electrical)
- ACCELERATION SWITCHES
- IMPACT SWITCHES
- PROGRAMMERS
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A complete family of Timers
from 1 second to 15 minutes.

Built especially for Missile Application
Built to MIL-E-5272A

For Additional Information Call or Write

Timech Corp. — 13866 Saticoy, Van Nuys, Calif.

Dept. M ST 2-1914 or ST 3-3651

CIRCLE 138 ON READER-SERVICE CARD

NEW LITERATURE

Servos

139

Electric servos designed for missile applications are covered in this four-page brochure. Pictures, graphs of output torque and other descriptive material are contained on eight units. Advantages of these units are also described. Lear Inc., Grand Rapids Div., 110 Ionia Ave., N.W., Grand Rapids 2, Mich.

Mounting Systems

140

Bulletin No. 714 outlines the firm's capabilities for handling mounting system requirements. Examples of standard, special and high-performance mounting system for electronic equipment used in missiles and advance jets are explained and illustrated. Pictures are included and data is provided in tabular form. Lord Manufacturing Co., Erie, Pa.

Inertial Guidance

141

This eight-page, pocket-size catalog contains a listing of inertial guidance components and equipment. Also included is a list of engineering reports available from the company on inertial guidance, and a bibliography on the subject. Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, L.I., N.Y.

Strain Gages

142

Bulletin 4320 describes etched foil strain gages with improved design and engineering features. The distinguishing characteristics of foil strain gages are their sensitivity and ruggedness due to the grid structure produced by photo-etching extremely thin foil sheets. Pictures and technical data in tabular form are provided. Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., 42 Fourth Ave., Waltham 54, Mass.

Beryllium Copper Alloys

143

Information on beryllium copper 10, 25, and 165 alloys for electronic, instrument, temperature control and other applications is given in this 12-page data sheet series. Chemical analysis, physical constants and mechanical properties of each alloy are described. Heat treating procedures are outlined and illustrated. Forms in which the alloys are available are also listed. The data sheet series is illustrated with nine tables and four graphs. The Brush Beryllium Co., Pennrold Div., 501 Crescent Ave., Reading, Pa.

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CIRCLE 144 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1959



HOW TO USE REGOHM

the plug-in device that
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down to $\pm 0.05\%$

Wherever system performance requires precision regulation of input voltage, REGOHM earns a place. And wherever circuitry includes vacuum tubes, REGOHM will substantially extend tube life. The REGOHM is a voltage regulator of great sensitivity and stability, providing stepless continuous control over a wide frequency range. Light in weight, low in cost, its applications are almost unlimited. Here are typical applications:

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- Consolidated Electrodynamics — for Diatron Mass Spectrometers
- Stoddard Aircraft Radio —for Power Supplies
- Hevi-Duty Electric Company —for Airport Lighting Brightness Control

How you may use REGOHM in your own applications will become clear to you from design data, performance specs and case histories, available to you on request.



REGOHM



ELECTRIC REGULATOR CORPORATION
NORWALK CONNECTICUT
CIRCLE 145 ON READER-SERVICE CARD

Microwave Data

146

"PRD Reports," Vol. 6, No. 1, six pages, is entitled "Waveguide Rotary Standing Wave Indicators," and describes the theory, operation and design of RSWI's. These measuring devices present a solution for vswr and impedance measurements in waveguide systems. The units replace slotted sections where length, size, and weight are important factors. Polytechnic Research and Development Co., Inc., 202 Tillary, Brooklyn 1, N.Y.

Switches

147

This four-page catalog and price list describes basic snap action switches, enclosed snap action switches, foot switches, mercury switches and actuating switches. Pictures, physical specifications and electrical characteristics are provided. General Controls Co., PIC Automation Controls Div., McCormick Blvd., Skokie, Ill.

Magnetic Recording Heads

148

Specifications, outline dimensions and general information on the firm's Magnetic Tape and Drum Heads are given in this four-page brochure and data sheets. Also included are design sheets with spaces for electrical and mechanical parameters to aid in the design of a tape or drum head to customer specifications. General Transistor Western Corp., 6110 Venice Blvd., Los Angeles 34, Calif.

Instruments

149

Bulletin E-1111, "Recording Voltmeters and Ammeters," describes one-, two-, and three-pen instruments in wall-mounting, panel-mounting portable and pole-mounting models. Operating principles are explained, and models are described in detail. The bulletin includes a list of charts and accessories for use with the instruments. The Bristol Company, Waterbury 20, Conn.

Phototube Applications

150

"Phototubes and How to Use Them" is the title of this application bulletin. Bulletin PA-227, 6 pages, explains photo emission and spectrum response. It also describes the phenomenon of gas amplification, gives precautions concerning environment, and explains the phototube rating system. Special sections treat photo multipliers and photo resistive cells. Typical circuits illustrating the use of high-vacuum and gas-filled phototubes, and a minaturized circuit using transistors and a photocell are included. CBS-Hytron Advertising Service, Parker St., Newburyport, Mass.

Accurate



These tolerances are from absolute frequency under any combination of the conditions within operating specifications. For specific operating conditions much closer frequency tolerances may be maintained.

TRANSISTORIZED TUNING FORK FREQUENCY STANDARDS

TYPE MAFC — Frequency Standard

- Frequency Range Available: 360 cps to 4 kc
- Tolerances % \pm : 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Ranges: —20 to +71°C
—55 to +100°C
—55 to +125°C
- Power Supply Voltage: 12 or 28 vdc \pm 15%
- Size: 1 $\frac{1}{4}$ "x1 $\frac{1}{4}$ "x2 $\frac{1}{4}$ " • Weight: 8 oz.

TYPE AFC — Frequency Standard

- Frequency Range Available: 360 cps to 4 kc
- Tolerances % \pm : 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Ranges: —20 to +71°C
—55 to +100°C
—55 to +125°C
- Power Supply Voltage: 12 or 28 vdc \pm 15%
- Size: 2 $\frac{1}{4}$ "x2 $\frac{1}{4}$ "x3 $\frac{1}{4}$ " • Weight: 13 oz.

TYPE MAFCD — Frequency Standard

- Frequency: 60 cps
- Tolerances % \pm : 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Range: —55 to +71°C
- Wave Shape: Sine w/less than 1% harmonic distortion
- Power Supply Voltage: 10 to 14 vdc
- Size: 4 $\frac{1}{4}$ "x4 $\frac{1}{4}$ "x4 $\frac{1}{4}$ " • Weight: 4 lbs.

TYPE MFB — Frequency Divider

- Ratios Available: 2:1, 4:1, 5:1, 8:1, 10:1, 16:1
- Temperature Ranges: —20 to +71°C
—55 to +100°C
- Power Supply Voltage: 12 or 28 vdc \pm 15%
- Size: 1 $\frac{1}{4}$ "x1 $\frac{1}{4}$ "x2 $\frac{1}{4}$ " • Weight: 6 oz.

TYPE MFS — Frequency Standard for Laboratory or Field

- Type MFS is a small, lightweight frequency standard that can replace units many times its size without sacrificing frequency stability. Internal batteries and provisions for external power supply make the unit ideal for either laboratory or field applications.
- Frequency Ranges Available: 50 cps to 4 kc
 - Frequency Stability: 2 parts in 10⁶/per month
 - Temperature Range: —20 to +71°C
 - Size: 3 $\frac{1}{8}$ "x5 $\frac{1}{8}$ "x5 $\frac{1}{8}$ " • Weight: 2 lbs.

TYPE MLS — Laboratory — Frequency Standard

- Type MLS is an extremely high stability laboratory frequency standard. The clock on the panel facilitates easy checking of stability.
- Frequency Ranges Available: 50 cps to 4 kc (Multiple Taps Optional)
 - Frequency Stability Available: 5 parts in 10⁶
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 - Size: 9"x10"x7" • Weight: 15 lbs.

A wide variety of units are designed to comply with the most severe military specifications.

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Ask for Catalog BED-A90



BORG EQUIPMENT DIVISION
AMPHENOL-BORG ELECTRONICS CORPORATION
JANESVILLE, WISCONSIN

MICROPOTS • MICRODIALS • INSTRUMENT MOTORS • FREQUENCY STANDARDS
CIRCLE 152 ON READER-SERVICE CARD

NEW LITERATURE

Silicon Transistors 153

This six-page illustrated brochure describes the firm's pnp alloyed junction silicon transistors. Called S-100, it devotes one page each to high speed switch, medium speed switch, high speed linear amplifier, medium speed linear amplifier and high voltage types. General Transistor Corp., 91-27 138th Pl., Jamaica 35, N.Y.

Small Motors 154

Four types of ac shaded pole, reversible, non-g geared motors are described in this eight-page catalog, No. R-1. Information on performance characteristics, ratings, construction, dimensions and typical applications is included. Duty cycle data, power source considerations, special features, braking and speed control information are also covered. Barber-Colman Co., Rockford, Ill.

Resistance Welding Equipment 155

This 16-page catalog describes a complete line of resistance welders, welding heads, power supplies, handpieces, and accessories. There are sections devoted to basic resistance welding, a comparison of stored-energy vs. ac welding, and points to consider in selecting the proper equipment. Weldmatic, Div. of Unitek Corp., 380 N. Halstead Ave., Pasadena, Calif.

Plastics 156

This eight-page, illustrated catalog lists available shapes and sizes of Teflon plastic. Permissible tolerances are given on all stock shapes. Properties and end use applications of Teflon shapes are described. Shapes cataloged include sheets, rods, tubing, tapes and cementable etched tapes. Also, large diameter molded bars and cylinders. Cadillac Plastics & Chemical Co., 15111 Second Blvd., Detroit 3, Mich.

Recording Data

Entitled "New Concepts in Recording—for Military, Industrial and Scientific Applications," this 16-page booklet describes various methods of recording and identifies and defines those circumstances under which direct writing recording systems provide maximum benefit to military and industrial users. Applications of the firm's recording systems in monitoring military, space technology and scientific data gathering systems are discussed. Also shown is a broad range of oscillographs, special-purpose amplifiers and system configurations. Write to: Brush Instruments, Dept. ED, 37th and Perkins, Cleveland 14, Ohio.

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... how can you be sure it's
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Did you know that there are 4,500 different electronic test instruments manufactured by some 400 different companies?

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CIRCLE 157 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1959

Expanding the Frontiers
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ELECTRO- MECHANICAL DESIGN

Lockheed Missiles and Space Division has complete capability in more than 40 areas of science and technology. As systems manager for such projects as the Navy POLARIS FBM; DISCOVERER Satellite; Army KINGFISHER; Air Force Q-5, X-7 and X-17, the Division is heavily engaged in all phases of design and packaging.

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If you are experienced in electro-mechanical design or packaging with specific knowledge of electronic packaging; wiring design; harness assembly; ignition and separation systems design or auxiliary power systems design, we invite your inquiry.

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SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO • HAWAII

Servomotors

158

Servo-brief 1583 contains technical data on the use of inertia and velocity damped servomotors. The 11-page booklet compares various forms of electromagnetic damping, detailing the characteristics of each type. Transfer function equations for servomotors, servomotor-rate generators, inertia and velocity damped servomotors are developed to aid the systems engineer in determining unit damping requirements. Charts of additional damping that can be provided in sizes 11, 15 and 18 of the firms inertial and velocity damped units and a check-list of servomotor specification requirements are also included. Beckman Instruments Inc., Helipot Div., Dept. ED, 2500 Fullerton Rd., Fullerton, Calif.

System Building Blocks

159

This eight-page booklet describes a new line of eight transistorized "DEC System Building Blocks." Electrical, logical and mechanical characteristics of the new units are described in detail. There are also application examples showing how the units can be used as a binary up-down counter and a high speed parallel adder. Included in the fully compatible System Building Block family are flip-flops, inverters, diode logic units, pulse delays, clock, pulse amplifier, and pulse generator. Digital Equipment Corp., Maynard, Mass.

Fastenings

160

Catalog No. 765, 32 pages, covers the firm's socket screw products. The two-color catalog includes hex socket set screws, hex socket cap screws, hex socket flat head cap screws, hex socket button head cap screws, hex socket shoulder screws, and hex socket pipe plugs. Included are unified screw thread tables, tables giving physical properties and dimensional standards, and tables listing plating and finishing treatments and the government specifications to which they conform. The Bristol Co., Waterbury 20, Conn.

Tantalum Capacitors

Specifications on solid tantalum capacitors are presented in this revised engineering bulletin. The four-page Electronics Products Engineering Bulletin No. 1 contains a general description of solid tantalum capacitors, a list of possible applications, and data on performance characteristics. A full-page table lists specifications such as capacitance, working voltage, weight, dimensions, and leakage current for 60 different solid tantalum capacitors. Typical performance curves show the relationship of capacitance and temperature, and the effect of both voltage and temperature on leakage current. Write to: Kemet Co., Dept. ED, P.O. Box 6087, Cleveland 1, Ohio.



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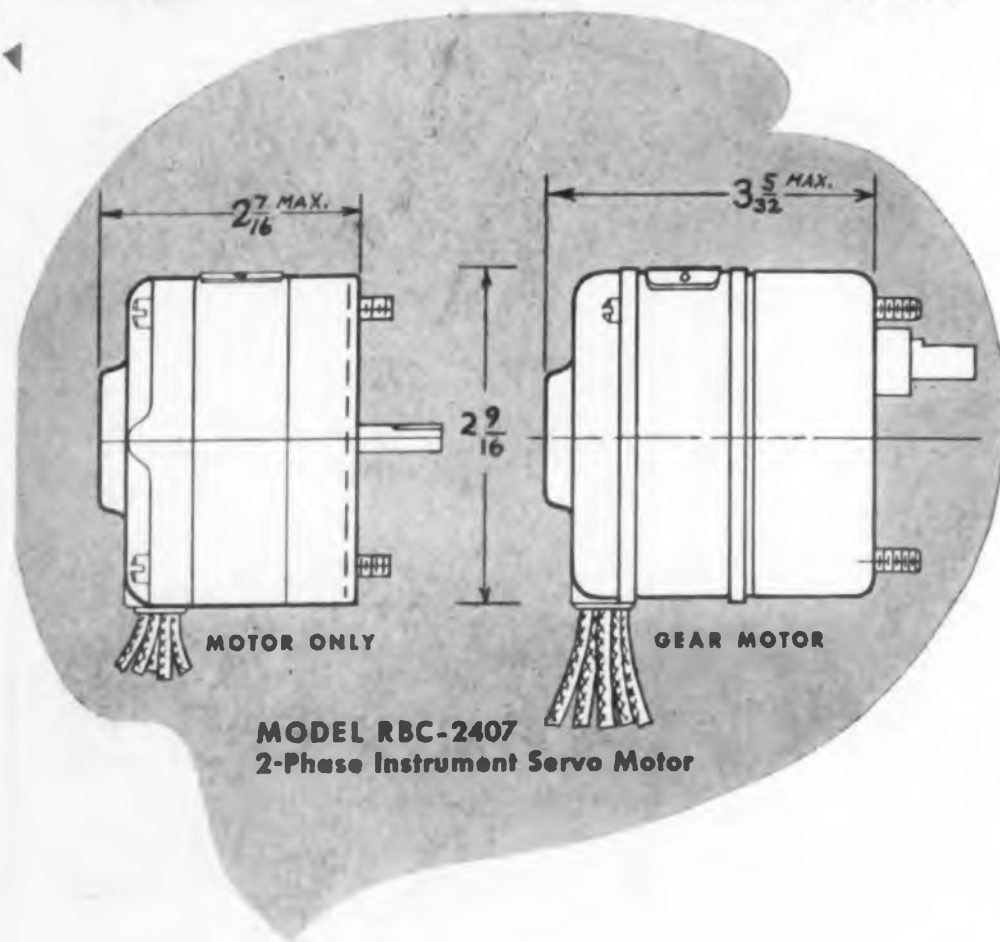
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CIRCLE 162 ON READER-SERVICE CARD

NEW LITERATURE

Power Supplies

163

Basic data on a hybrid series of voltage regulated power supplies is contained in this four-page brochure. The units have both transistor and vacuum tube circuitry. Electrical, mechanical and pictorial material is provided on the units which have a voltage range of from 125 to 325 v. Kepco Inc., 131-38 Sanford Ave., Flushing 55, N.Y.

WWV and WWVH Services

164

Bulletin S-159 describes services available from the National Bureau of Standards radio stations WWV and WWVH. It contains information on time intervals and signals, frequencies, and graphic illustrations depicting schedule of broadcasts by the minute, hour, day and year. Specific Products, 21051 Costanzo St., Woodland Hills, Calif.

Computing Galvanometer

165

Basic theory, application and specifications of type 7-370 computing galvanometer are described in illustrated, four-page, brochure No. 1605A. This instantaneous-watt galvanometer is designed to perform the three basic functions of addition, multiplication and subtraction, permitting calculation of power factor, average power and other multi-variable problems from a single moving trace. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Magnetic Tape Recorder

166

Bulletin 1578A describes the type 5-701 magnetic tape recorder for data acquisition systems where high precision is required with minimum size and weight. It contains pictures, and covers electrical specifications and environmental limits. The unit features 14-track data recording, precision tape drive, self-contained power supplies, a lightweight cast magnesium case and all-metal record heads. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Reliability Data

167

This 64-page brochure describes the firm's system testing concept in terms of participating groups, i.e., test planning, test methods, production test, quality control, reliability groups and other groups concerned with testing electrical circuitry. Entitled "The DIT-MCO Matrix Chart," the brochure contains criteria for an ideal test system, a suggested test system flow diagram and an outline for setting up the test system. DIT-MCO, Inc., Electronics Div., 911 Broadway, Kansas City 5, Mo.



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ALCOA ALUMINUM TEAMS NATURALLY
WITH ELECTRICITY

A NEW CONCEPT

—first step to better coil design

Manufacturers of electromagnetic equipment can reduce material and production costs now — by switching to ALCOA® Aluminum strip windings. Equipment designed with ALCOA strip is more compact, lighter in weight, and better able to dissipate heat than conventional wire. For information about recent ALCOA developments in this field and how they benefit you — please turn the page.

NEW DESIGN CONCEPTS WITH ALUMINUM STRIP

by Robert R. Cope, Aluminum Company of America, Pittsburgh, Pa.

Light weight, better space factor, better heat dissipation, low voltage between turns, less point-to-point contact . . . these characteristics of aluminum strip have long intrigued designers of electrical windings. Today, this aluminum application is a practical reality.

Intensive research and testing by ALCOA have contributed to important technical breakthroughs. New techniques are solving problems relating to edge effect, joining and insulation.

Recently, ALCOA purchased the transformer division of Automation Instruments, Inc., to perfect winding techniques and to produce prototype coils for customers' evaluation. With this added facility, the electrical windings division of ALCOA Research Laboratories is equipped to wind coils from small solenoids up to distribution transformer sizes for testing by manufacturers—an important, new service for the electrical industry.

ALUMINUM'S NATURAL ADVANTAGES

Aluminum weighs less. In general, an aluminum strip winding weighs only half as much as an equivalent winding of copper. Based on equal current-carrying capacity, 0.48 pounds of aluminum replaces one pound of copper. (Figures are for 61.0 per cent conductivity aluminum, 97 per cent conductivity hard-drawn copper.) ALCOA No. 3 EC alloy has been developed expressly for electrical windings. Space factor of aluminum strip can be 90 per cent and higher; for copper wire, 55 per cent to 65 per cent is typical. Thus, although an aluminum strip requires more conductor volume than a conventional wire winding, the total space occupied by each is about the same. Variations in space factor will depend on the strip-to-insulation thickness ratio.

Aluminum strip windings permit higher current densities because each turn has an outside radiating edge that provides effective heat dissipation. Layer-to-layer temperatures are constant; hot spots are virtually eliminated. The inner turns of a wire-wound coil cannot radiate heat as efficiently as the outer turns.

In most cases, aluminum strip windings can be manufactured at lower cost than equivalent wire windings. Aluminum strip lends itself to automation; new high-speed winding techniques have reduced fabrication costs by eliminating much of the hand labor necessary with wire.

Conventional wire windings require heavier insulations to withstand (1) abrasion during winding, (2) abrasion from point-to-point contact between turns, (3) layer-to-layer voltage, which may be many times the turn-to-turn voltage. Aluminum strip insulation needs to withstand only turn-to-

turn voltage because a single turn occupies the entire width of the coil. Thus, thinner and less abrasion-resistant insulations can be used, such as interleaved sheets of Mylar or Kraft paper . . . coatings of varnish, lacquer or epoxy . . . anodized films or vitreous enamel.

ALCOA has tested every known method of joining aluminum. Some techniques proved impractical or costly. But successful joining has been accomplished with ultrasonic welding, high temperature soldering, shielded inert arc welding, cold pressure welding, resistance welding and mechanical joining. Cold pressure welding is quite practical; joints have high strength and conductivity. Ultrasonic welding requires no heat, precleaning or flux; joints are made quickly between parts of different thicknesses, or of multiple thicknesses—and the weld can be made through many types of insulation.

Where is the best application for aluminum strip windings? In power devices or electronic equipment, the economics of aluminum strip windings are indicated when customary wire sizes are 24 gage or larger. However, in many aircraft and missile applications, where weight is a critical factor, aluminum strip is a natural application regardless of size.

Here, at a glance, are the main areas of comparison:

| PROPERTY | COPPER WIRE | ALUMINUM STRIP No. 3 EC |
|--|----------------------|----------------------------|
| Weight (lb/cu in.) | 0.321 | 0.098 |
| Specific gravity | 8.89 | 2.70 |
| Coefficient of linear expansion (1/°C) | 0.000017 | 0.000023 |
| Thermal conductivity at 20°C ($\frac{\text{watts/sq in.}}{\text{in./°C}}$) | 9.7 - 10.0 | 6.0 |
| Electrical conductivity at 20°C, per cent IACS | 97 - 100 | 61.0 |
| Electrical resistance at 20°C (microhms/sq in./ft) | 8.40 - 8.14 | 13.14 |
| Temperature coefficient of electrical resistance at 20°C (1/°C) | 0.00392 - 0.00381 | 0.00409 |
| Modulus of elasticity | 17 x 10 ⁶ | 10 x 10 ⁶ |

ALCOA Aluminum Electrical Windings will reduce your costs and improve your product. We'd like to prove it. Send your specifications to us and we will wind sample coils. Then make your own test.

ALUMINUM COMPANY OF AMERICA, 2263-G Alcoa Building, Pittsburgh 19, Pennsylvania.



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Drafting Equipment 169

Vertical and roll filing equipment for storing and protecting plans, blueprints and other types of drawings are described in catalog No. 4-59, 10 pages. Pictures, dimensions and descriptive material on the equipment is furnished. Plan hold Corp., 5204 Chakemco St., South Gate, Calif.

Piezoelectric Ceramics 170

Bulletin 6900, 2 pages, shows typical shapes which can be fabricated from this material and some of the components that can be made with it, such as accelerometers and actuators. Physical properties and electrical specifications are given. Sprague Electric Co., North Adams, Mass.

Computer Transistors 171

Brochure G-140-A describes types 2N315A-317A pnp and 2N356A-358A npn germanium alloy transistors for applications where high speed, high current switching is important. The brochure, besides detailing standard specification data, includes drawings of each unit, its switching circuit, and its wave form, and graphs of dc collector voltage vs dc base current, dc base voltage vs dc base current, and dc current gain vs collector current. General Transistor Corp., 91-27 138th Place, Jamaica 35, N.Y.

Components 172

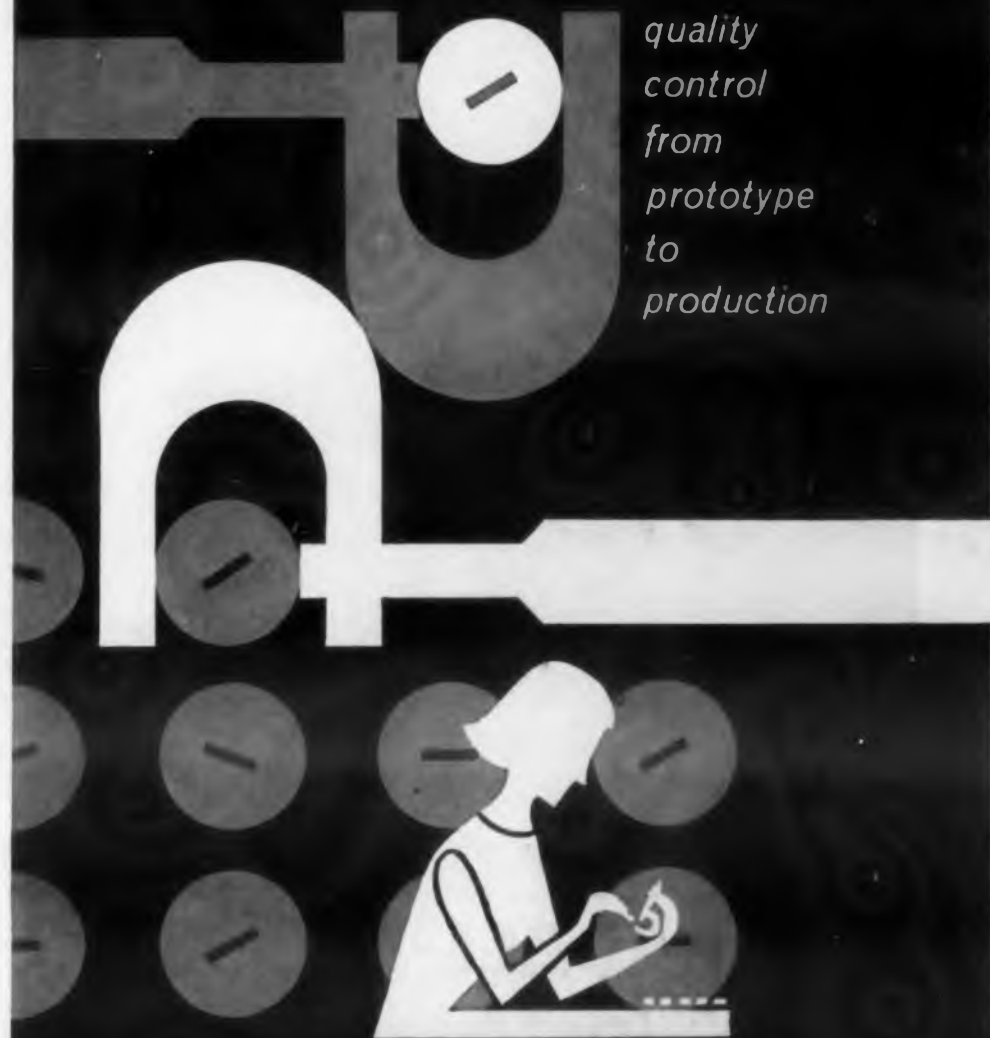
Helinews, No. 19, covers with pictures and technical data the firm's series 7220 and series T potentiometers, both 7/8 in. in diameter. Also included is descriptive material on the series 5200 potentiometer, expanded scale voltmeters, a size 11 servomotor-rate generator, and a list of data sheets available from the company. The last page of the catalog humorously provides basic English translations of typical engineering statements. Helipot Information Service, Helipot Division of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

Insulation 173

Illustrated with both product and application pictures, and containing descriptive data, catalog No. 30, 36 pages, covers electrical insulations for repair and maintenance of motors, generators, and electrical or electronic equipment. Products included are: tubing and sleeving; mica plates and laminates; varnished fabrics; insulation papers; high temperature insulating materials for treatment of Class H units; baking and impregnating varnishes; and pressure sensitive tapes. Insulation Manufacturers Corp., Publications Dept., 565 W. Washington Blvd., Chicago 6, Ill.

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TRANSLATION Both readout instruments operate directly on binary codes on a null-seeking basis. This eliminates the need for external equipment for translation from binary to decimal code, as required with other readout devices.

VISUAL READ-OUT Union readout instruments are designed for quick, easy readability, even when mounted in rows.

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USES Union Switch & Signal READALL readout instruments can be used in the output of digital computers, in teletype receiving equipment, in telemetering systems, or wherever data needs to be displayed.

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CIRCLE 201 ON READER-SERVICE CARD

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ABS Abstract
DF Design Forum
ED Engineering Data
GA German Abstract
ID Ideas for Design
PF Product Feature
RT Russian Translation

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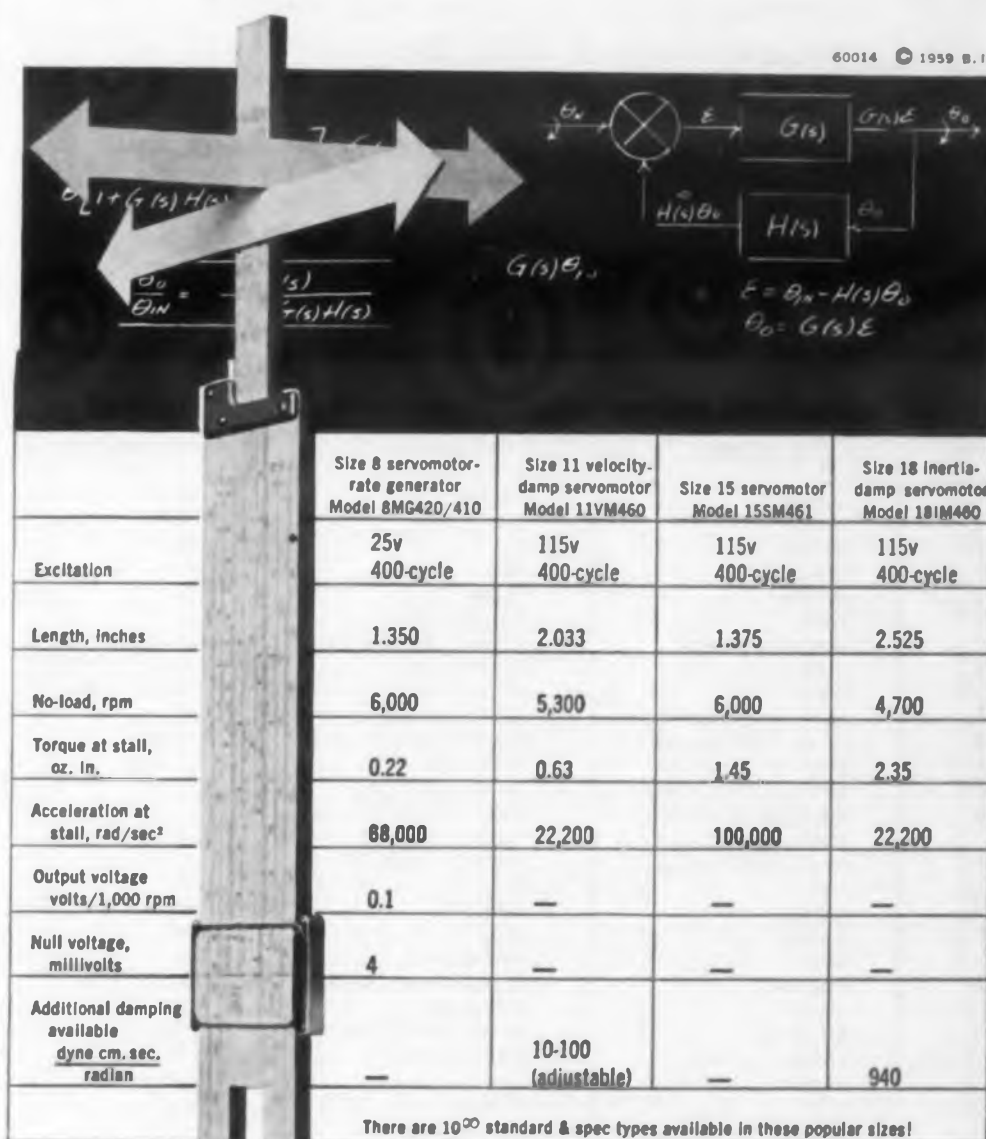
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| | Size 8 servomotor-rate generator Model 8MG420/410 | Size 11 velocity-damp servomotor Model 11VM460 | Size 15 servomotor Model 15SM461 | Size 18 inertia-damp servomotor Model 18IM400 |
|---|--|---|-------------------------------------|--|
| Excitation | 25v 400-cycle | 115v 400-cycle | 115v 400-cycle | 115v 400-cycle |
| Length, inches | 1.350 | 2.033 | 1.375 | 2.525 |
| No-load, rpm | 6,000 | 5,300 | 6,000 | 4,700 |
| Torque at stall, oz. in. | 0.22 | 0.63 | 1.45 | 2.35 |
| Acceleration at stall, rad/sec ² | 68,000 | 22,200 | 100,000 | 22,200 |
| Output voltage volts/1,000 rpm | 0.1 | — | — | — |
| Null voltage, millivolts | 4 | — | — | — |
| Additional damping available dyne cm. sec. radian | — | 10-100 (adjustable) | — | 940 |

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| UME-13 | output | 1000/1200 | 50/60 |
| UME-14 | output | 600 | 3.2 |
| UME-15 | output | 1200 | 3.2 |
| UME-16 | output | 10,000 | 3.2 |
| UME-18 | choke | 3 hy @ 2 Macd | — |
| UME-19 | output or driver | 10,000 CT/12,500 CT | 500 CT/600 CT |
| UME-20 | driver | 10,000/12,500 | 1200 CT/1500 CT |
| UME-21 | driver | 10,000/12,500 | 2000 CT/2500 CT |
| UME-22 | single or PP output | 150 CT/200 CT | 12/16 |
| UME-23 | single or PP output | 300 CT/400 CT | 12/16 |
| UME-24 | single or PP output | 600 CT/800 CT | 12/16 |
| UME-25 | single or PP output | 800 CT/1070 CT | 12/16 |
| UME-26 | single or PP output | 1000 CT/1330 CT | 12/16 |
| UME-27 | single or PP output | 1500 CT/2000 CT | 12/16 |
| UME-28 | single or PP output | 7500 CT/10,000 CT | 12/16 |
| UME-29 | output | 300 CT | 600 |
| UME-30 | output | 500 CT | 600 |
| UME-31 | output | 900 CT | 600 |
| UME-32 | output | 1500 CT | 600 |
| UME-33 | interstage | 20,000 CT/30,000 CT | 800 CT/1200 CT |
| UME-34 | input | 200,000 CT | 1000 CT |
| UME-35 | interstage | 10,000 CT/12,000 CT | 1500 CT/1800 CT |
| UME-36 | choke | 6 hy @ 2 Macd | — |
| UME-37 | choke | 1 hy @ 2 Macd | — |
| UME-38 | choke | 12 hy @ 0 dc | — |
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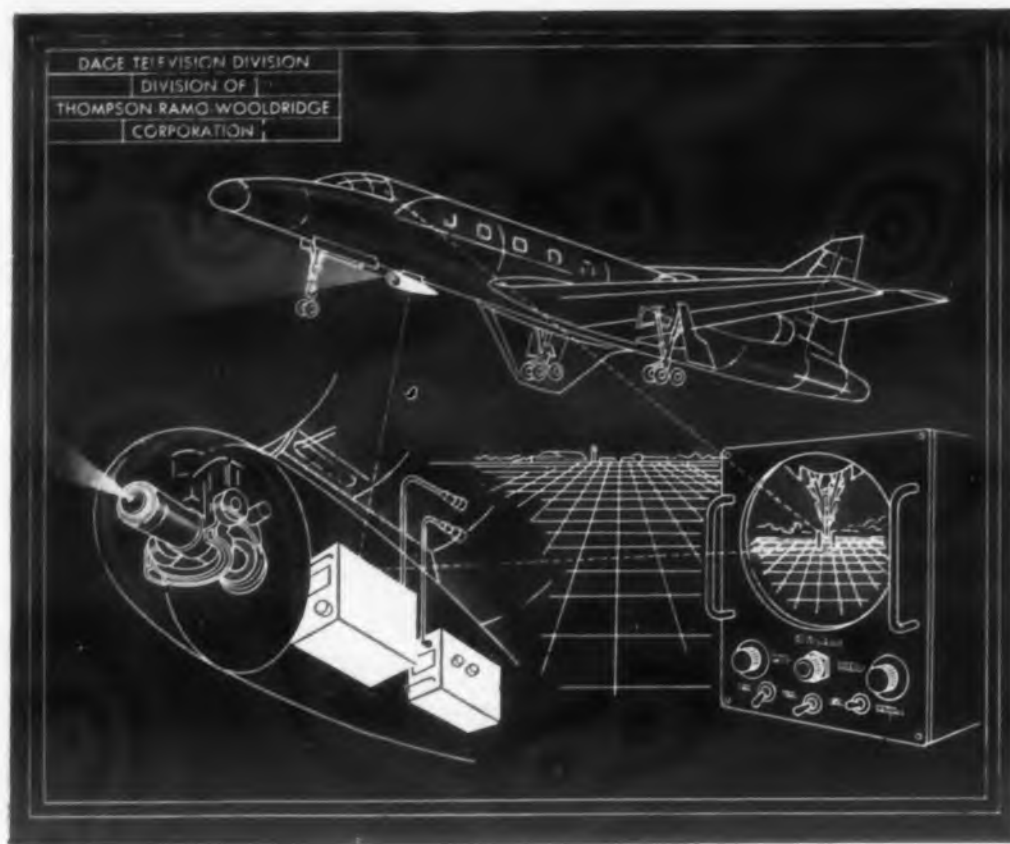
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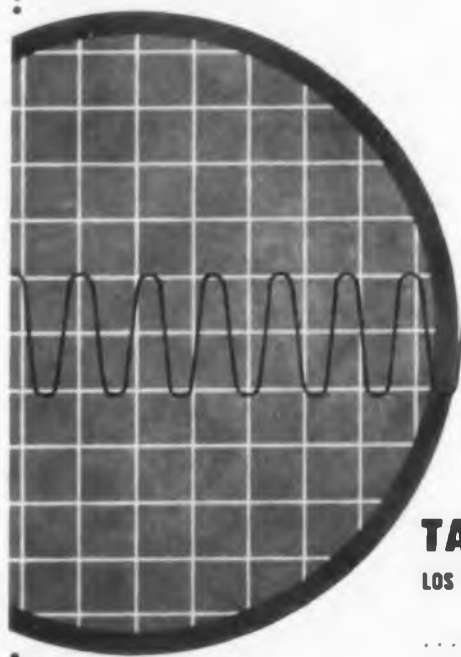
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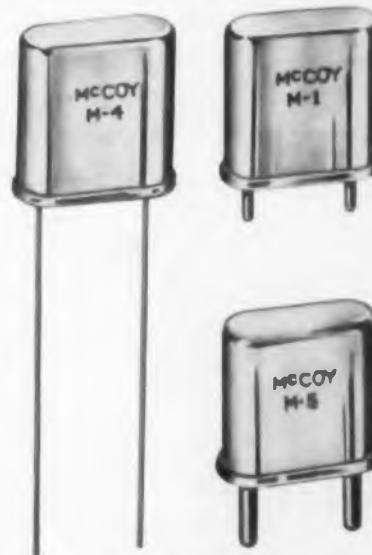
Zener Diode Voltage Regulators, Designingp30, Apr. 1

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Regardless of size, weight, or shape, a McCoy crystal will deliver the utmost in stability under extreme conditions of shock and vibration.

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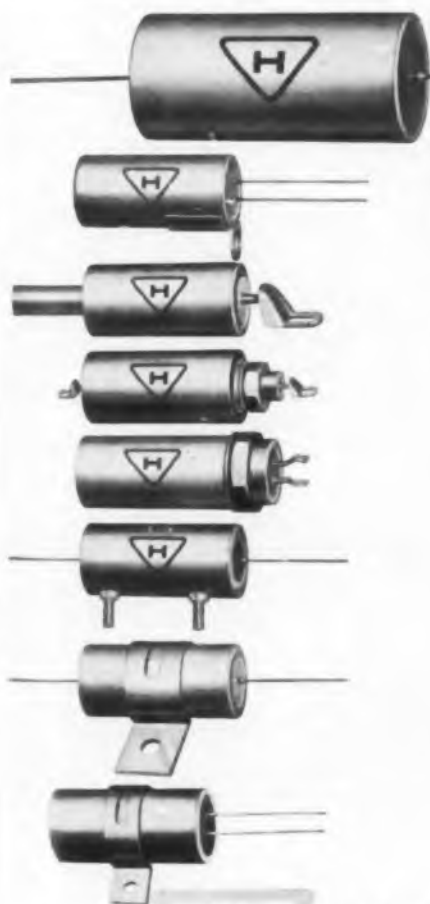
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CIRCLE 212 ON READER-SERVICE CARD

1959 ELECTRONIC DESIGN • July 8, 1959

CIRCLE 213 ON READER-SERVICE CARD

ELECTRONIC DESIGN Tour of the Japanese Electronics Show

Japanese imports in the consumer product field are offering serious competition to the American manufacturer. Some of the new products, displayed in New York City in the middle of June, reflect the compact packaging and smart styling responsible for the increase in quantity of imports. Not only are the items

relatively cheap, they are well designed electronically and style-wise.

Of special interest to those who tend to link the word "copy" with Japanese products, is the Sony Corp.'s completely transistorized AM-FM portable—no other country has produced this item as yet.



Single-lever control, battery-operated tape recorder, with four-transistor amplifier, operates at 3-3/4 ips. Only 7-1/4 in. by 2-1/2 in. by 5 in., the unit, made by Victor of Japan Ltd., weighs a mere four pounds.



Portable four-speed stereo phonograph, shown by Sonritsu Elec. Mach. Co. of Tokyo, includes a self-contained four-transistor amplifier and speaker. Although the turntable is only slightly larger than 2 in. diam, records up to 12 in. size can be played. The complete set weighs only three pounds and is approximately 3 in. by 3 in. by 8 in. A separate speaker plus transistor amplifier accessory is available for stereo playback.



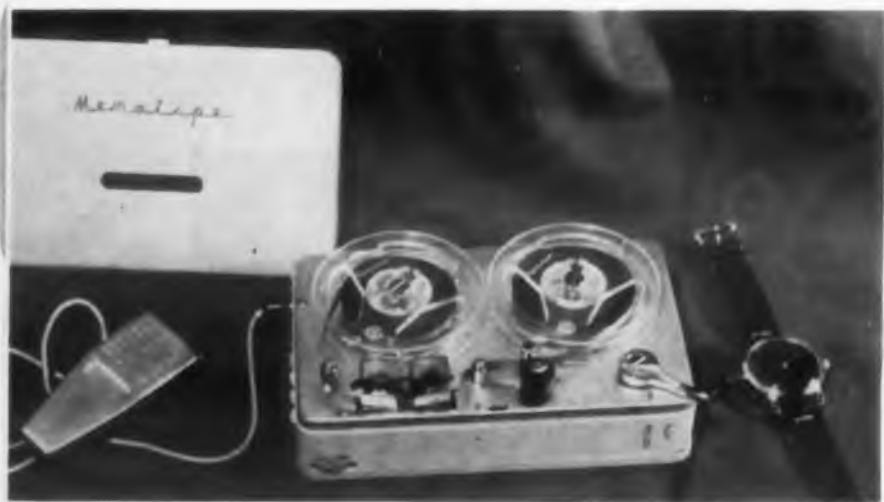
Sony Corp. showed the world's largest transistor portable radio, measuring 2 ft by 1 ft by 6 in. Its baby brother, Sony TR-610, is more popular with the miniature-minded. Incidentally, the giant version is actually a working model.



Low-priced VU meter, imported by Mura Corp. of Great Neck, N. Y., is available for less than two dollars each in quantity lots. Note its size relative to a quarter.

(Continued on page 108)

Japanese Electronics Show



Three pound tape recorder, from Sonritsu Elec. Mach. Co., provides up to one hour recording at a 1-7/8 ips speed. Wrist watch, at right, is actually microphone for interview or news work.



Latest AM-FM transistorized portable from Sony Corp. contains 12 transistors plus 2 diodes and is provided with a multiplex output jack. The FM antenna conveniently folds into the carrying handle when not in use. The retail price is under \$100.





Three speed, seven transistor portable radio-phonograph by Crown Radio of Tokyo weighs only three pounds.



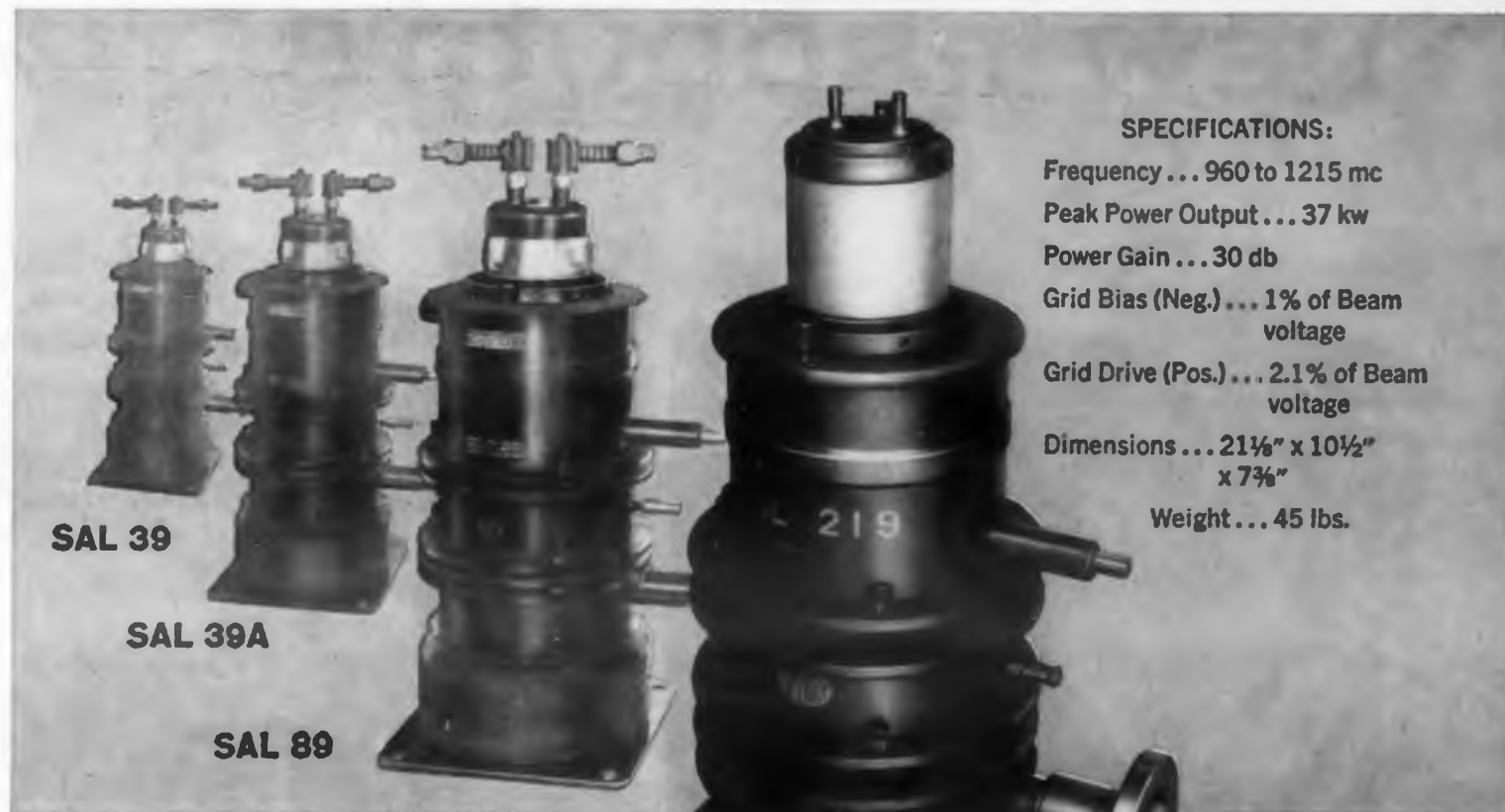
Disassembled unit (above) shows printed circuit board and simple switch assembly. Batteries are contained in compartment to the right of the speaker.

Two design approaches (left) to transistorized intercoms were displayed by Nippon Elec. Co. Ltd. of Tokyo. Both sets use four transistor amplifiers and operate between distances up to 500 ft. Power is consumed only when Talk-Listen switch is operated, thus eliminating drain during standby periods.

Development of klystrons began 20 years ago—at SPERRY



Today—in addition to facilities in Great Neck—Sperry has this modern plant and laboratory in Gainesville, Fla. devoted to klystron development.



SPECIFICATIONS:

Frequency ... 960 to 1215 mc
 Peak Power Output ... 37 kw
 Power Gain ... 30 db
 Grid Bias (Neg.) ... 1% of Beam voltage
 Grid Drive (Pos.) ... 2.1% of Beam voltage
 Dimensions ... 21½" x 10½" x 7¾"
 Weight ... 45 lbs.

... and now

SAL 219

SPERRY'S NEW PULSE AMPLIFIER KLYSTRON FOR AIR NAVIGATION AND TRAFFIC CONTROL

SAL-219 is the latest and most advanced addition to the Sperry family of pulsed amplifier klystrons. Soon going into operational use, this new three-resonator amplifier was developed for current air-navigation-aid applications. And, typical of Sperry's contributions in the tube field, modifications of SAL-219's basic performance characteristics will suit it to a variety of future applications.

SAL-219 has a high- μ control grid, greatly reducing the required modulator power. A space-charge focused beam

reduces weight, size and power requirements by eliminating the need for focusing magnets. A powerful and "clean" R.F. signal can be provided at any frequency through the wide range of 960 to 1215 mc. Integral R.F. cavities are continuously tunable and a ceramic seal, terminated in a standard 1½" coaxial connector, easily accommodates the high peak power level of the R.F. output.

Sperry originated this design concept of klystrons for the aeronautical radio navigation frequencies, and has steadily

improved the product in terms of cost, size, performance, versatility and life. This design concept can result in tubes useful in other applications. For further information on our development capability or specific microwave tubes, write or phone nearest Sperry district office.

SPERRY

SPERRY ELECTRONIC TUBE DIVISION, SPERRY RAND CORPORATION, GAINESVILLE, FLORIDA
 Address all inquiries: Gainesville, Florida or Sperry offices in Brooklyn • Boston • Los Angeles • Montreal • Export Dept., Great Neck, New York

CIRCLE 216 ON READER-SERVICE CARD

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

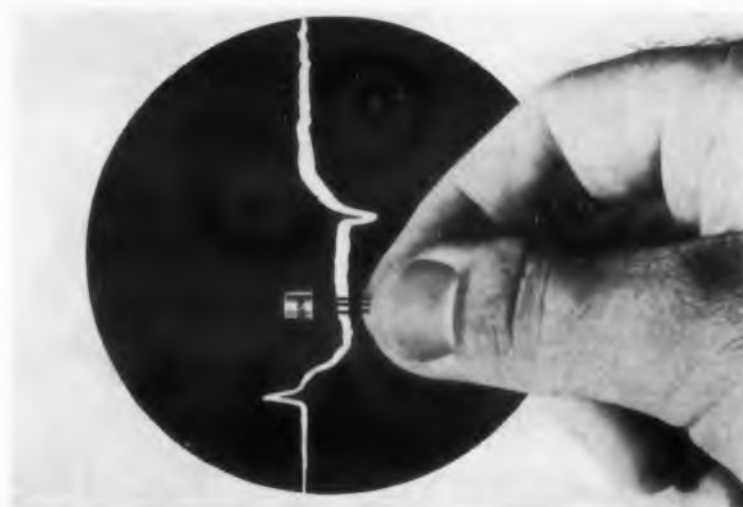


Thermistor Probes Are Interchangeable

Designed for telemetry and general instrumentation use, these two thermistor probes have identical resistance-temperature characteristics. Absolute resistance of each unit is given in 1 F increments from 0 to +350 F. Resistance ranges from 26520 ohms at 0 F to 70.4 ohms at 350 F. Any quantity of the probes is within 2% of the resistance at any point in the temperature range.

Fenwal Electronics, Inc., Dept. ED, 51 Mellen St., Framingham, Mass.

CIRCLE 217 ON READER-SERVICE CARD

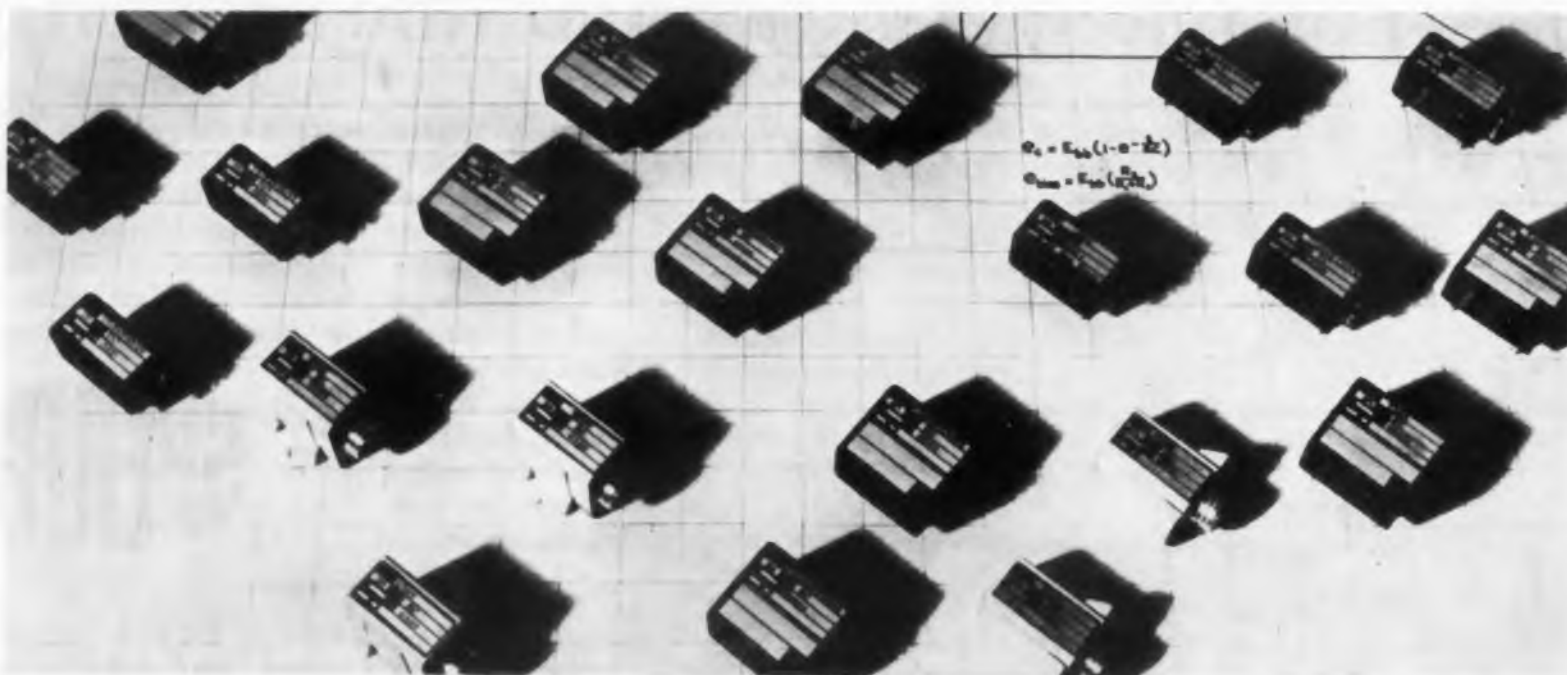


Transistor Switches in 25 μsec

Type 2N702 diffused-base silicon mesa transistor switches in 25 μsec and dissipates 150 mw at 100 C in free air. It provides a dc beta spread of 15 to 45 and a maximum collector cutoff current of 0.5 μamp. Minimum breakdown voltage is 20 v and maximum saturation voltage 0.6 v.

Texas Instruments Inc., Semiconductor-Components Div., Dept. ED, P.O. Box 312, Dallas, Tex.

CIRCLE 218 ON READER-SERVICE CARD



Time Delay Relays Have ±3% Accuracy

These electronic time delay relays have a transistor timing module and are designed to meet the reliability requirements of airborne and ground support equipment. Fixed time delay, which occurs on pull-in, is from 0.07 to 300 sec. Having a nominal time delay accuracy of ±3%, they can meet such conditions as: input voltage variations from 15 to 31 v dc; temperatures from -55 to +125 C, vibrations to 20 g, 200 cps; shock to 50 g, 11 msec acceleration to 20 g.

Tempo Instrument Inc., Dept. ED, P.O. Box 338, Hicksville, N. Y.

CIRCLE 219 ON READER-SERVICE CARD

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON MANUFACTURING COMPANY, WALTHAM 54, MASS., Vol. 1, No. 2

NEW ONE-WATT COMMUNICATION KLYSTRONS COVER GOVERNMENT AND COMMON CARRIER BANDS

Designed primarily for use in microwave relay links, the QK-661 and the QK-754, one-watt transmitter klystrons, operate at frequencies of 7,125 to 8,500 Mc and 5,925 to 6,425 Mc, respectively. The QK-661 is the first tube of its kind to cover the entire government band. The QK-754 is the first of a planned series of tubes to cover the entire communications band.

Both are mechanically tuned, integral-cavity, long-life, reflex-type tubes. The QK-754 uses a coaxial output; the QK-661, a waveguide output.

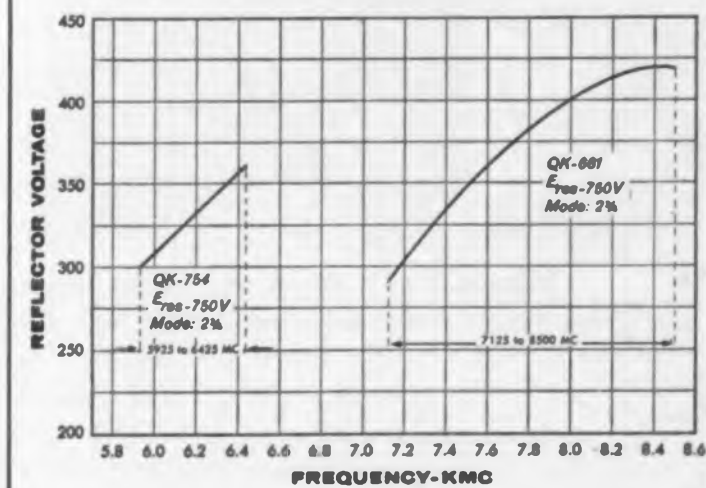
To insure efficient operation the tubes are available with integral cooling fins or with a heat-sink attachment suitable for connection to the chassis.



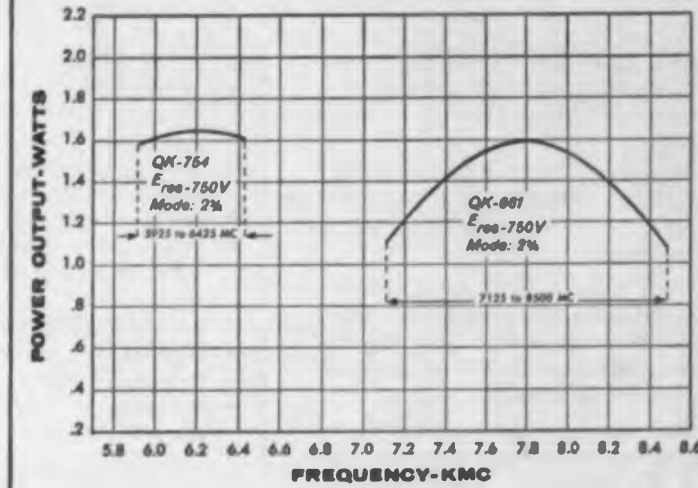
Typical operating characteristics

| | QK-754 | QK-661 |
|---|-----------------|-----------------|
| Frequency Range | 5925 to 6425 Mc | 7125 to 8500 Mc |
| Power Output | 1.5 watts | 1.6 watts |
| Electronic Tuning (to half-power pts) | 50 Mc | 25 Mc |
| Modulation Sensitivity (10 V pk-to-pk mod volt) | 1 Mc/V | 600 Kc/V |
| Temp. Coefficient | ± 0.1 Mc/°C | ± 0.1 Mc/°C |

TYPICAL REFLECTOR VOLTAGE
(AT MAXIMUM POWER OUTPUT)
vs. FREQUENCY



TYPICAL POWER OUTPUT
vs.
FREQUENCY

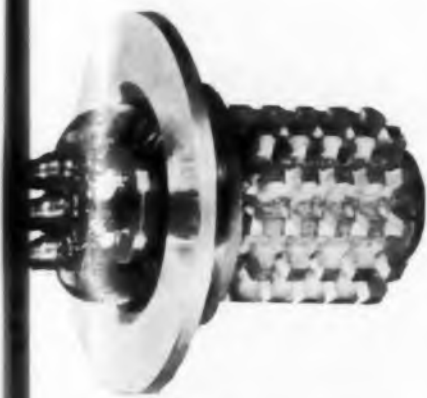


You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Massachusetts

Excellence in Electronics



A LEADER IN CREATIVE MICROWAVE TECHNOLOGY



Vapor Cools Power Tube

Using a vapor cooling technique, the anode dissipation for this power tube exceeds 800 w per sq in. Cooling equipment consists of a boiler filled with distilled water and cooling coils immersed in the water. The tube sets in the boiler and is sealed against its own weight. The tubes may be used in modulators, amplifiers and oscillators.

Raytheon International Telephone and Telegraph Corp., Components Div., Dept. ED, 100 Kingsland Rd., Cliffside Park, N. J.

CIRCLE 220 ON READER-SERVICE CARD



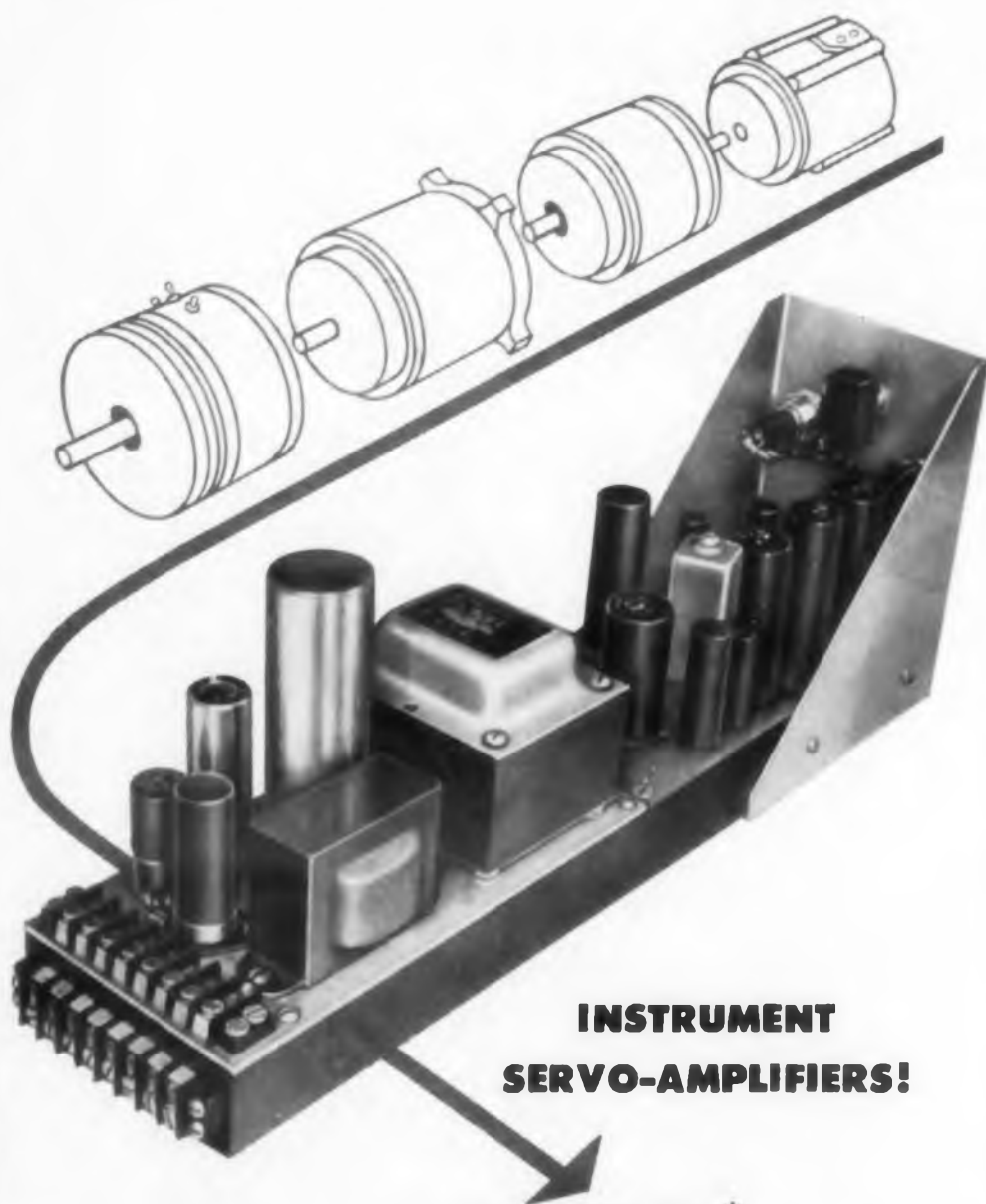
Ferrite Circulator Tees Are Adaptable

These ferrite circulator tees are adaptable as a configuration for a modulator or fast-acting switch by placing the magnet with an electronic magnet. Further modification of the basic configuration results in a four-port circulator. The fourth port is used for a second signal input or for special needs. Typical specifications for one model are: frequency of 9.3 kmc $\pm 4\%$; isolation at III is 15 db min; insertion loss at I or II is 1 db max, and at III or IV is 0.6 db max; vswr is 1.15 max at I and 1.6 max at II.

Raytheon Company, Inc., Microwave and Power Tube Division, Dept. ED, 14844 Oxford St., Van Nuys, Calif.

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**INSTRUMENT
SERVO-AMPLIFIERS!**

an addition to the **DIEHL*** family of
INSTRUMENT SERVO COMPONENTS

This new line of Instrument Servo-Amplifiers, coupled to an already established family of DIEHL Instrument Servomotors, Tachometers and Gear Reducers, further expands the new DIEHL concept of furnishing high quality servo components in modular form.

These units have been designed so that a true servomotor-amplifier combination featuring faster SERVO response is at last available from a single source of supply.

DIEHL Instrument Servo-Amplifiers are supplied in ratings suitable for driving the popular 1, 5 and 10 watt motors and use printed circuitry for high reliability.

Write for detailed information on this complete line of Instrument Servo Components.

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Electrical Division of THE SINGER MANUFACTURING COMPANY

Finderne Plant, SOMERVILLE, N. J.

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- AC SERVO MOTORS • AC SERVO MOTORS WITH AC TACHOMETERS • DC SERVO SETS
- AC SERVO MOTORS WITH DC TACHOMETERS • AC AND DC TACHOMETERS • RESOLVERS

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CIRCLE 223 ON READER-SERVICE CARD

FEATURES

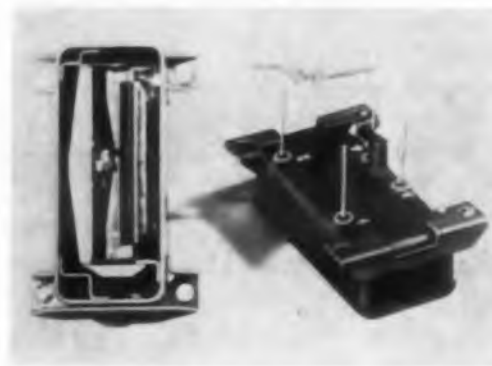
- Standard rack mounting.
- Control adjustments for gain, phase, internal feedback, and external feedback.
- Push-pull output stage matched to motor control phase.
- A.C. or D.C. input.
- With or without integral power supply.
- Reliable, premium quality vacuum tubes.



NEW PRODUCTS

Thermal Relay

Takes 50 g Shock



Able to take 50 g shock for 11 msec, the type PT thermal time delay relay has an operating time delay of from 3 to 60 sec. It can operate under vibration of 20 g up to 2000 cps and has no resonance below 2000 cps. Delay of unit is set within $\pm 5\%$. Effects of temperature are held within $\pm 5\%$ over the range of -65 to $+125$ C. Hermetically sealed in a 1-3/16 x 2-1/4 x 3/4 in. case, the relay weighs a maximum of 2-1/4 oz.

G-V Controls Inc., Dept. ED, Okner Parkway, Livingston, N. J.

CIRCLE 224 ON READER-SERVICE CARD

Synchro Tester

Conforms to MIL-S-20708A



Equipped to perform synchro acceptance tests outlined in BuOrd specification MIL-S-20708A, the model MST-5SSA tester measures electrical error, fundamental null, total null, and electrical zero of synchros CX, CT, and CDX. Testing by the proportional voltage gradient method, the unit incorporates a phase-sensitive voltmeter that measures electrical error and fundamental null voltages and a 360 deg phase shifter that comprises the reference voltage to the voltmeter. Null accuracy is 2% and electrical error is less than 10% of maximum synchro error. Dimensions are 24 x 25 x 17 in.

Theta Instrument Corp., Dept. ED, 48 Pine St., East Paterson, N.J.

CIRCLE 225 ON READER-SERVICE CARD

Timesaving . . . cost-cutting
**first aid
for the
DESIGN LAB**



SERVOBOARD® Electromechanical Assembly Kits are truly first-aid kits for the engineer with model-making problems.

These modern kits are scientifically designed and packaged by Servo Corporation of America to eliminate the majority of breadboarding headaches...swiftly, economically, and with precision.

Selection of components has been made by experts with years of servo systems design and production experience. Enough components are included in each kit to meet almost every model-making need. Extra components are always available out of open stock.

Exclusive SERVOBOARD features eliminate model shop costs and time lags inherent in usual model-making techniques. For example:

PRECISION — 1/2"-thick, anodized aluminum mounting board is **absolutely rigid**. Extraneous stresses cannot produce spurious results.

SPEED OF ASSEMBLY — Holes are tapped to receive captive screws on mounting clamps, permitting easy assembly from the top and eliminating underhanded fumbling.

FLEXIBILITY — Components may be assembled at any angle, not just parallel or at right angles. Kits include wide variety of co-ordinated components.

ECONOMY — Quick set-up and knock-down permit maximum re-use for new problem solving.

SPACE-SAVING — Mounting boards stack one above the other.

EXPANDABLE — No system too large.

Three sizes of kits are available, any one of which can begin eliminating design headaches immediately. Get full details (without obligation) by writing for free SERVOBOARD Electromechanical Assembly Kits Brochure. Do it today... WRITE NOW! Request TDS 1110-7.



**SERVO
CORPORATION
of AMERICA**

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CIRCLE 226 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1958

Wideband Amplifiers

Have under 0.01% noise



Solid state wideband amplifiers with transistor choppers, these potentiometric and operational amplifiers have a frequency response that exceeds -3 db at 200 kc, an input impedance of 100 meg, gain accuracies to $\pm 0.002\%$, and linearity of $\pm 0.05\%$. Noise is less than 0.01% peak-to-peak from any source. Each unit is completely self-powered and measures 8 x 4 x 1-1/2 in. Up to ten can be installed within 5-1/4 in. of a standard 19 in. rack. Packard Bell Computer Corp., Dept. ED, 1905 Amiacost Ave., Los Angeles 64, Calif.

CIRCLE 227 ON READER-SERVICE CARD

Signal Generator

Has 2000 to 4600 mc range



A microwave signal generator in the 2000 to 4600 mc range, the model MSG-2P provides a maximum signal strength of 10 mw with calibrated attenuation down to -127 dbm. Its direct-reading internal attenuator is accurate to ± 0.5 db below 1 mw, to 8 db above. The instrument generates cw, pulse, square wave, fm, and synchronizing pulse signals. Internal pulse and square wave repetition rates are adjustable from 1 to 4000 pps; pulse widths, from 0.5 to 10 μ sec; and delays, from 2.5 to 300 μ sec. The portable unit may be externally modulated and features direct-reading linear frequency dial accurate to $\pm 0.1\%$ and noncontacting short-type klystron cavities for noiseless tuning. Pulse rise and decay times are less than 1 μ sec.

Polaroid Electronics Corp., Dept. ED, 43-20 66th St., Long Island City 1, N. Y.

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.005 μ sec. to 5,000 μ sec.

ESC DELAY LINES TAKE GIANT STEPS!



From the smallest to the largest— .005 μ sec. to 5,000 μ sec.—ESC's research staff has custom-designed delay lines for virtually every military and commercial application! And with every delay line prototype comes a comprehensive laboratory report, which includes submitted electrical requirements, photo-oscillograms (which indicate input and output pulse shape and output rise-time), the test equipment used, and an evaluation

of the electrical characteristics of the prototype.

In addition, an extensive factory rep organization spans the nation, ready to provide on-the-spot assistance in specification and installation.

For complete technical data, write to ESC—America's leading manufacturer devoted to the design, development and production of custom-built and stock delay lines!



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Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers • Pulse transformers • Medium and low power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

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1959



LECTROFILM*-B CAPACITORS



General Electric Announces for Missile Use . . .

New Lectrofilm*-B Capacitors for 44,000 Hours of Reliable Life

New G-E Lectrofilm-B capacitors offer you maximum reliability at lowest possible cost . . . results of over 3,000,000 unit-hours of life test data (per G-E Spec. MTC-3) indicate a probability of survival in excess of 0.99 for 44,000 hour life under rated voltage at 85C. Under rated voltage at 125C, the indicated probability of survival is in excess of 0.98 for 44,000 hour life.

LOW FAILURE RATE AND LONG LIFE of these inexpensive G-E capacitors result from using only the highest quality materials and the closest of process controls . . . units are tightly wound with high-purity aluminum foil and capacitor-grade Mylar† film dielectric. No solder is used, and introduction of contaminants through impregnation is eliminated.

SMALL, LIGHTWEIGHT ENCLOSURE consists of tape wrapped around the compact roll and sealed with epoxy resin, forming a rugged case which resists humidity, vibration and shock.

TO MEET YOUR APPLICATION REQUIREMENTS, 14 case sizes are available in five ratings—100-, 200-, 300-, 400-, and 600-volts. Capacitance range within each rating is: 0.015 to 0.68 uf in 100 volts; 0.010 to 0.47 uf in 200 volts; 0.0047 to 0.22 uf in 300 volts; 0.0033 to 0.15 uf in 400 volts; and 0.0010 to 0.10 uf in 600 volts.

GET A QUOTATION TODAY ON NEW LECTROFILM-B CAPACITORS by contacting your General Electric representative. Ask for your copy of life-test data and G-E Specification MTC-3. Or, write to Section 447-4, General Electric Co., Schenectady, N. Y.

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NEW PRODUCTS

Transformers

Coil oscillator inductor type



Inductance, coil oscillator type—these transformers have 280 to 630 mh inductances. Normal excitation is 10 v rms between opposite ends of the winding at any frequency between 1 and 2 kc.

Mercury Transformer Corp., Dept. ED, 12964 Panama St., Los Angeles 66, Calif.

CIRCLE 231 ON READER-SERVICE CARD

Video Amplifiers

Incorporate miniature circuit board



Using a miniature circuit board (shown) for crystal video detection—these video amplifiers have a high input impedance and low noise. Included in the line is the model 17 which operates from -50 to +55°C and can be supplied to accept positive or negative input pulse. It can also be provided with 400 cps video chopping to permit cw reception. The circuit board in the unit is built to MIL-E-5400 and has solid tantalum capacitors throughout.

American Electronic Labs, Inc., Dept. ED, 121 N. Seventh St., Philadelphia, 6, Pa.

CIRCLE 232 ON READER-SERVICE CARD
CIRCLE 230 ON READER-SERVICE CARD

Accelerometer

Weighs 9 g



Accelerometer model 2224 is 1/2 in. high, weighs 9 g, and provides 100 mv per g peak sensitivity with a resonant frequency of 30 kc. Frequency response $\pm 5\%$ is 2 to 2000 cps; amplitude linearity is 1%; and temperature range is -70 to $+250$ F.

Endevco Corp., Dept. ED, 161 E. California Blvd., Pasadena, Calif.
CIRCLE 233 ON READER-SERVICE CARD

Electronic Counter

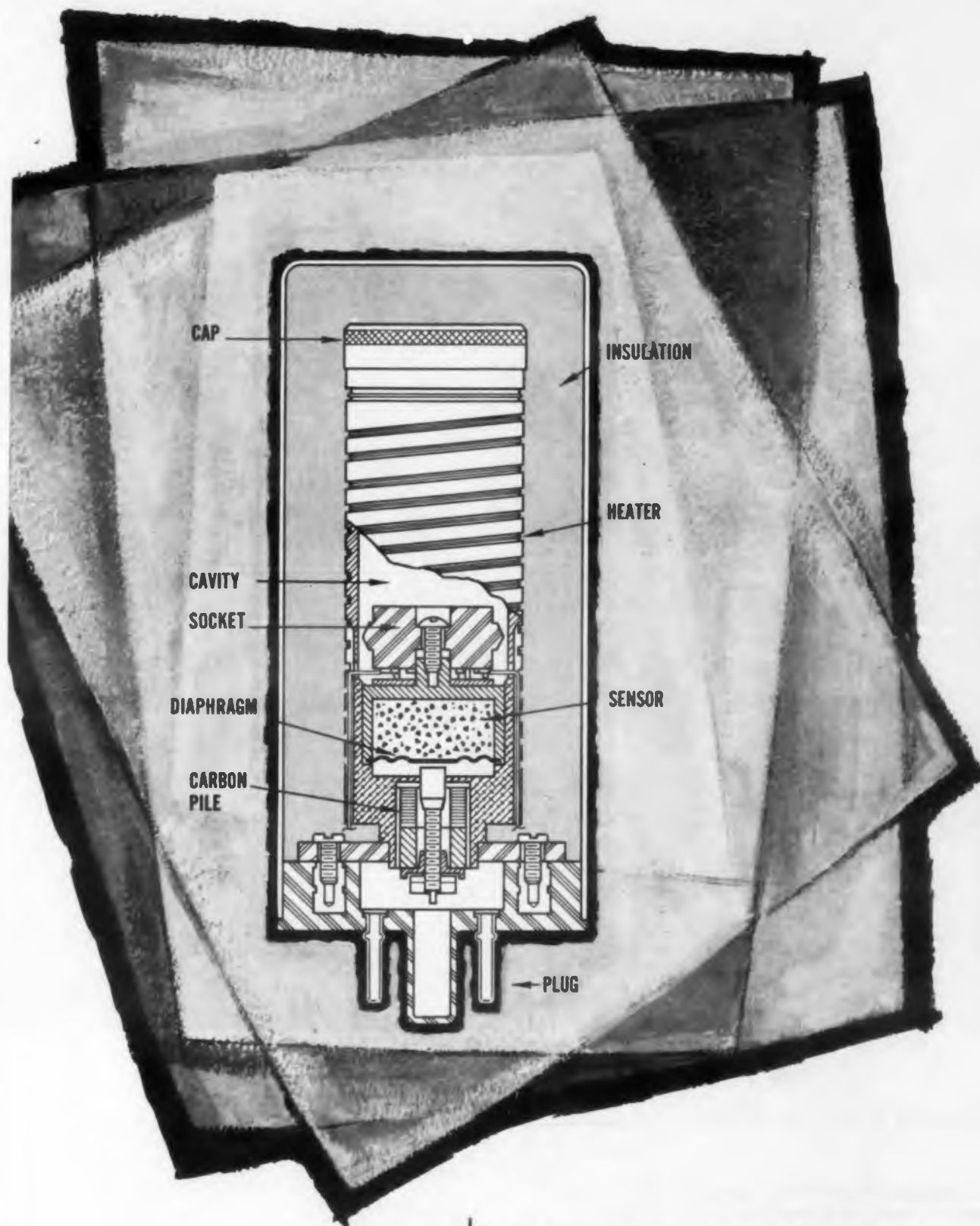
Has 8-decade readout



Counter model 524D has a uni-decade 8-decade numerical readout and a crystal oscillator stability of ± 1 part in 10^8 for short terms or 5 parts in 10^8 per week. It provides full frequency measurements from 10 cps to 10 mc and period measurements from 0 to 10 kc. Plug-in units are available for measuring up to 220 mc frequencies, over 1000 periods, and 1 μ sec to 100 μ sec of time. Total registration is 99,999 counts.

Hewlett-Packard Co., Dept. ED, 1565 Page Mill Rd., Palo Alto, Calif.

CIRCLE 234 ON READER-SERVICE CARD
CIRCLE 235 ON READER-SERVICE CARD



**NOW —
CIRCUIT
SIMPLICITY
THROUGH
ABSOLUTE
TEMPERATURE
CONTROL**

Robertshaw Crystal Oven Solves Temperature Compensation Problems

Design engineers can now eliminate temperature compensating circuits and still use inexpensive, temperature sensitive components by housing critical elements in Thermal-Set, Robertshaw's latest change-of-state crystal oven. The reason—Thermal Set's extremely accurate temperature control. To accomplish this, Robertshaw has incorporated two basic features uncommon to conventional ovens—thermal stability and thermal constancy. Thermal stability, or the absence of temperature drift with time, is attained by using the melting point of pure crystalline salt as an absolute and unvarying temperature reference standard. Thermal constancy, the absence of cyclical temperature variation, results from using a proportional heat control system. Combined, these features offer unmatched thermal accuracy... the key to optimum system performance.

SPECIFICATIONS Standard Cavity Temperature: 53°C, 70°C, 87°C. Temperature Control: 0.007°C average cavity temp. change per degree ambient changes. Heater Voltage: 6.3 volts AC or DC $\pm 5\%$. Heater Power: 4.0 watts max. @ 25°C. External Dimensions: 1-7/16" x 1 1/8" x 4-1/16" seated height. Cavity Dimensions: 0.92" dia. by 1.625" deep. Weight: Approx. 6.15 oz. Mounting: Octal Plug. Cavity Sockets Available: Standard 2 or 9 pin. Special configurations and more exacting performance characteristics available on special order. Complete information in Technical Bulletin RF-594. Robertshaw-Fulton Controls Co., Aeronautical and Instrument Division, Santa Ana Freeway at Euclid Avenue, Anaheim, California.

APPLICATIONS

Crystals
Crystal Oscillator Circuits
Zener Diodes
Thermocouple Reference Junctions
Transistorized Circuitry
Tuning Forks
Thermistors
Reference Networks
LC and RC Oscillator Circuits

CLEVITE SILICON JUNCTION DIODES

ACTUAL SIZE

*250 MW Package . . .
Fast Switching and General Purpose Types
Featuring . . .*

- **MECHANICAL RELIABILITY** — Rugged, hermetically sealed, subminiature packages. Designed to meet both military and commercial requirements.
- **ELECTRICAL SUPERIORITY** — Excellent high temperature operation . . . thermally stable . . . high forward conductance . . . efficient rectification.
- **PRODUCT UNIFORMITY** — Tight manufacturing controls.

For details, write for Bulletin B217A-1 B217A-2

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Twinbrook 4-9330

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Silicon Junction Diodes Germanium Diodes Power Transistors Solder Lug Power Transistors

TECHNICAL DATA

| Type | Max. DC Inver. Oper. Voltage | Forward Current @ Specified Voltage | Max. Inverse Current | | |
|-------|------------------------------|-------------------------------------|----------------------|------------------------|------------|
| | | | @ 25°C | @ 150°C | Test Volts |
| 1N457 | 60 V | 20 ma @ 1.0 V | 0.025 μ a | 5.0 μ a | 60 V |
| 1N458 | 125 V | 7 ma @ 1.0 V | 0.025 μ a | 5.0 μ a | 125 V |
| 1N459 | 175 V | 3 ma @ 1.0 V | 0.025 μ a | 5.0 μ a | 175 V |
| 1N662 | 90 V | 10 ma @ 1.0 V | 20 μ a | 100 μ a (@ 100° C) | 50 V |
| 1N663 | 90 V | 100 ma @ 1.0 V | 5.0 μ a | 50 μ a (@ 100° C) | 75 V |
| 1N778 | 100 V | 10 ma @ 1.0 V | 0.5 μ a | 30 μ a (@ 125° C) | 100 V |
| 1N779 | 175 V | 10 ma @ 1.0 V | 0.5 μ a | 30 μ a (@ 125° C) | 175 V |

NEW PRODUCTS

Miniature Relay Current sensitive



Current sensitive type S Powrmiter relay is a miniature dpdt unit that withstands 100 g shock for 11 msec and 30 g, 55 to 2000 cps vibration. It operates from -65 to +125 C and is available with coil resistances from 185 ohms to 10 K. Contact rating is 2 amp resistive; pull-in time, 5 msec; drop-out time, 5 msec and maximum weight, 0.5 oz.

Filtors, Inc., Dept. ED, 30 Sagamore Hill Dr., Port Washington, N.Y.

CIRCLE 237 ON READER-SERVICE CARD

Clutches and Brakes Miniature



For use in servo and control systems, analog computers, and precision instruments, these miniature clutches and brakes come in frame sizes 5, 8, 11, 13, and 18. They have torque ratings from 6 to 224 oz-in and consume 2.5 to 5 w, depending upon size. OD's range from 0.94 to 2.047. The units have a long life, fast response time, and resistance to environments. They may be wound with Teflon for performance under Class H temperatures.

Dynamic Instrument Corp., Dept. ED, 59 New York Ave., Westbury, N.Y.

CIRCLE 238 ON READER-SERVICE CARD
← CIRCLE 236 ON READER-SERVICE CARD

Spring Motor

Retracts light loads



The Spir'ator motor is powered by a fully enclosed spring that produces a relatively constant output torque throughout a long deflection. The outer rim of the spring case serves as a pulley for a cable through which motor torque can be applied as a linear force. The cable extends 5 ft, and the force exerted on it varies from 12 oz at full extension to 7 oz at full retraction. The unit retracts or counterbalances light loads.

Hunter Spring Co., Dept. ED, 1 Spring Ave., Lansdale, Pa.

CIRCLE 239 ON READER-SERVICE CARD

Oscilloscope Camera

Direct view



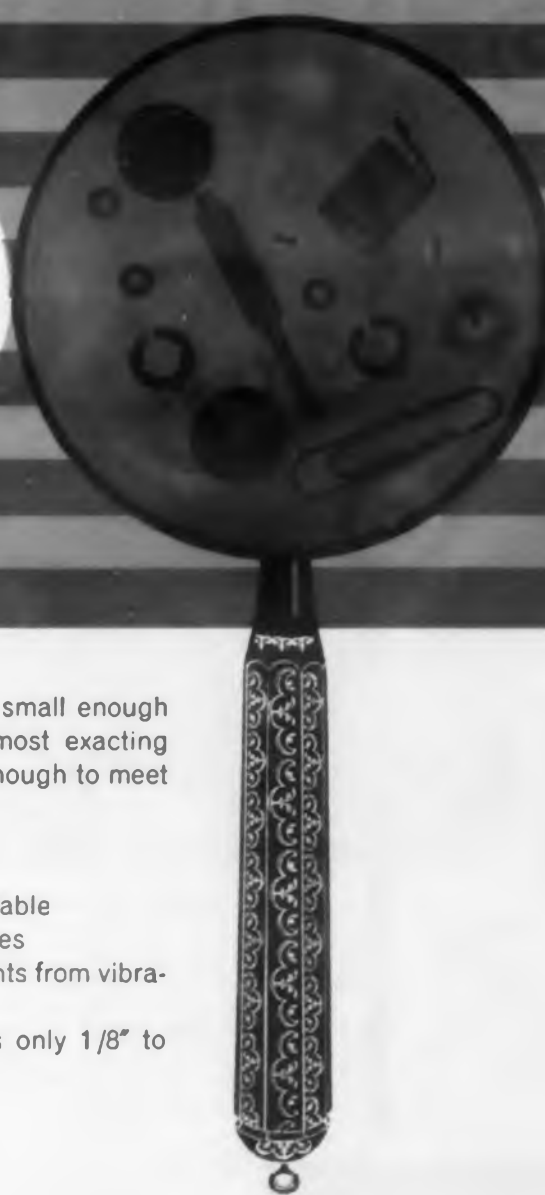
Attached to any standard oscilloscope, the Direct-View Oscillotron provides a direct view of the cathode ray tube during recording. It has no mirrors, permitting binocular viewing without image reversal. The unit is available with either a Polaroid Land back or an electrically pulsed 35 or 70 mm magazine for automatic remote operation. Continuous motion magazines may also be supplied. The camera springs back to give access to the lens and shutter.

Beattie-Coleman, Inc., Dept. ED, 1000 N. Olive St., Anaheim, Calif.

CIRCLE 240 ON READER-SERVICE CARD

CIRCLE 241 ON READER-SERVICE CARD

SETTING THE PACE IN POT DESIGN



Daystrom Pacific Series 341 potentiometers are small enough (case length 1-9/64, dia. 35/64) to meet the most exacting weight and space requirements, and accurate enough to meet the most exacting performance requirements.

OUTSTANDING FEATURES

- Mechanical:* 10 Turn Standard—3 and 5 turn available
Servo, Bushing or Shaft Locking Styles
Double Wiper—eliminates intermittents from vibration and shock
Built-in Slip Clutch Available—adds only 1/8" to length
- Electrical:* Operates to 140°C
2.5 watt rating at 40°C
Resistances from 10Ω to 600K
Linearity to 0.05%

For more information, write for Data File ED-686-1



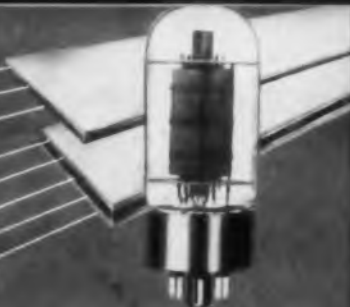
DAYSTROM PACIFIC

a division of DAYSTROM, INC.

9320 LINCOLN BOULEVARD, LOS ANGELES 45, CALIFORNIA

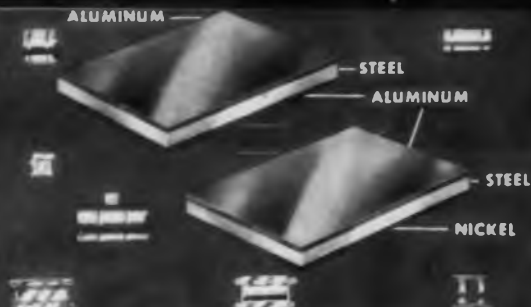
potentiometers / gyro instruments / airborne systems

ALUMINUM
STEEL
COPPER
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COPPER
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ALUMINUM



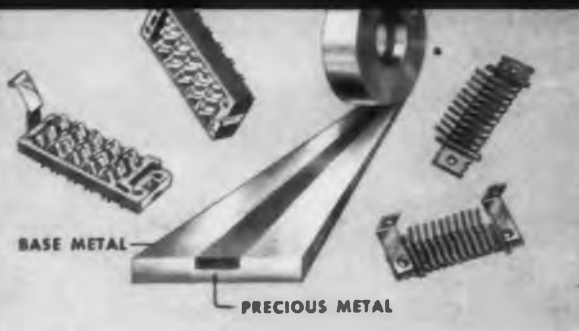
ALIRON[®] Copper-Base and Copper-Cored

Three-layer and five-layer materials used for anodes in rectifier and amplifier tubes. Provide longer power output life . . . uniform heat dissipation . . . high electrical conductivity . . . improved anode reradiation . . . and reduce costs.



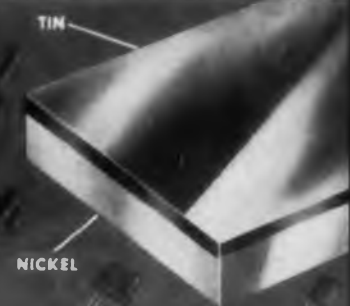
ALNIFER[®], NIFER[®]

These clad metals are used as alternate materials for solid pure nickel in electron tubes. They conserve critical material . . . reduce costs substantially. Supplied in annealed coils ready for your production.



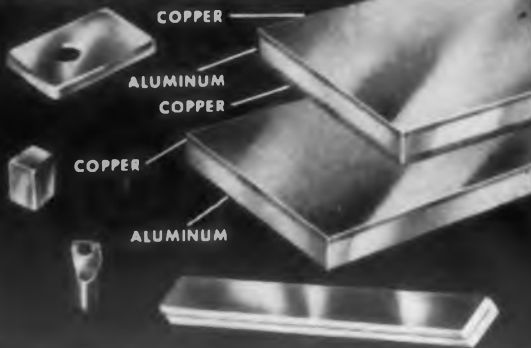
CLAD PRECIOUS METAL CONNECTOR MATERIALS

High reliability of connectors, clips, terminals obtained by using gold and other precious metal alloy stripe materials . . . place high performance materials in the contact areas . . . cost-savings and improved performance over gold electroplated parts.



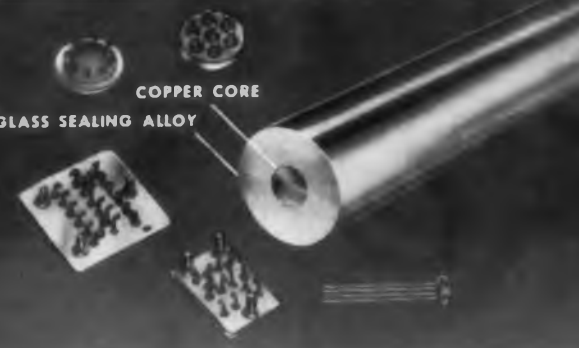
TIN CLAD METAL STRIP and other Semiconductor Clad Metals

A number of combinations of clad metals are available for use on base tabs, lead wires, whisker wires, base materials and enclosures in silicon and germanium diodes, transistors and germanium power transistors.



ALCUPLATE[®]

Easily formed, deep drawn or spun. Used for waveguides, component cases, variable condenser blades, chassis and electrical or thermal conductive parts. Light in weight, saves up to 30% over the cost of solid copper.



COPPER-CORED GLASS SEALING WIRES

Featuring a sound metallurgical bond, these wires give three times greater conductivity than solid 52 alloy wire of equal diameter . . . they facilitate miniaturization. Features include: leakproof seal between alloy and core, high electrical and thermal conductivity, lower costs.



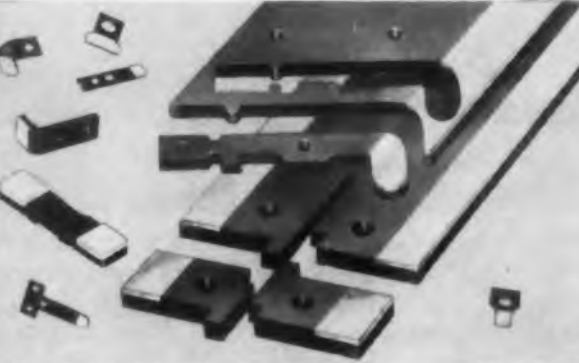
ALUMINUM-IRON ALLOYS

For magnetic applications requiring low core losses and high permeability at low flux densities in current and pulse transformers, relays, gyro mechanisms, servo mechanisms, missile guidance systems, etc.



CLAD ELECTRICAL CONTACT TAPES

For products you want to automate, this modern contact form permits greater latitude in contact assembly design . . . automatic assembly of two or more parts in a single operation. Tape contacts are easily attached by spot welding . . . are self-aligning . . . and allow broader assembly tolerances. Save up to 40% in contact costs.



CLAD CONTACT MATERIALS

Single and double inlay, overlay and toplay provide better electrical performance, longer operating life and lower fabrication costs. Complete assemblies can be made to close tolerances by single blanking and forming operations.

**General Plate
Clad Metals and Clad
Electrical Contact Materials
Solve Design Problems . . .
Provide High
Performance Reliability**

General Plate clad precious-to-base or base-to-base metals are inseparably bonded by a patented solid-phase bonding process without the use of brazing alloys or other intermediate material.

If you are seeking metals with useful characteristics that can't be found in a single metal or alloy, investigate clad metals. If you want stronger or lighter components — or better electrical and mechanical properties — or fewer corrosion problems — or if you are interested in conserving critical metals or reducing parts costs, you can profit by using General Plate Clad Metals.

Write for a General Plate Clad Base Metals catalog today. Or better yet, why not talk over your requirements with a competent field engineer? His knowledge of the applications of clad metals is yours for the asking. No obligation, of course.

METALS & CONTROLS

707 FOREST STREET, ATTLEBORO, MASS., U. S. A.

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

GENERAL PLATE PRODUCTS: Clad Metals • Electrical Contacts • Truflex[®] Thermostat Metal
Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

NEW PRODUCTS

Size 5 Servo Motor

Delivers 0.1 oz-in. stall torque



Designed for air and missile borne guidance systems, this size 5 servo motor weighs 0.6 oz and delivers 0.1 oz-in. of stall torque. It requires 1.5 w per phase at 26 v ac, 400 cps, and, under these conditions, accelerates at 39,000 radians per sec² until a free speed of 10,000 is reached. Moment of inertia is 0.18 g-cm².

Daystrom Transicoil, Dept. ED, Worcester, Montgomery Co., Pa.

CIRCLE 243 ON READER-SERVICE CARD

Servomotor

Radiation resistant



Type T175-001 size 15 servomotor operates effectively from -54 to +200 C and withstands 10¹⁰ through 10¹⁰ roentgens of radiation. It has a high torque-to-inertia ratio and its stator is integrally cast in a thermosetting resin that affords straight-through bores and minimum air gaps. The 115 (fixed phase), 400 cps unit has 0.4 power

◀ CIRCLE 242 ON READER-SERVICE CARD

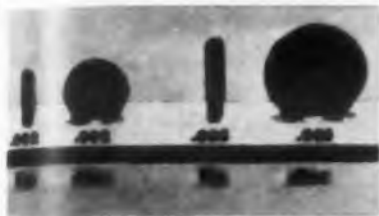
input c 6.1 w, a no load speed of 5000 rpm, and a stall torque of 1.45 oz-in. It weighs 7.3 oz.

Kearney Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 244 ON READER-SERVICE CARD

Tip Capacitors

0.1 in. diameter



Less than 0.1 in. in diameter, these tip capacitors are made in 1/4, 3/8, 1/2, and 3/4 in. tube lengths and in stable, by-pass, or temperature compensating types. They have the same capacity range as disc capacitors that take up six times the space. Leads can be supplied straight, short, or crimped.

Radio Industries, Inc., Dept. ED, 1066 Garland Place, Des Plaines, Ill.

CIRCLE 245 ON READER-SERVICE CARD

5 Inch Oscilloscope

Occupies 1/2 cu ft



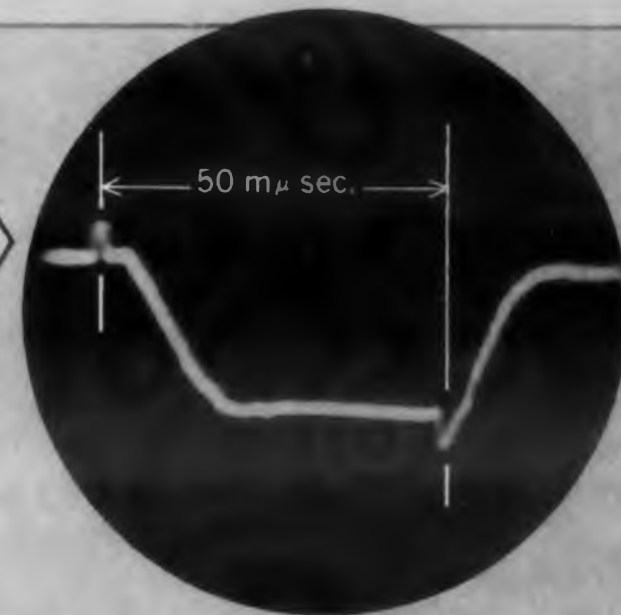
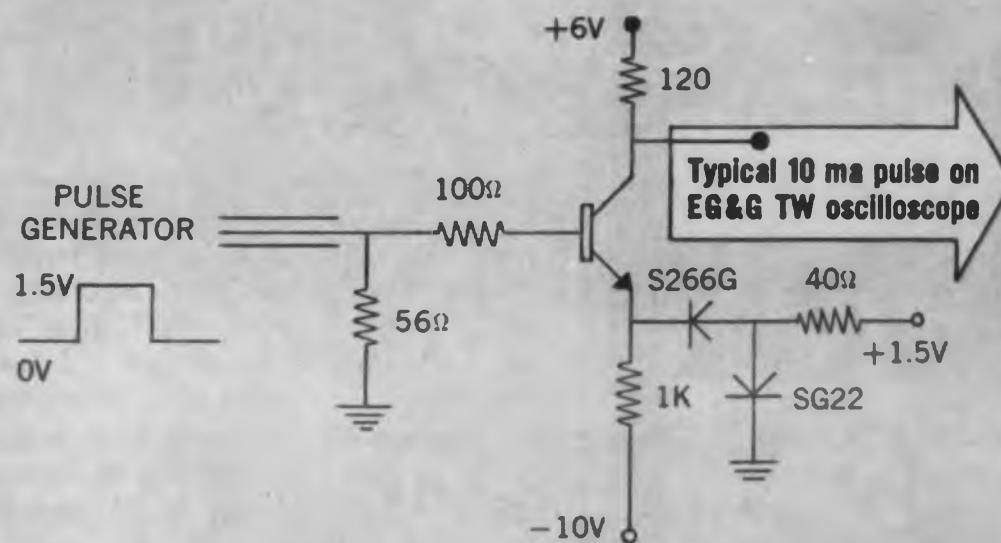
A portable 5 in. oscilloscope, the model S-16-A Craftscope occupies less than 1/2 cu ft and weighs 11 1/2 lb. It offers dc to 7 mc response, direct reading vertical calibration, wide range repetitive sweep with additional fixed sweeps for color and industrial TV work, phase inversion, and an edge lighted graph screen.

Waterman Products Co., Inc., Dept. ED, 2445-63 Emerald St., Philadelphia 25, Pa.

CIRCLE 246 ON READER-SERVICE CARD

CIRCLE 247 ON READER-SERVICE CARD

FIRST SILICON TRANSISTORS WITH 150 Mc Alpha Cutoff PLUS POWER



ABSOLUTE MAXIMUM RATINGS

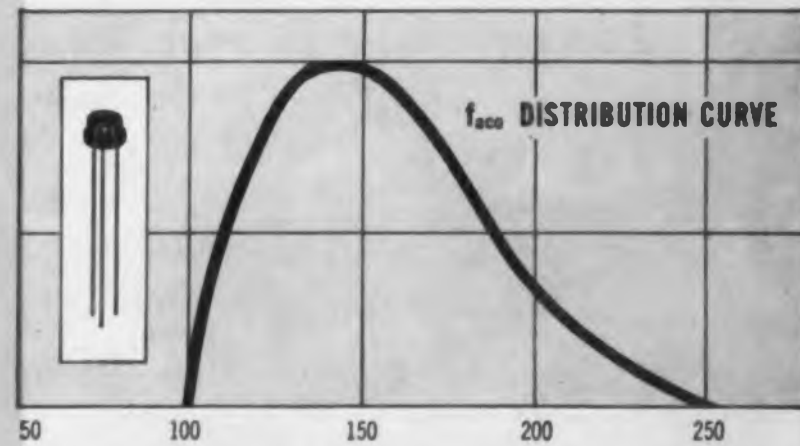
| | |
|--|-----------|
| Collector to Emitter Voltage — V_{CE} | 15 Volts |
| Collector to Base Voltage — V_{CB} | 15 Volts |
| Emitter to Base Voltage — V_{EB} | 3 Volts |
| Total Power Dissipation: at 125°C Case Temperature | .5 Watts |
| at 100°C Amb. Temperature | 0.5 Watts |

SPECIFICATIONS AND TYPICAL CHARACTERISTICS AT 25°C

| | Min. | Typical | Max. | Test Conditions |
|--|------|---------|--------------------------|--|
| D.C. Current Gain h_{FE} | 20 | 40 | — | $I_C = 10\text{ma}$, $V_{CE} = 6\text{V}$ |
| D.C. Collector Saturation Voltage V_{CE} | — | .5 | 0.6V | $I_C = 10\text{ma}$, $I_B = 2\text{ma}$ |
| Collector Cutoff Current I_{CO} | — | 2 | $5\mu\text{a}$ | $V_{CB} = \text{Rating}$ |
| Output Capacitance C_{ob} | — | 8 | $12\mu\text{f}$ | $V_{CB} = 6\text{V}$, $I_E = 0\text{mA}$ |
| High Frequency Current Gain h_{fe} | 5 | 7.5 | — | $F = 20\text{mc}$, $V_{CE} = 6\text{V}$, $I_E = 10\text{mA}$ |
| Delay Time t_d | — | 6 | $\text{m}\mu\text{sec.}$ | |
| Rise Time t_r | — | 12 | $\text{m}\mu\text{sec.}$ | |
| Fall Time t_f | — | 10 | $\text{m}\mu\text{sec.}$ | |

Here's a silicon logic transistor with the speed of the fastest germanium types . . . PLUS POWER HANDLING ABILITY! Transistron's 2N1139 represents a giant step forward in transistor technology, augmenting the industry's most complete line of silicon transistors. Typical total switching times average less than 30 milli-microseconds.

Transistron's fast switching types now cover the entire current range up to 5 amperes — offer a rugged silicon transistor for every switching application.



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Transitron

electronic corporation • wakefield, massachusetts

VISIT OUR WESCON BOOTHS NOS. 3002-3004



SMALLER, LIGHTER SERVO MOTORS

*Bendix now producing
1/2" diameter units*



Weighing a mere 0.94 ounces, the new Bendix size 5 servo motor is ideal for meeting the ever-increasing, space-saving demands of miniaturization. And, as with other Bendix servo motors and generators, large-scale precision manufacturing makes possible laboratory quality at volume prices.

The new motors, with their center-tapped control windings, eliminate the need for coupling transformers and thus help solve packaging problems. Besides size 5, you can choose from sizes 8, 10, 11, 15, 20 and 28. Both corrosion-resistant and high-temperature models are available. Other features include: high-operating torque characteristics . . . availability of integral gear heads for frame sizes 8 and 10 in ratios from about 10:1 to 6000:1 . . . and one-source engineering of complete "package".

THE STEP THAT PAYS—Find out how we can meet your needs promptly, efficiently and economically.

Eclipse-Pioneer Division

Teterboro, N. J.

District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C. Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.



"FOR PRECISION
COMPONENTS THAT DO
THE JOB BETTER—TRY THE
**BENDIX
SUPERMARKET**"



CIRCLE 248 ON READER-SERVICE CARD

NEW PRODUCTS

Regulated Power Supplies

Deliver 10 to 50 v dc



Series PTR transistor regulated power supplies are available with fixed or adjustable outputs ranging from 10 to 50 v dc. Input requirements are 105 to 125 v, 50 to 63 cps; regulation is 0.5% from full load to half load and 1% from half load to no load; and output voltage stabilization is within $\pm 0.5\%$ for $\pm 10\%$ change in input voltage with constant load. The unit is designed to MIL-T-27A and MIL-E-5272. It measures 2-5/8 x 3-1/16 x 4-1/4, weighs 2.5 lb, and operates from -30 to $+85$ C.

Power Sources, Inc., Dept. ED, South Ave., Burlington, Mass.

CIRCLE 249 ON READER-SERVICE CARD

Electronic Demodulator

Has $\pm 0.5\%$ linearity



Electronic demodulator model 1802 furnishes a dc voltage which is directly proportional to both amplitude and phase difference between the signal and reference input. Its dc output is constant within 3 db from 60 to 60,000 cps for 10 v rms reference and signal inputs. Input impedance is 15 K; output impedance, 50 K; output voltage, 10 v dc maximum; temperature coefficient, 0.04% per deg C; linearity, within $\pm 1\%$ for 0 to 10 v rms signal input with 25 v rms reference input. Built to MIL-E-5272A, the 2 oz, plug-in unit operates from -55 to $+105$ C.

Varo Mfg. Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 250 ON READER-SERVICE CARD

*P.S. and don't forget these
other quality products at the*

BENDIX "SUPERMARKET"

With our greater variety and greater volume of the precision components listed below, we have become the "supermarket" of the industry. We feature fast delivery and mass-production economy—plus the highest precision quality.

400-CYCLE SYNCHROS

(Frame sizes: 8, 10, 11, 15, 22)

Control Transformers
Differentials • Receivers
Resolvers • Transmitters

GYROS

Directional, Free, Rate, Roll
and Vertical Gyro Transmitters
• Stable Platforms

MOTORS AND GENERATORS

Gear Head Motors and Motor
Generators • Motor Generators
• Precision Induction Tachometer
Generators • Rate Generators

PACKAGED COMPONENTS

Analog-Digital Converters •
Azimuth Counters • Cam Compensators
• Clutched Synchros • Dual-Speed
Synchros • External Slip-Ring
Synchros • Follow-Up Mechanisms
• Miniature Differential Gear
Assemblies • Servo Assemblies

RADAR DEVICES

Airborne Radar Antennae •
Ground Antenna Pedestals

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You Can't Beat The Bendix
"Supermarket". Try us.

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Teterboro, N. J.

"FOR PRECISION
COMPONENTS THAT DO
THE JOB BETTER—TRY THE
**BENDIX
SUPERMARKET**"



CIRCLE 251 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 3, 1958

DC to DC Converter

Airborne



Airborne model M116 dc to dc converter is hermetically sealed and built for missile flight environments. It has an input of $28\text{ v} \pm 10\%$, an output of 350 v at 110 ma , and a regulation of $\pm 5\%$ from 75 to 100% of full load. Base plate temperature range is 30 to 135 F and storage range is -65 to $+160$ F. The unit is protected against output short circuits and input spike voltages. Output ripple is under 1.2 v rms and efficiency is more than 60%.

Alto Scientific Co., Inc., Dept. ED, 855 Commercial St., Palo Alto, Calif.

CIRCLE 258 ON READER-SERVICE CARD

Coaxial Cable

Operates to 1000 F



For missile and reactor use, Super-Jet high frequency coaxial cable is operational to 1000 F. Resistant to direct flame, it enables electrical circuits to continue functioning after an outburst of fire. It has low attenuation, gamma radiation resistance, and flexibility after exposure to high temperatures. The cable may be combined with other high temperature leads in multiconductor cable and is available in 20 gage with 50, 75, and 90 ohm impedances. Wire braid armoring can be furnished.

Boston Insulated Wire & Cable Co., Dept. ED, 15 Bay St., Boston 25, Mass.

CIRCLE 259 ON READER-SERVICE CARD

meanwhile back on the earth



Rockets, missiles, moon shots, and interplanetary space travel make highly fashionable advertising these days. Naturally, it is gratifying to know that Fusite Glass for Metal Hermetic Terminals are taking nearly all these history-making trips into the outer universe. But at least part of the excitement of participation is passing us by.

We have our top secret labs in special assembly on exact military model terminals. The Fusite Terminals that are performing so well in these extreme conditions—high pressure, and mechanical shock—are pretty much the same as the ones we produce every day for the general public for commercial use.

We're fairly certain that the only something so other-worldly as Fusite Terminals to perform rather well in your earth-bound extreme environments. But we suspect you're not going to point to your collection of earth-bound terminals from your store.

and exploring was a lot of terminals. It may seem like an "army" approach, but it makes sense to you, samples, the parts for the earth.



THE FUSITE CORPORATION

Dept. C-4

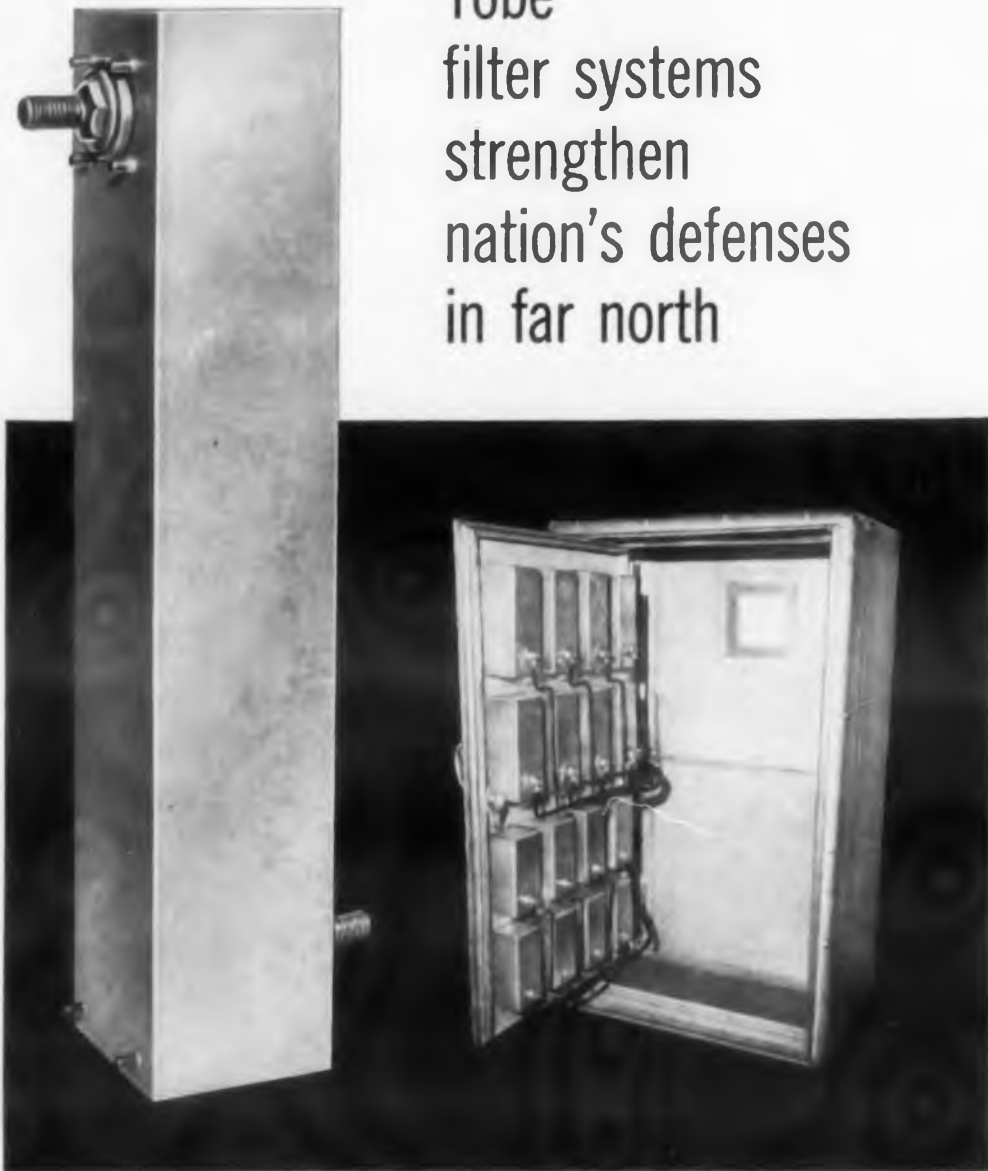
6000 Fernview Ave., Cincinnati 13, Ohio

IN EUROPE: FUSITE N. V. KÖNIGWEG 16, ALMELO, HOLLAND

CIRCLE 260 ON READER-SERVICE CARD

LOOK TO TOBE FOR PROGRESS

Tobe
filter systems
strengthen
nation's defenses
in far north



This is one of several filter cabinets that Tobe is supplying for installation at an early warning radar line in Northern Canada. The single filter shown at the left is typical of the nine different types — used in combinations of 16 to 200 filters per cabinet — that make up a Tobe filter system for the line.

The rigors of long-range transporting, and the severe environmental conditions encountered at the remote bases require that these filters and rf barrier cabinets (Tobe supplies both) be sturdy, reliable and long-lasting. But these are not the only reasons why Tobe was chosen

for the job. Tobe also supplies something not listed in the specs... *creative engineering*. For example, here in *one* cabinet, Tobe packages multi-circuit filters that range in voltage from 120 to 4160 VAC.

Creative engineering goes into every Tobe product, from the smallest Filterette to the largest thermonuclear condenser. Don't settle for anything less on your next filtering assignment. Talk to Tobe today for technical information and engineering aid... *creative engineering aid*. Tobe Deutschmann Corporation, Norwood, Massachusetts.

specify
TOBE
PRODUCTS

TOBE DEUTSCHMANN • CONDENSER PIONEERS SINCE 1922
CIRCLE 261 ON READER SERVICE CARD

NEW PRODUCTS



Acceleration Switch
Responds to 0.05 g

The model 60U-01 switch responds to accelerations of 0.05 to 1 g in under 35 msec with 10% accuracy. It has normally open contacts, provides unidirectional control, meets MIL-E-5272A, and has a 100,000 cycle service life.

Inertia Switch, Inc., Dept. ED, 311 W. 43rd St., New York 36, N.Y.

CIRCLE 262 ON READER-SERVICE CARD

Coaxial Relay

Has rates to 500 closures per sec



For input applications in data systems, this coaxial relay provides coil impedances to 6 K, low contact resistance, and operating rates to 500 closures per sec. Pull in and release times are less than 1 msec and contact capacitance is under 1 μ f. At 60 closures per sec, operating life is 20,000 hr. The hermetically sealed unit is 1 x 1 x 4-1/2 in.

Electronic Computer Co., Dept. ED, 618 Maple St., Conshohocken, Pa.

CIRCLE 263 ON READER-SERVICE CARD

Power Bias Supply

Completely transistorized

Model 1020, completely transistorized, low ripple, dc power bias supply can be used with preamplifiers, instruments, and other transistor or tube devices under repair, development, or study. The unit provides continuous variable output voltage monitored by a dual range voltmeter (0 to 6 and 0 to 30 v dc). Two type 2N256 power transistors are incorporated in the transformer-operated circuit to permit output voltages up to 30 v. It is fused for protection against short circuits, and is available in both kit and wired models.

Electronic Instrument Co., Dept. ED, 33-00 Northern Blvd., Long Island City 1, N.Y.

CIRCLE 264 ON READER-SERVICE CARD



Beattie Oscilloscope **DIRECT VIEW** Oscilloscope Recording Camera

Now, get a direct view with both eyes of the cathode ray tube while you're recording. No mirrors — full, clear vision. The new Beattie Direct-View Oscilloscope is the most versatile instrument of its kind — actually three cameras in one — and the only system to offer all these important features:

- Direct binocular view of CRT.
- Non-reversed image.
- Camera swings back for easy access to lens and shutter, or lifts off completely. Can be rotated.
- Available with large Polaroid® Land back or electrically-pulsed 35mm or 70mm camera for automatic, remote operation. Adapters for film pack or sheet film available.
- Continuous motion magazines available for 35mm and 70mm models.
- Electric shutter actuator optional with Polaroid® Land model.
- Attaches easily to bezel of 5" CRT. Adaptable to other sizes. No special tools.

"Polaroid"® by Polaroid Corp.

Write today for full details

B BEATTIE-
C COLEMAN INC.

1000 N. Olive St., Anaheim, California
Branch: 437 Fifth Ave., New York, N.Y.
CIRCLE 265 ON READER-SERVICE CARD

MEGOMETER.—Model 2570 Vi-
brotest has six direct reading ranges
from 1 meg to 5 million meg. Test
voltage variation is under 0.5% over
the full range with line fluctuations
of 95 to 135 v. Measurements are sta-
ble with no drift in the high range.
Dimensions are 8-7/8 x 6 x 8 in.;
weight, 14 lb.

Associated Research, Inc., Dept.
ED, 3777 W. Belmont Ave., Chicago
Ill.

CIRCLE 266 ON READER-SERVICE CARD

DC AMPLIFIER.—Chopper stabilized
model 2803-A has gains to 1000 with
accuracy and 0.05% stability. Noise
under 10 μ v rms referred to the in-
put; frequency response is flat to 10
kc and 3 db down at 40 kc. Chopper
modulation, under 0.1%; overload
recovery time, under 0.25 sec; size, 2
x 5-3/4 x 16-3/4 in.

Electronic Computer Co., Dept.
ED, 618 Maple St., Conshohocken, Pa.

CIRCLE 267 ON READER-SERVICE CARD

SNAP ACTION THERMOSTAT.—
Miniature type VAL 90 for missile
and other airborne components. Nor-
mally preset up to 350 F with differ-
ential of 3 F and setting tolerance of
 \pm 3 F. Capacity is 40 w, 30 v and
100 w, 120 v ac or dc, noninductive.
Ceramic header body is one termi-
nal, compression header pin the other.
Unit weighs under 0.2 oz., is sealed
in brass capsule 15/16 in. long and
7/8 in. in diameter.

Valverde Labs, Dept. ED, 252 La-
fayette St., New York 12, N.Y.

CIRCLE 268 ON READER-SERVICE CARD

**STRAIN GAGE CONTROL MOD-
EL.**—Model SRB-200 combines
strain gage power supply with strain
balance and calibration circuitry.
Manual switch sets power supply for
constant current or constant voltage
operation. Regulation 0.1% line or
load, maximum ripple, 1 mv; maxi-
mum noise to ground, 10 μ v peak-to-
peak when measured with strain gage
500 ohms impedance; leakage re-
sistance, over 10,000 meg. Output is
driving at under 0.1 ohm impedance.
Models available: model SRB-200RC
for use with remotely programmed
operation.

Video Instruments Co., Inc., Dept.
ED, 3002 Pennsylvania Ave., Santa
Ana, Calif.

CIRCLE 269 ON READER-SERVICE CARD

Ain't she sweet...!



40 Watts MONOPHONIC... 20 Watts STEREOPHONIC... with **RCA-6973 TUBES**

See her sitting there so neat. And I tell you very confidentially...
the 6973's got POWER... real power for such a small "bottle". Four of them,
in twin, push-pull class AB₁ circuits, put 20 watts of power into each of
two output-transformers to give you the brilliant stereo sound you dream about.
With the flip of a switch, you can parallel the twin circuits for 40 husky
watts' monophonic power output. Big on power... small in size... long on
low-cost design possibilities... everything about RCA's 6973
beam-power tube makes sweet news.

Whether you're designing for monophonic or stereo high fidelity, you'll want
to hear the many other facts your RCA Field Representative can give you
on the RCA-6973. For technical data, write RCA Commercial Engineering,
Section G-18-DE-1, Harrison, N. J.

RCA tubes for High Fidelity also available from your local Authorized RCA Tube Distributor



RCA FIELD OFFICES

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Electron Tube Division
Harrison, N. J.

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MOST ADVANCED LINE OF STANDARD AND SPECIAL



MULTICHANNEL PRODUCTS FOR TELEMETRY

THE LARGEST SPECIAL PURPOSE FACILITIES FOR ENGINEERING AND PRODUCTION, THE NATION'S MOST PIONEERING EXPERIENCE.



PDM



Subminiature all electronic 45 channel multicoder with both PDM and PAM outputs.



Standard low level and mixed high and low level PDM multicoder for IRIG channel configurations ML and MX series.



RLM series PDM multicoder for rack and panel installation in fixed ground equipment.



SX series - New ultra subminiature mixed high and low level multicoders.

COMPLETE PDM DATA ACQUISITION SYSTEMS.

FIRST IN QUALIFIED ALL ELECTRONIC SOLID STATE MULTICODER PRODUCTION. HIGH, LOW AND MIXED INPUT LEVELS IN STANDARD CONFIGURATIONS.



FM



Smallest Silicon Solid State Sub-carrier for all FM-FM Bands.



Complete Plug-in Solid State FM-FM systems including mixer and power supply.

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PAM

Complete missile commutation package includes 2 double pole electronic commutators and a low level electro-mechanical commutation and amplifier.



Standard double pole solid state electronic commutators providing IRIG and special wave forms.

Production units of new minicom commutators providing low contact resistance, small size, long life.



Typical of many mechanical commutator designs employing proven high performance Perma Brush®.

THE NATION'S MAJOR SUPPLIER OF COMMUTATION PRODUCTS. QUALIFIED MECHANICAL COMMUTATORS AND ALL-ELECTRONIC SOLID STATE COMMUTATORS IN PRODUCTION FOR MAJOR PROGRAMS. GEARED FOR LOW COST, HIGH PRODUCTION AND FOR QUICK DELIVERY.

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PRINCETON, NEW JERSEY

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NEW PRODUCTS

PRESSURE TRANSDUCER.—Model 217 measures corrosive gas and liquid pressures to 200 psi. Response, 1 msec; resolution, infinite; linearity, 0.3%; hysteresis, 0.25%; repeatability, 0.1%; ambient range, -150 to +250 F.

Taber Instrument Corp., Dept. ED, North Tonawanda, N.Y.

CIRCLE 271 ON READER-SERVICE CARD

NYLON SNAP BUSHING.—Snaps into 7/8 in. diameter chassis hole and locks under finger pressure, providing unbreakable insulation protection. For panels to 1/8 in. thick. UL and CSA approved.

Heyman Mfg. Co., Dept. ED, 1200 Michigan Ave., Kenilworth, N.J.

CIRCLE 272 ON READER-SERVICE CARD

LOW ENERGY SAFETY CONTROL WIRE.—For NEC Class 2 circuits of 30 v maximum and temperatures to 105 C. Suited for connecting limit switches to general signal and control circuitry. Choice of two or three conductors of 18 or 16 AWG, parallel.

Chester Cable Corp., Dept. ED, Chester, N.Y.

CIRCLE 273 ON READER-SERVICE CARD

DIAZOTYPE REPRODUCTION MACHINE.—Model 42 Copyflex produces low cost engineering and construction blue and white prints in seconds. Handles tracings to 42 in. wide and any length.

Charles Bruning Co., Inc., Dept. ED, Mt. Prospect, Ill.

CIRCLE 274 ON READER-SERVICE CARD

BALL PLUNGERS.—Size 10-32 and 1/4-20 instrument and missile use. Standard balls are type 440 stainless steel. Other materials and sizes down to 8-36, 6-40, and 4-48 can be furnished.

Vlier Engineering Corp., Dept. ED, 8900 Santa Monica Blvd., Los Angeles 46, Calif.

CIRCLE 275 ON READER-SERVICE CARD

PENCIL SIZE RADIATION COUNTER.—Model BF-3, 6 in. long and 1/2 in. in diameter, measures distribution of neutron flux in critical assemblies. Approximate operating region, 900 v; typical plateau length, 150 v; average plateau slope, 3% per 100 v.

Radiation Counter Labs, Inc., Dept. ED, Nuclear Park, Skokie, Ill.

CIRCLE 276 ON READER-SERVICE CARD

VIDICON TUBE.—High sensitivity type WL-7325 can produce satisfactory pictures with an average of 0.1 ft-c on the faceplate.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

CIRCLE 277 ON READER-SERVICE CARD

THE FINISH IS ONLY THE BEGINNING

To meet demands for perfect finish on stainless and nickel Thinstrip®, Somers installs unique new annealing furnace.



This new Selas vertical continuous annealing furnace assures uncontaminated, commercially unmarred surfaces as well as uniform temper and faster delivery on stainless, nickel and nickel alloy Thinstrip up to 25" wide. But this is only part of the story of Somers' quality. Sendzimir rolling mills, Accu-Ray gauging plus 50 years leadership in thin gauge metals (from .010 down to .000125") are a few of the features Somers offers to assist you with your Thinstrip® problems.

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CIRCLE 278 ON READER-SERVICE CARD

Subaudio Tuned Amplifier

0.3 to 3000 cps range



With a rejection ratio of over 60 for third and higher harmonics, the type 301 subaudio tuned amplifier is suitable for isolating harmonics and noise from the fundamental component of a complex nonsinusoidal signal. Amplification at center frequency is about unity. The unit has a 0.3 to 3000 cps continuously adjustable range with 35 db attenuation for the second harmonic, 45 db for the third, and 50 db for higher harmonics. Maximum input is 30 v rms with attenuator off, 300 v rms with it on. Input impedance is 10 meg shunted with 25 μ f and output impedance is about 300 ohms.

Ad-Yu Electronics Lab., Inc.,
Dept. ED, 249-259 Terhune Ave.,
Passaic, N.J.

CIRCLE 388 ON READER-SERVICE CARD

AC Voltage Regulators

Supply 500 or 1500 va



Model 500MIL and 1500MIL electronic ac voltage regulators supply 500 and 1500 va, respectively, at 115 v ac. They provide an output voltage regulation of $\pm 0.5\%$ against variations in input line voltage, load, and power factor changes and introduce less than 5% harmonic distortion. The units have 0 to 150 v ac output meters and fit standard 19 in. racks. They are designed to MIL-I-4158A and MIL-E-16400A.

Sorenson & Co., Dept. ED, South
Norwalk, Conn.

CIRCLE 389 ON READER-SERVICE CARD

CIRCLE 279 ON READER-SERVICE CARD

quality control series no. 3
HARDNESS TEST

THIS
TELEMETER
MAGNETICS
MEMORY CORE
IS HARD ENOUGH
TO CUT GLASS *(but this way is madness)*

STC. [unclear]
*but we hope it attracts your attention
to the thorough three-stage
inspection and testing given every
TMI product—from ferrite cores to core
arrays to buffers and memory systems.*

Advancing The Art—TMI RANDOM ACCESS MEMORIES

high speed...high reliability...large capacity...economical

TMI is a pioneer in the design and production of fully transistorized random access memories. TMI's many years of experience in core memory design and manufacture has made them a recognized leader in the art.

TMI solid state core storage systems have achieved new standards of performance in speed, capacity, and reliability at economical cost. Every state of the art is represented at TMI, complete integrated facilities for core production—through array wiring—to precision construction of complete systems.

Components, assemblies, and completed random access memories each undergo rigorous tests. Write for complete specifications.

TMI fully transistorized memory modules are available in three basic series distinguished by differences in their cycle times. Modules can be combined to achieve large capacity. In addition, memories will be designed and constructed to satisfy requirements not met by a standard unit.

| STANDARD MEMORY MODULES | | | |
|-------------------------|-----------------------------|-------------------|---------------------|
| SERIES | CYCLE TIME μ seconds | CAPACITY words | WORD LENGTH bits |
| MQ | 24 | 512 to 4096 | as desired |
| RQ | 6 to 8 | 1000 to 8192 | 4 to 80 |
| LQ | 3 | 512 to 8192 | 4 to 80 |



Complete Solid State Memory
10,752 Bits

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NEW SILICON

TO-18 PACKAGED DIFFUSED-BASE 'MESA' TRANSISTORS

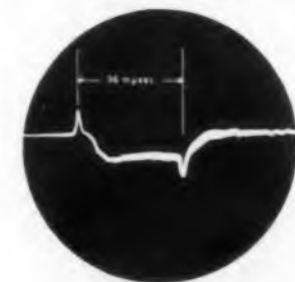


Now available for your evaluation, the subminiature 2N702 is built specifically for your 5-20 ma transistor logic switching applications.

This newest addition to TI's line of diffused-base 'mesa' transistors features...

- Guaranteed dc beta of 15 to 45
- 50 mc minimum unity beta frequency (f_β)
- Maximum 12 μf output capacitance
- Subminiature TO-18 package

As do all other TI semiconductors, the 2N702 carries a *full-year guarantee* to published specifications. Check the specs at right and contact your nearest authorized TI distributor or your TI sales office for detailed information.



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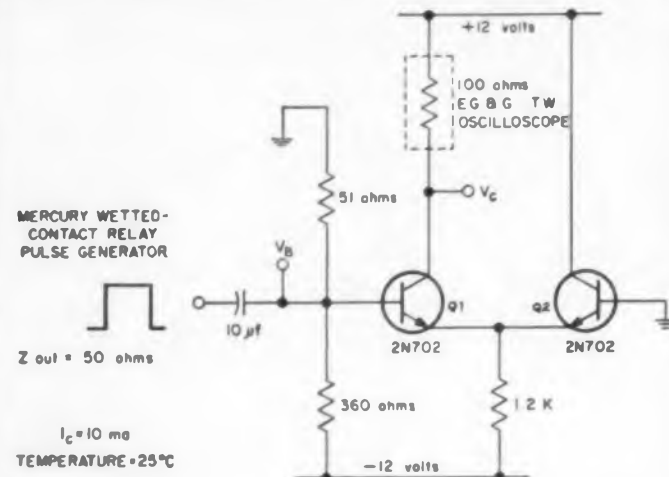
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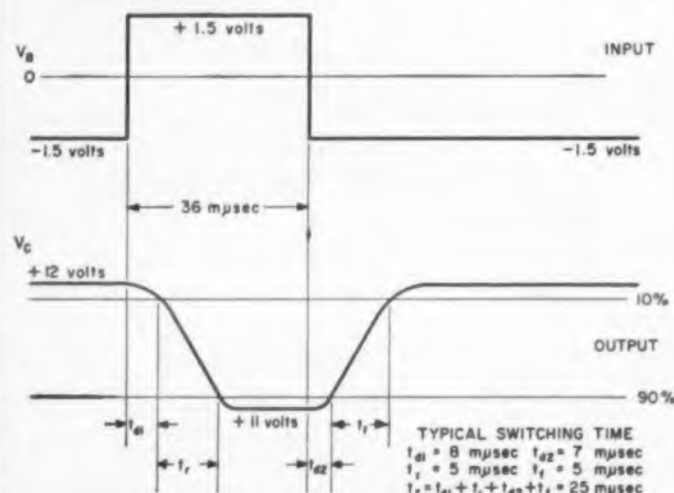
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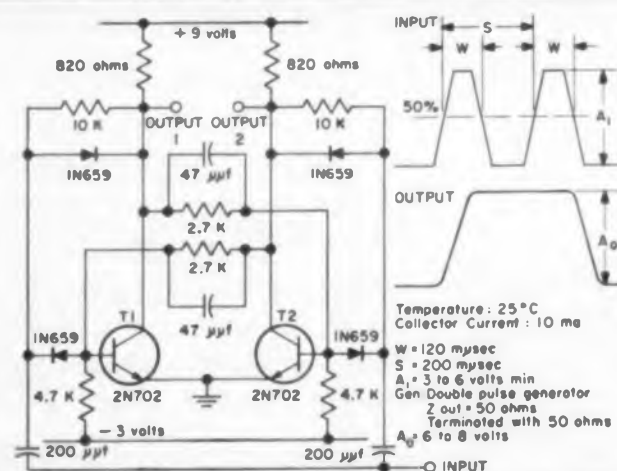
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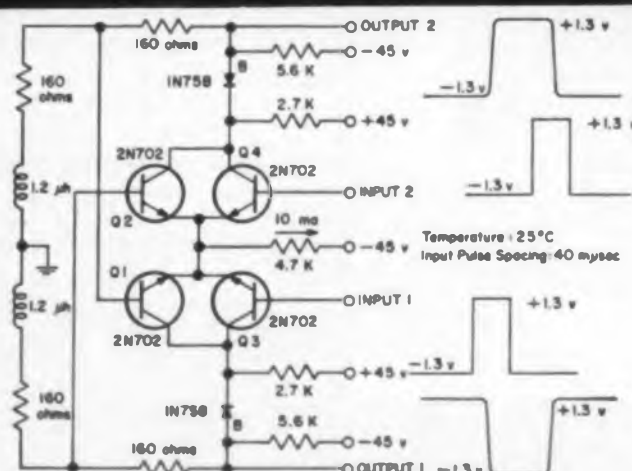
TYPICAL NON-SATURATED LOGIC SWITCHING CIRCUIT



TOTAL SWITCHING TIME NON-SATURATED CIRCUIT

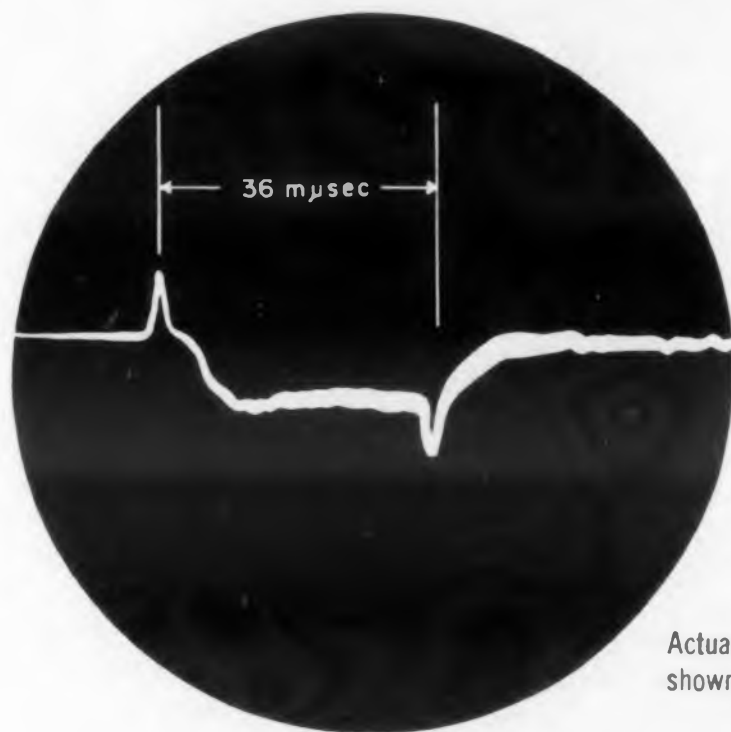


TYPICAL CIRCUITRY FOR OBTAINING 5-MC REP RATE
IN SATURATED FLIP-FLOP



TYPICAL CIRCUITRY FOR OBTAINING 25-MC REP RATE
IN NON-SATURATED FLIP-FLOP

25 mμsec SWITCHERS FROM TI



Actual photo of collector wave form as shown on traveling-wave oscilloscope

absolute maximum ratings (25°C)

| | |
|---|--------|
| Collector Voltage Referred to Base | 20 v |
| Collector Voltage Referred to Emitter | 15 v |
| Emitter Voltage Referred to Base | 5 v |
| Collector Current | 50 ma |
| Dissipation (100°C Free Air, Derate 0.5°C/mw) | 150 mw |

design characteristics at 25°C (except as indicated)

| Symbol | Characteristic | Test Conditions | Min | Typ | Max | Unit |
|------------------|---|---|-----|-----|-----|----------------|
| I_{CBO} | Collector Cutoff Current | $V_{CB} = 10\text{ v}, I_E = 0$ | | | 0.5 | μa |
| I_{CBO} | @ 150°C | $V_{CB} = 10\text{ v}, I_E = 0$ | | | 50 | μa |
| BV_{CBO} | Breakdown Voltage | $I_{CBO} = 10\text{ }\mu\text{a}, I_E = 0$ | 20 | | | v |
| BV_{CEO} | Breakdown Voltage | $I_{CEO} = 10\text{ }\mu\text{a}, I_B = 0$ | 15 | | | v |
| h_{FE}^* | DC Beta | $V_{CE} = 5\text{ v}, I_C = 10\text{ ma}$ | 15 | | 45 | |
| BV_{EBO} | Breakdown Voltage | $I_E = 10\text{ }\mu\text{a}, I_C = 0$ | 5 | | | v |
| V_{BE}^* | Input Voltage | $V_{CE} = 5\text{ v}, I_C = 10\text{ ma}$ | 0.7 | | 1.2 | v |
| C_{ob} | Output Capacitance | $V_{CB} = 5\text{ v}, I_E = 0$ $f = 1\text{ mc}$ | | 7 | 12 | μpf |
| f_t | Frequency at which h_{fe} is unity | $V_{CE} = 5\text{ v}, I_E = 10\text{ ma}$ | 50 | 100 | | mc |
| V_{CE}^* (Sat) | Saturation Voltage | $I_C = 10\text{ ma}, I_B = 2\text{ ma}$ | | | 0.6 | v |

* Tested using pulse measurement.

NOTE: These units meet JEDEC outline TO-18 dimensions. A drawing of this package is attached.

CIRCLE 280 ON READER-SERVICE CARD



INSTRUMENTS

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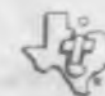
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THE HIGHER THE STAKES

THE MORE YOU NEED



Electra's New Molded Precision Metal Film Resistor

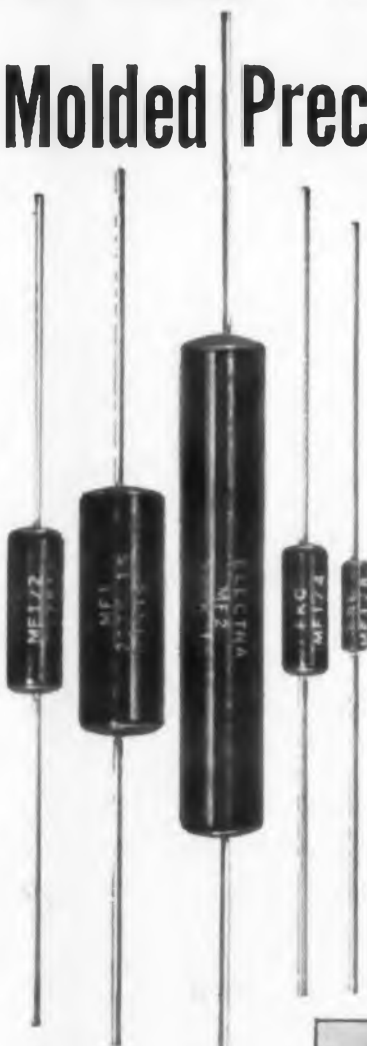
IF YOU WANT . . .

- Low controlled temperature coefficient
- Low noise level
- Combination of high stability on load, in addition to low controlled temperature coefficient
- Close tracking of the resistance values of two or more resistors over a wide range of temperature
- High stability under severe humidity conditions
- Special resistor combinations to produce accurate ratios.

YOU WANT NEW ELECTRA MOLDED METAL FILM RESISTORS

AVAILABLE IN THESE SIZES

| Electra Part No. | Wattage | Resistance Range | Maximum Rated Voltage |
|------------------|---------|-------------------|-----------------------|
| MF 1/8 | 1/8 | 100 ohms 300 K | 250 |
| MF 1/4 | 1/4 | 100 ohms 500 K | 300 |
| MF 1/2 | 1/2 | 100 ohms 1 meg | 350 |
| MF 1 | 1 | 100 ohms 2 meg | 500 |
| MF 2 | 2 | 250 ohms 5 meg | 750 |



Razor Sharp Precision, plus Amazing Stability—

Here is new and greater-than-ever accuracy, coupled with new and greater-than-ever stability . . . the kind of a combination you need to meet the continuing demand for more and still more reliability. To give you this truly outstanding combination, a metallic resistive film is firmly bonded with exacting precision to an especially compounded ceramic core. This unit is then coated and molded in a compound of resins selected for the exceptional thermal stability it offers. The result is a metal film resistor that offers you performance which equals or surpasses that of a precision wire wound resistor, yet is smaller, lower in cost, also gives you better RF performance plus uniformity in size over wide resistance ranges. Here is a real "break-through" in resistor manufacturing. Why not get all the facts, today.

TYPICAL PERFORMANCE IN % OF CHANGE UNDER TEST

| Type | Temp. Cycle | Low Temp. Exposure | Short Time Overload | Solder Change | Moisture | 1000 Hours @ 125°C |
|--------|-------------|--------------------|---------------------|---------------|----------|--------------------|
| MF 1/2 | .025% | .07% | .035% | .02% | .03% | .035% |

TEMPERATURE COEFFICIENT — Available in three standard temperature coefficient tolerances:

| T.C. | CODE MARKINGS** |
|----------------|-----------------|
| 0 ± 100 PPM/°C | T-1 |
| 0 ± 50 PPM/°C | T-2 |
| 0 ± 25 PPM/°C | T-5 |

Proposed MIL-R-10509C specification calls for temperature coefficient measurements from -55°C to +165°C. The lowest temperature coefficient is 0 ± 50 PPM/°C. Code T-2 meets this requirement. Resistors in code T-5 are production tested over a range of +25°C to +105°C. Special temperature coefficients—Code T-3, 0 to +100 PPM, and Code T-4, 0 to -100 PPM—are available for special applications.

*Parts Per Million Per Degree Centigrade (100 PPM equals 0.01%)
**The T.C. code marking is combined with the code for the date of manufacture

MANUFACTURING COMPANY Electronics Division

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CIRCLE 281 ON READER-SERVICE CARD

NEW PRODUCTS

Cathode Ray Tubes

Have resolutions to 2000 lines per inch



These cathode ray tubes offer a choice of four resolution levels up to 2000 lines per in., three screen sizes, and three screen phosphor characteristics. They can be used in strip radar, photo reconnaissance, visual indication, photo reproduction, information transfer, closed circuit TV, and remote data pickup. They can be supplied with interchangeable yokes, focus coils, and video driver stages. The P5, P11, and P16 phosphors provide a choice of blue or near ultraviolet spectral colors and short or very short persistence times.

CBS-Hytron, Dept. ED, Parker St., Newburyport, Mass.

CIRCLE 282 ON READER-SERVICE CARD

Digital Modules

Magnetic



These magnetic digital modules are compatible with the company's transistorized digital modules and can be mounted in the same self-powered case. The units permit the operation of up to 50 core stages from one drive transistor. Both core and solid state core driver modules are available. The devices can be incorporated in any digital system.

Packard Bell Computer Corp., Dept. ED, 1950 S. Armacost Ave., Los Angeles 25, Calif.

CIRCLE 283 ON READER-SERVICE CARD

SEALED RELAYS—unmatched for reliability



1951—Miniature sealed relay



1953—Sub-miniature sealed relay



1955—Micro-miniature sealed relay

1959

NEW 4-pole micro-miniature relay
NEW Unimite relay



Unimite is world's smallest 1-amp relay

The slim cylindrical shape of the new Unimite relay saves space in the important vertical dimension. Its high-speed operation—operates in 1.5 milliseconds max., release time 3.5 milliseconds max.—offers a new approach to automatic switching. Its welded, totally isolated contact capsule eliminates organics from switching chamber, provides lifetime freedom from contact contamination. Every Unimite is a dry-circuit relay.



4-Pole micro-miniature suited for 160C ambient

New micro-miniature provides four-pole configuration and exceptionally long life performance—minimum of 10 million low-level operations, test units have run over 50 million operations. Suitable for continuous operation in a 160C ambient, the relay provides a valuable safety factor in application to 125C equipments. Vibration performance is excellent; it withstands 55 to 2000 cycles at 30G acceleration without contact opening. Operate power is only 400 mw.

GENERAL ELECTRIC ANNOUNCES . . .

Two new, ultra-small relays

From the company which first introduced the revolutionary micro-miniature relay in 1955 come two more important new developments in sealed-relay miniaturization.

General Electric has added the world's smallest one-amp relay, the single-pole Unimite, and a new four-pole micro-miniature to its sealed-relay line. Both new relays incorporate an important advance in relay manufacture. No solder and no solder flux are used anywhere in either relay's structure. A new inert-arc welding process seals headers to cans, eliminating a major cause of contact contamination.

The new Unimite and four-pole relays lend themselves admirably to printed-circuit-board work. The Unimite relay can be soldered into the board or is available for stud, lug, or bracket mounting. Its flexible leads can be formed or fanned for any circuit requirement. The four-pole relay terminations are on 0.2 inch centers in accord with the popular grid-spaced pattern.

These new relays, combined with a full line of miniature and double-pole micro-miniatures, offer equipment designers a new dimension in relay flexibility. Both new relays meet or exceed

applicable requirements of MIL-R-5757 and MIL-R-25018.

All General Electric sealed relays combine minimum size with unmatched reliability under severe shock, vibration, and temperature conditions. For complete information on G.E.'s full line of sealed relays, contact your G-E Apparatus Sales Office or mail coupon at the right. General Electric Co., Specialty Control Dept., Waynesboro, Va.

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CIRCLE 284 ON READER-SERVICE CARD

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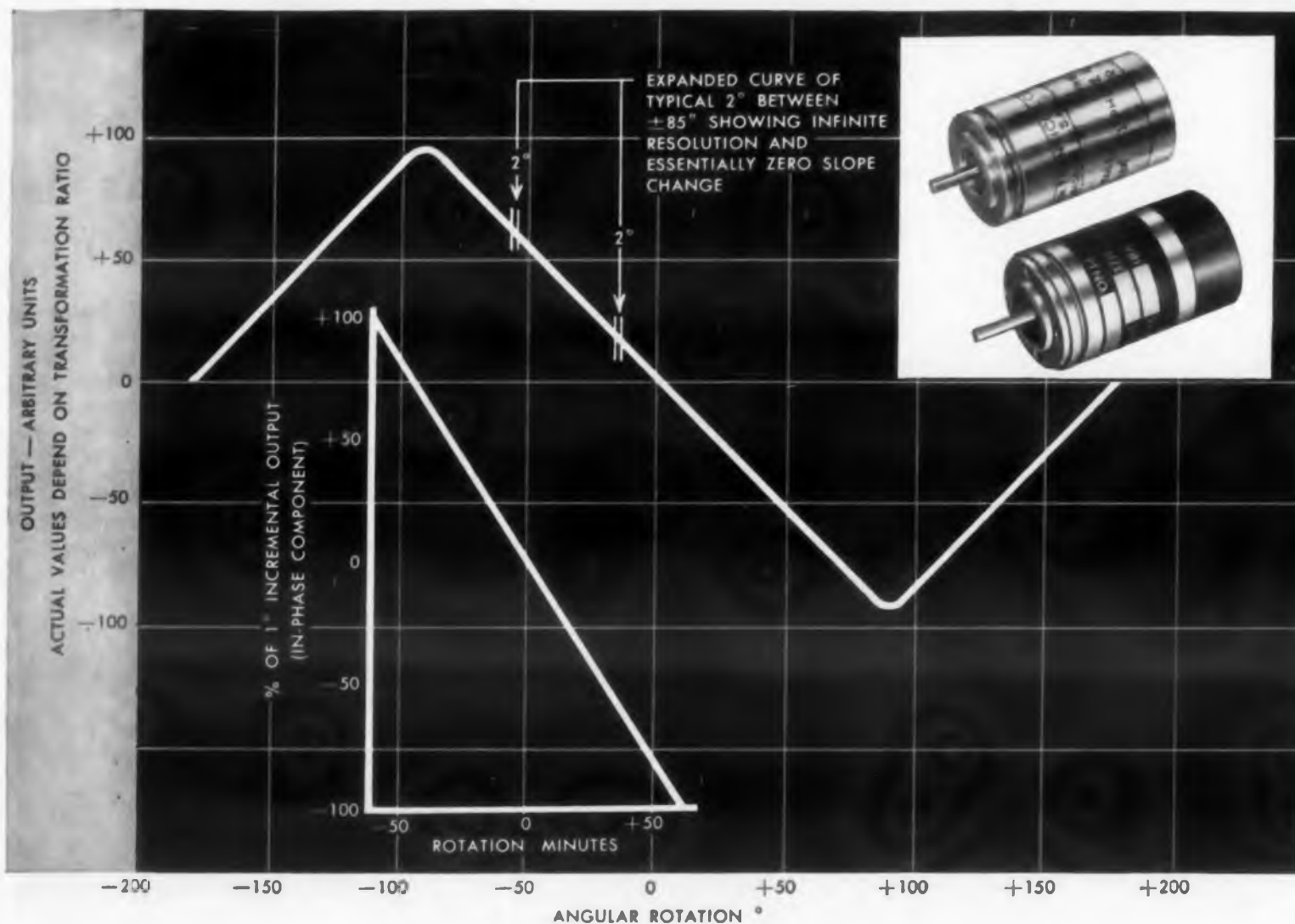
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GENERAL  ELECTRIC



Inductive pots give accurate noiseless output with infinite resolution

Weapons systems... analog computers... proportioning circuits—wherever the limitations of wirewound potentiometers can not be tolerated, these precision linear pots are the answer.

The Daystrom Transicoil Size 8 and 11 Inductive Pots provide extreme angular accuracy for applications requiring linear output and high gain amplification. There are no brushes wiping over turns of resistance wire to generate noise. Grounding problems are eliminated since each phase is electrically insulated from the other. When operated into the correct load, output is linear to within $\pm 0.25\%$ over the 170° ($\pm 85^\circ$ from null) operating range. Output phase is dependent on direction of shaft displacement from null.

Write for complete specifications. Daystrom Transicoil, Division of Daystrom, Inc., Worcester, Montgomery

County, Penna. Phone: JUNO 4-2421. In Canada: Daystrom, Ltd., 840 Caledonia Rd., Toronto 19, Ontario. Foreign: Daystrom International Division, 100 Empire Street, Newark 12, New Jersey.

TYPICAL CHARACTERISTICS

| | Size 8 | | Size 11 | | |
|----------------------|-----------------|-------|---------|-------|------|
| | | | | | |
| Volts | 26 | 26 | 26 | 26 | 115 |
| Excitation | Power (watts) | .16 | .16 | .15 | .45 |
| | Current (ma) | 27 | 27 | 30 | 24 |
| | Frequency (cps) | 400 | 400 | 400 | 400 |
| Sensitivity (v/°) | .107 | .346 | .107 | .346 | .620 |
| Null Volts (mv) | 7 | 20 | 7 | 20 | 40 |
| Transformation Ratio | .350 | 1.130 | .350 | 1.130 | .458 |

DAYSTROM TRANSICOIL DIVISION OF DAYSTROM, INC.

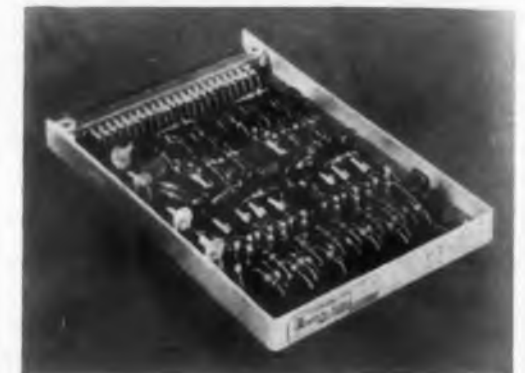
Representatives in Canada and Other Foreign Countries

CIRCLE 285 ON READER-SERVICE CARD

NEW PRODUCTS

Dual Flip-Flop Module

Operates at any speed to 5 mc



Dual flip-flop model 1209 contains two identical flip-flops with built-in output amplifiers. A single package, transistorized plug-in unit, it operates at any speed to 5 mc. Each of the two flip-flops has a direct and a gated input to the zero and one side, and each has one pulse gate internally connected to the gated one input terminal. The flip-flops have continuous dc output signals so that actions need not occur at any fixed clock rate.

Digital Equipment Corp., Dept. ED, Maynard, Mass.

CIRCLE 286 ON READER-SERVICE CARD

Floated Rate Integrating Gyros

2-3/4 in. long



Series M2500 floated rate integrating gyros, designed for missiles and severe environments, are 2 in. in diameter and 2-3/4 in. long. They consist principally of a gyro motor, a torque motor, a signal generator, and a constant damping device. The torque motor and signal generator are combined in a single unit with a restraint trimming tertiary winding. The gyros operate at unlimited altitudes and can be provided with a variety of performance characteristics.

Kearfott Co., Inc., Dept. ED, 1500 Mon Ave., Clifton, N.J.

CIRCLE 287 ON READER-SERVICE CARD

Sequential Sampling Switch

Makes 3600 closures per sec



This Roto-Jet noiseless sequential sampling switch can make more than 3600 closures per sec. Actuated by a rotating jet of air, its only moving part, it transmits noise free signals of 1, 2, and 5 mv without amplification or filtering. Of wiperless design, the unit needs no maintenance. It provides sampling speeds to 40 rps and may have up to 45 contact pairs in one enclosure. Two-pole switching can be supplied to any phase angle by adding a second row of contacts and incorporating two synchronized air jets inside the shell. Contact closing time is under 60 μ sec; opening time, under 80 μ sec.

Electric Regulator Corp., Dept. ED, Norwalk, Conn.

CIRCLE 288 ON READER-SERVICE CARD

Relays

10 μ w



Series 160 transistor amplified, 10 μ w relays are available with current sensitivities of 10, 25, 50, or 100 μ a at 1 v dc. Standard contact arrangements are spdt or dpdt for contact loads up to 3 amp, 15 v ac or 29 v dc, noninductive. Required bias voltage, which may be supplied from an external source or from an internal mercury battery, is 16 to 25 v positive dc. The units last for about 25 million operations and withstand sensing currents 10 times the normal in both positive and negative directions. They operate from 32 to 122 F.

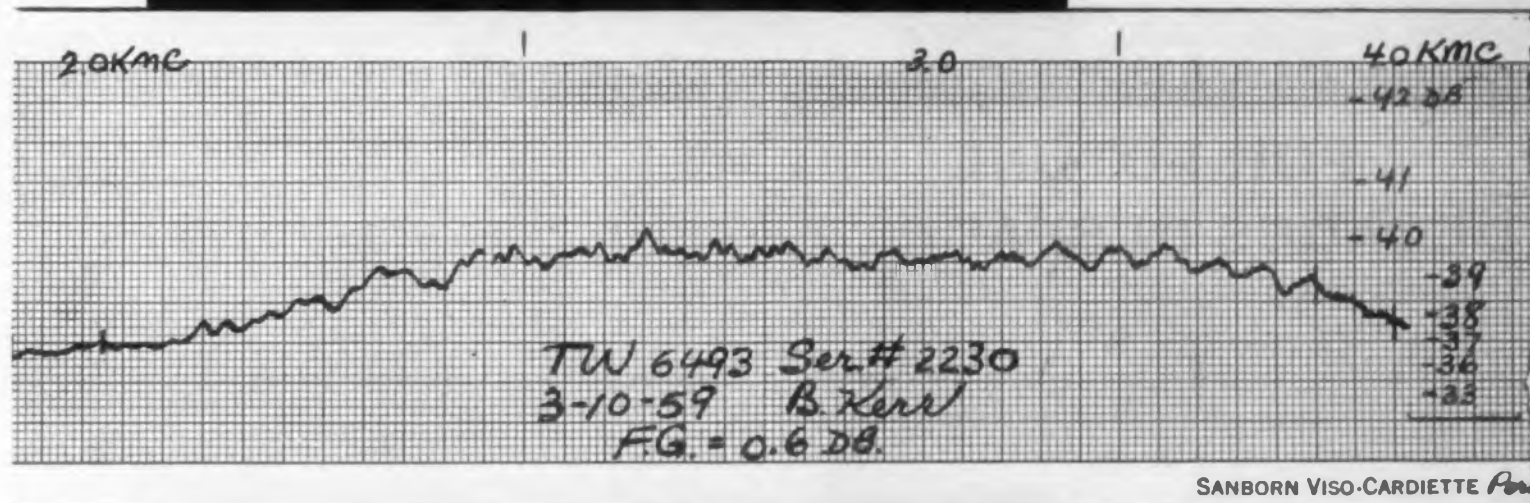
General Automatic Corp., Dept. ED, 12 Carlton Ave., Mountain View, N.J.

CIRCLE 289 ON READER-SERVICE CARD

Microwave Component News

from SYLVANIA

Now available—a wide range of traveling wave tubes



ONLY SYLVANIA CAN OFFER YOU

AVAILABILITY—now in production, 16 types of traveling wave tubes covering the microwave spectrum from 1 to 11 kmc, and milliwatts to kilowatts. Backward wave oscillators are also available. Modifications and new designs for your special requirements are part of Sylvania's service.

HIGHEST GAIN—Sylvania's traveling wave tubes deliver 2 to 5 times the gain of competitive types. For example, TW-4002 delivers a minimum gain of 37 db over its full 2 to 4 kmc band.

GUARANTEED UNIFORMITY—Sylvania guarantees gain variations one-half those of other tubes; i.e. 2 to 3 db narrower limits. Other test limits are correspondingly more rigid.

PROVEN RUGGED DEPENDABILITY—Sylvania traveling wave tubes have proved their performance by meeting tough military standards and by being specified and used in modern supersonic aircraft.

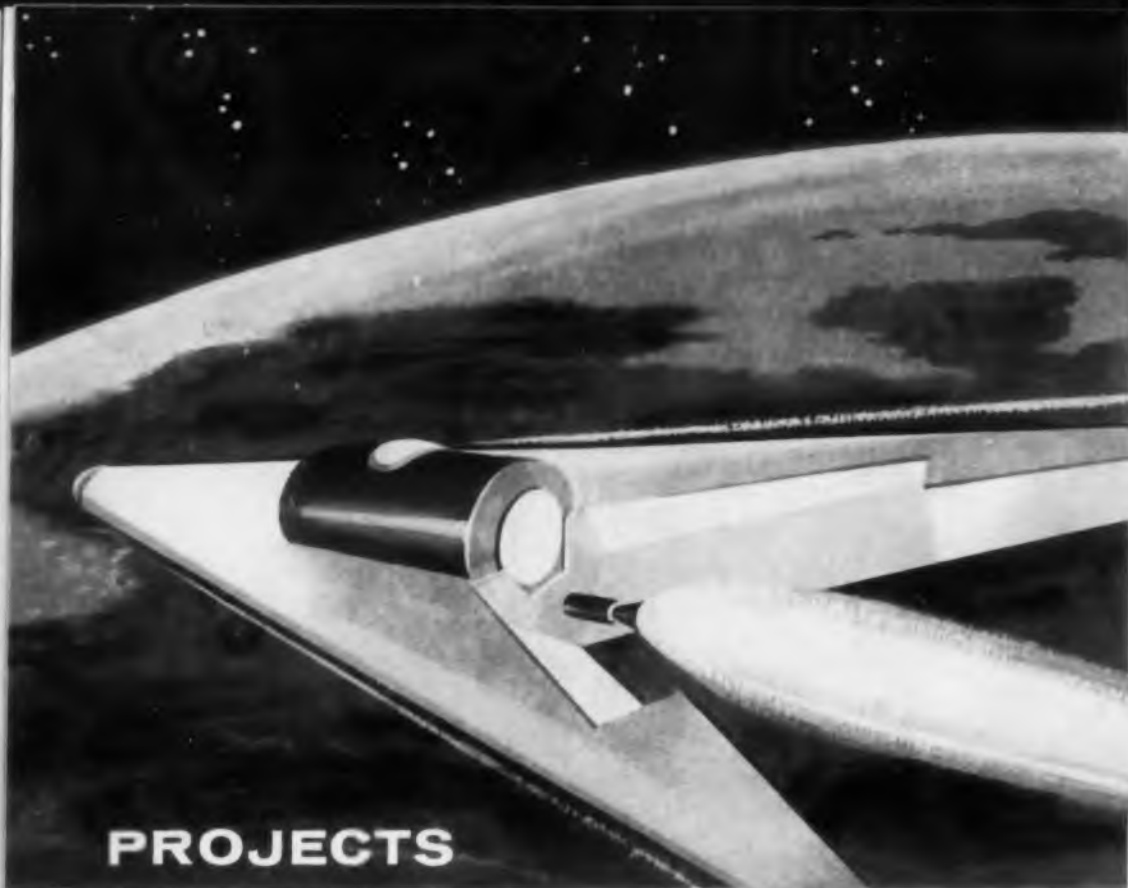
For more information write your nearest Sylvania tube sales office or Sylvania Electric Products Inc., Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.

SYLVANIA
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS



CIRCLE 290 ON READER-SERVICE CARD

Actual strip chart recording of test on a production tube shows the uniform gain characteristics of this Sylvania tube over the 2.0 KMC to 4.0 KMC spectrum



Space Transports

are under development now, capable of transporting a pilot and 1000 pounds of payload or three passengers—equipped to work in space—to an orbit of 1000 miles altitude. Indications are that an operational vehicle will be feasible and practical in the 1965 period.

PROJECTS

FOR FUTURE

DECADES IN SPACE... another Lockheed Progress Report to Engineers

Plotting the nation's future space exploration projects requires the capabilities of a forward-looking company; one with vision, superiority in technical skills and advanced facilities. Lockheed, Burbank, long a leader in extending the science of flight, is placing its vast resources and accumulated knowledge into programs designed to provide major breakthroughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Shown here are artists' renderings of a few of these important projects. Such project diversification calls for high-level technical skill, offers genuine challenge to experienced engineers. At Lockheed these varied projects require engineers in many fields. Take advantage of this need. Go forward with a forward-looking company: Lockheed, Burbank.



Supersonic Transports—have held an important place in our thinking for the past several years. Extensive wind tunnel tests have been conducted on many design concepts, supplemented by exhaustive laboratory and structure studies. Lockheed is prepared to build an airliner that will travel at speeds in excess of Mach 3 at an altitude of 75,000 feet.

Infrared Systems studies are being conducted using an advanced method of detecting fast-moving missiles and high-speed aircraft. A new facility, which includes an advanced laboratory, with an infrared tunnel, for basic research and development of prototype equipment in this expanding field, has been set up to push Lockheed, Burbank, to the forefront in infrared study.



Vertical Take-off and Landing Projects—Lockheed, Burbank, is engaged in exploring the potential of VTOL projects on a very broad scale. Different VTOL features are embodied in each proposal. Considerable emphasis is being placed on VTOL "air recovery" vehicles, designed for air rescue and reentry missiles recovery missions.

Solar Radiation Studies—are being conducted at Lockheed's flight test radio station at Briar Summit, California, placing particular emphasis on solar flares as our contribution to the International Geophysical Year. We have already accumulated more than a quarter of a million images of the sun for analysis. In cooperation with other companies, we will determine the processes by which solar energy is released.

High caliber scientists and engineers are invited to take advantage of Lockheed's outstanding career opportunities. Openings now exist in: Electronics; aero and thermodynamics; propulsion; servo-mechanisms; materials and processes; structures and stress; operations research; research in optics, infrared, acoustics, magnetohydrodynamics, instrumentation, mechanics and hydraulics; mathematics; and in all phases of design. Write today to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1307, 2400 North Hollywood Way, Burbank, California.

NEW PRODUCTS

Miniature Tantalum Capacitors

Operate to 175 C

Type XTK tantalum capacitors have a 0.65 in. diameter case and operate to 175 C. The 7/16 in. case length covers ratings from 70 μ f, 8 vdc to 8 μ f, 90 vdc. Other case lengths are 23/32 in. for 4 μ f, 170 v dc; 1-1/32 in. for 2.5 μ f, 255 v dc, and 1-5/16 in. for 2 μ f, 340 v dc. Added to the XTM series of 175 C tantalum capacitors are ratings of 140 μ f, 8 v dc; 100 μ f, 10 v dc; and 70 μ f, 18 v dc. All are in 0.65 in. diameter cases 9/16 in. long.

P. R. Mallory & Co., Inc., Capacitor Div., Dept. ED, Indianapolis 6, Ind.

CIRCLE 291 ON READER-SERVICE CARD

Silicon Grown Ingots

Large diameter

For lenses in infrared sensing devices, these silicon grown ingots are available as lenses with diameters to 10 in. and as domes with diameters to 8 in. Coated silicon lenses from this material pass 92 to 97% of the infrared wave length band between 1 to 8.5 microns.

Knaptic Electro-Physics, Inc., Dept. ED, 936 Industrial Ave., Palo Alto, Calif.

CIRCLE 292 ON READER-SERVICE CARD

Signal Samplers

Monitor coaxial systems

For monitoring the signals present in coaxial systems, these samplers are sections of 50 ohm transmission line with type N, BNC, TNC, C, or HN fittings at each end and an extra arm in the center. The HX series uses a loop probe to couple the signal to a self-contained crystal holder; the HY has no crystal holder; and the HZ uses an electrostatic probe, providing no direct return.

T.E.M., Inc., Dept. ED, 7 Okner Parkway, Livingston, N.J.

CIRCLE 293 ON READER-SERVICE CARD

LOCKHEED

CALIFORNIA DIVISION • BURBANK, CALIFORNIA

◀ CIRCLE 914 ON CAREER FORM F E 57

Microwave Ferrites

For L, S, and X bands

The microwave ferrites include types for resonance isolators, Faraday rotation devices, circulators, switches, and other devices. They operate in the L, S, and X bands. Typical compounds are the magnesium-manganese MGM-11-MW for S band and above; the alumina nickel AN-15-MW for intermediate frequency use where moderate magnetization and line width are needed; the large line width, sintered nickel N-40-MW for broad-band resonance isolators; and the low frequency resonance isolator alumina nickel-ferrite type AN-50-MW for use where low saturation magnetization is critical.

Kearfott Co., Inc., Dept. ED,
1500 Main Ave., Clifton, N.J.

CIRCLE 294 ON READER-SERVICE CARD

Delay Network

Fast rising

Model LD 30-1006 pulse delay network has input and output rise times of 0.075 and 0.25 msec, respectively. Time delay is 12 msec and taps are at 4, 8, and 10 msec. Impedance is 1 K and attenuation is 2.3 db. The 3 x 4 x 2 in. unit meets MIL-E-5272 and MIL-STD-202A specifications.

Ratigan Electronics Inc., Dept. ED, 425 W. Cypress St., Glendale 4, Calif.

CIRCLE 295 ON READER-SERVICE CARD

Coaxial Diodes

12.4 to 18 kmc

For 12.4 to 18 kmc receivers, the 2N78B and reversed polarity 2N78BR coaxial silicon mixer diodes have a 6.5 db maximum conversion loss and a 1.3 noise temperature ratio. Noise figure at 16 kmc is 8.8 db and vswr is 1.6. Forward polarity 2N78BM and forward and reversed 2N78BMR matched pairs are available for balanced mixers.

Microwave Associates, Inc., Dept. ED, Hurlington, Mass.

CIRCLE 296 ON READER-SERVICE CARD

CIRCLE 297 ON READER-SERVICE CARD

Vital equipment in this Jupiter missile is protected 24 hours a day, month after month, by a specially designed Ellis and Watts refrigerated-type Dehumidifier. In the various compartments of the Jupiter missile this E-W Unit constantly maintains perfect environmental conditions during long periods of standby and storage. Without this specialized Dehumidification Unit, moisture and condensation could cause deterioration of vital equipment and one of our most important weapons would never even get off the ground!

Designing and building specialized dehumidification units for electronic or mechanical gear is our business at Ellis and Watts. Units of any capacity, configuration, control requirements or functions can be designed and built to any applicable military or commercial specifications. And, Ellis and Watts units will function perfectly in any climate conditions on earth.

For additional information on specialized dehumidification units for electronic or mechanical gear, write for bulletin 135-D.



E-W refrigerator-type Dehumidifier, developed especially to protect vital equipment in the Jupiter missile.

without E-W dehumidifiers, the Jupiter would drown in its own sweat!

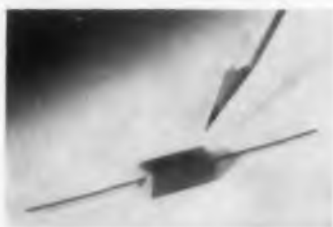


**ELLIS AND
WATTS
PRODUCTS, INC.**

P. O. Box 33-DD, Cincinnati 36, Ohio.

Jupiter missile developed by the Army Ballistic Missile Agency for operational use by U. S. Air Force. Photo courtesy U. S. Army.

NEW PRODUCTS



Wirewound Resistor

Low cost

This low cost, 2 w wirewound resistor comes in ± 5 , 10, and 20% tolerances and 0.27 to 4700 ohm resistances. It is 5/16 x 5/16 x 7/8 in. with 1-1/2 in. tinned copper axial leads.

Hamilton-Hall Resistor Corp., Dept. ED, 227 N. Water St., Milwaukee 2, Wis.

CIRCLE 298 ON READER-SERVICE CARD

Thin Capacitors

Have platform base



Type 602 Slim-Line capacitors have a thin silhouette, a Mylar dielectric, and a miniature mounting platform of epoxy glass laminate. They can withstand severe vibration on a printed circuit chassis. For transistor use, the 50 v units are available in capacitances from 0.01 to 0.33 μ f. They are of extended foil construction and coated with moisture tight epoxy.

Good-All Electric Mfg. Co., Dept. ED, 112 W. First St., Ogallala, Nebr.

CIRCLE 299 ON READER-SERVICE CARD

Control Chassis

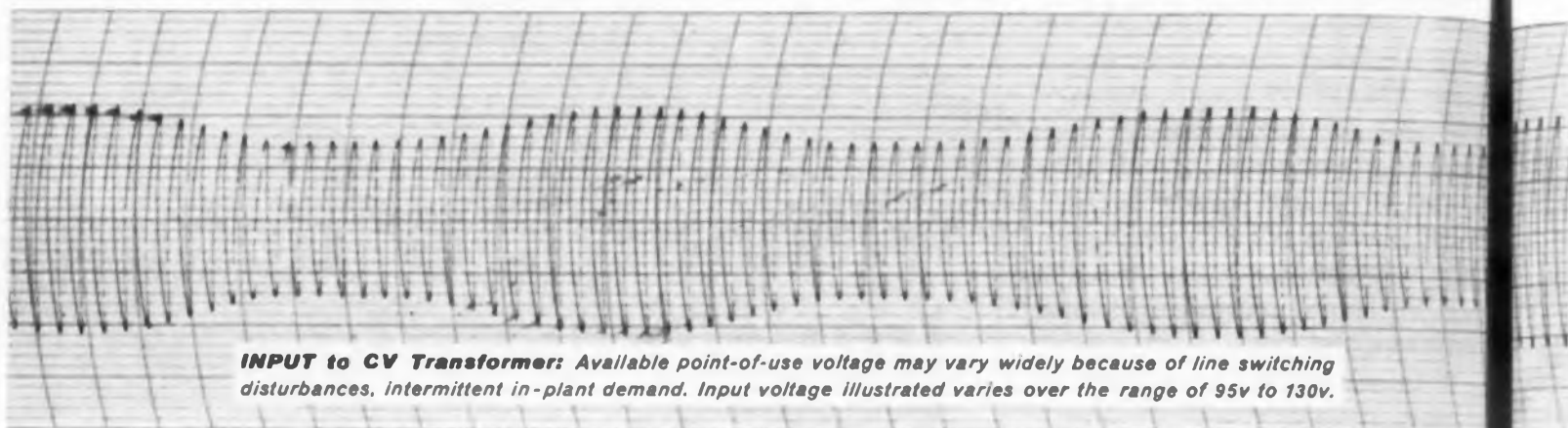
Acquires, stores, translates data

The model K-111 control chassis is designed for rapid acquisition, storage, and translation of data. It translates binary coded inputs into decimal or binary coded outputs and, upon command, stores the input information for remote readout or control. It provides transistor storage of encoder data and combines this buffer storage input with relay output.

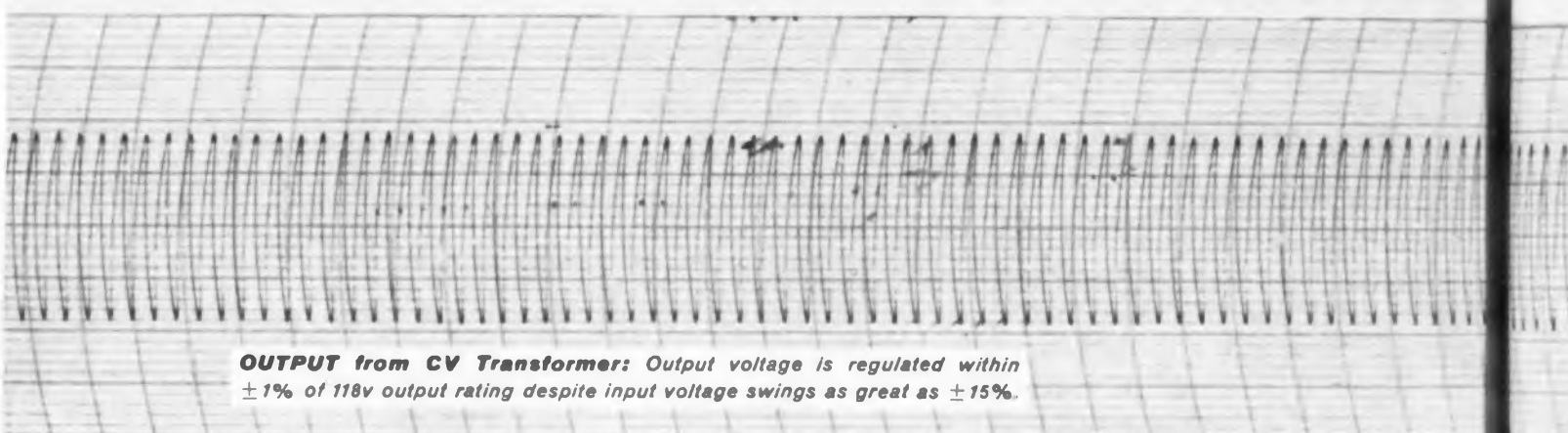
Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 300 ON READER-SERVICE CARD

Get sinusoidal output from a $\pm 1\%$ static-magnetic stabilizer for the cost of voltage regulation alone



INPUT to CV Transformer: Available point-of-use voltage may vary widely because of line switching disturbances, intermittent in-plant demand. Input voltage illustrated varies over the range of 95v to 130v.



OUTPUT from CV Transformer: Output voltage is regulated within $\pm 1\%$ of 118v output rating despite input voltage swings as great as $\pm 15\%$.

Sola now offers sinusoidal output in every standard-type regulator *with no price premium*. This development — a result of major design and production innovations — greatly widens the field of use for static-magnetic voltage regulation. The new standard sinusoidal design is now ideal for use with electrical and electronic equipment requiring a regulated input voltage with commercial sine wave shape — especially where harmonic-free supply had previously been too costly. The sinusoidal output also contributes to ease of selection and ordering, since this Sola stabilizer is virtually universal in application.

The Sola Standard Sinusoidal Constant Voltage Transformer provides output with less than 3% rms harmonic content. It automatically and continuously regulates output voltage within $\pm 1\%$ for line voltage variations of $\pm 15\%$. Average response time is 1.5 cycles or less. The new line includes nine stock output ratings from 60va to 7500va.

Besides the improved electrical characteristics, these units are substantially smaller and lighter than previous models. Size and weight reductions were accomplished without any loss of performance or dependability.

With the Sola Standard Sinusoidal Constant Voltage Transformer you also get all the proved benefits of a static-magnetic regulator. It is simple and rugged. There are no tubes . . . no moving parts . . . no replaceable parts. Maintenance and manual adjustment are not necessary.

Its current-limiting characteristic protects against shorts on the load circuit. It is available in step-up and step-down ratios, allowing substitution for conventional, non-regulating transformers. These units can be used in any electronic or electrical application requiring a regulated sinusoidal power source where the peak power demand does not exceed the capacity of the constant voltage transformer. Circuit design formulae based on sinusoidal wave shape are directly applicable. Custom units to specific requirements are available in production quantities.

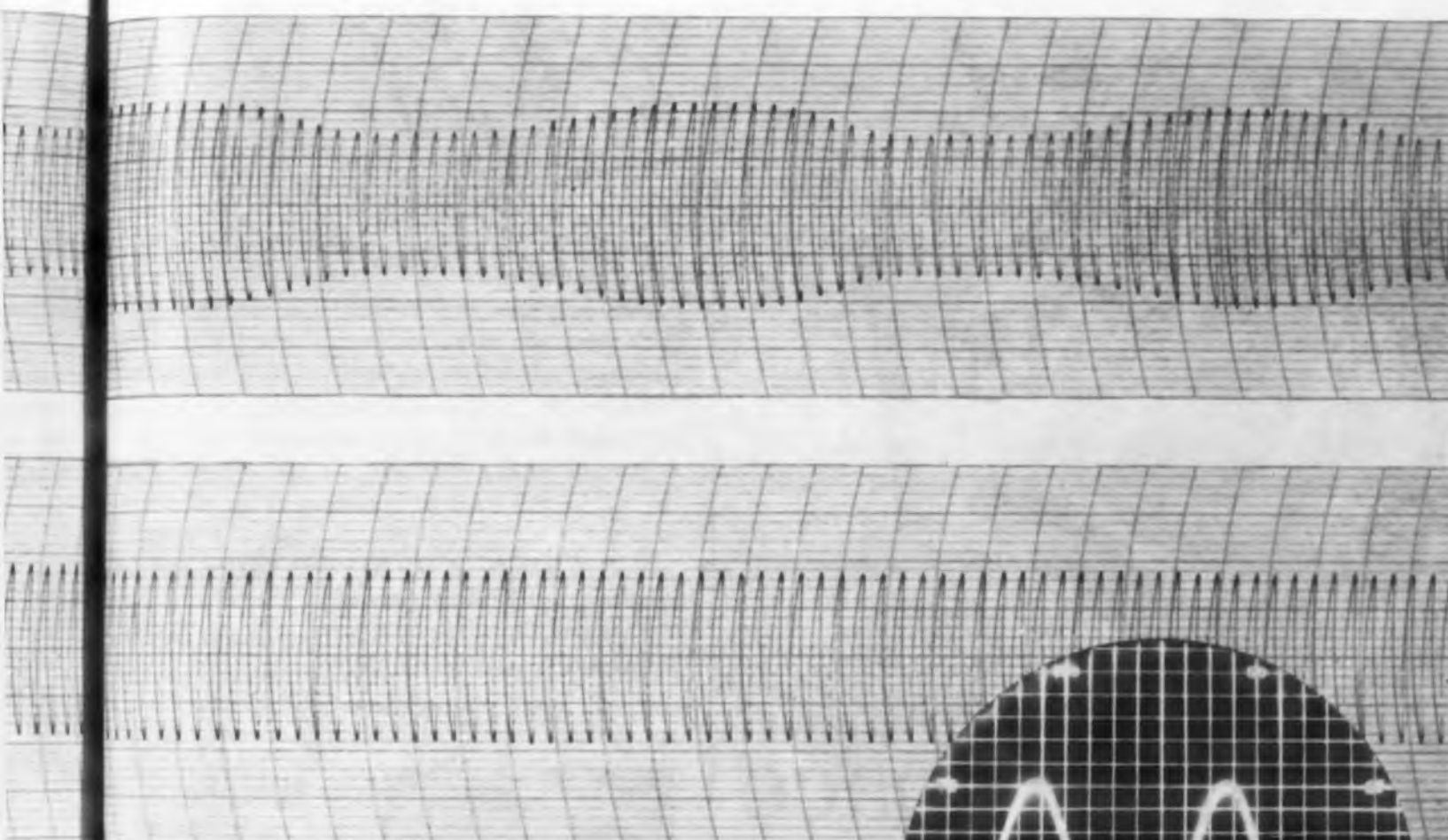
Write for Product Bulletin 316-CVS.

SOLA

A Division of Basic Products Corporation

SOLA ELECTRIC CO.,
4633 West 16th Street,
Chicago 50, Illinois

Sola Standard Sinusoidal Constant Voltage Transformer



OUTPUT from CV Transformer: Oscillogram of output from same CV transformer uses expanded horizontal scale to picture commercial sine wave shape retained by output.

New Prices of Sola Standard Sinusoidal Constant Voltage Transformers

| Catalog Number | Output Rating, VA | Price Each | % Price Reduction |
|----------------|-------------------|------------|-------------------|
| 23-13-060 | 60 | \$30 | 6.2 |
| 23-13-112 | 120 | 38 | 5.0 |
| 23-13-125 | 250 | 52 | 17.5 |
| 23-13-150 | 500 | 81 | 14.7 |
| 23-13-210 | 1000 | 135 | 14.6 |
| 23-25-220 | 2000 | 245 | 10.9 |
| 23-25-230 | 3000 | 330 | 9.6 |
| 23-26-250 | 5000 | 515 | new item |
| 23-28-275 | 7500 | 900 | new item |

CIRCLE 301 ON READER-SERVICE CARD



Electrical Impact Switch

Registers sideways shock

Impact switch model DWG 2-15 registers shock from any direction within 90 deg of the vertical axis. The dpdt unit may be set for any value from 5 to 15 g for about 10 msec. It is rated at 125 v ac, 5 amp; 28 v dc, 3 amp inductive and 3.5 amp, resistive, each switch.

George Harmon Co., Inc., Dept. ED, 18232 Parthenia St., Northridge, Calif.

CIRCLE 302 ON READER-SERVICE CARD



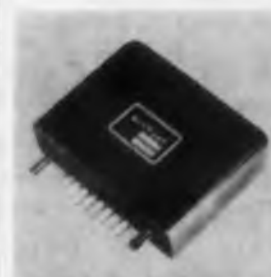
Analog-to-Digital Recorder

Shaft input type

Input torque requirements of the ADR shaft input analog-to-digital recorder are low enough so that the measured variable can usually drive the shaft directly. A servo system can be used where torque is insufficient or the signal is electrical. The unit records analog values on binary-decimal punched tape which can be read directly or translated automatically into standard punched cards or tape for computer processing. One 6 v dry cell battery powers the unit on a 15 min readout interval for a year.

Fischer & Porter Co., Dept. ED, 116 Jacksonville Rd., Hatboro, Pa.

CIRCLE 303 ON READER-SERVICE CARD



Servo Amplifier

Provides voltage gains to 1000

The model A 414 germanium transistor amplifier drives center-tapped servo motors up to size 11 with voltage gains to 1000. It operates from single-phase 115 or 26 v 400 cps power supplies over an ambient range of -55 to +71 C. Dimensions are 1 x 3-1/4 x 2-1/2 in.

Westamp, Inc., Dept. ED, 11277 Massachusetts Ave., Los Angeles 25, Calif.

CIRCLE 304 ON READER-SERVICE CARD





TO ENGINEERS

concerned with inner space

When there's no space to spare in your design, consider AE Class S relays. A basic Class S measures only $1\frac{1}{16}'' \times 1\frac{3}{16}'' \times 1\frac{1}{16}''$ and weighs only 2 ounces.

Or, if you need a stepping switch, we have one no larger than a pack of king-size cigarettes.

Relay or switch, they're as uncompromising in quality *and* ability as their larger brothers.

As an example: the Class S miniature has many of the features of the premium-quality Class B—including sure-footed independent twin contacts.

There's another way we can help on the space problem. AE engineers have had years of experience in devising simplified circuits

with complex capabilities for automatic telephone exchanges. Could be we could show you how to save a relay or two in your design. No harm in asking.

Or, if you'd like to put the switching end of the operation in our hands, we're equipped to supply completely wired and assembled, custom-built control units *or help you develop systems* to handle anything from sequential programming to... you name it.

Want to get together? Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. If you'd like literature ask for our Circular 1702-E: *Relays for Industry*, and the new 32-page booklet on *Basic Circuits*.

AUTOMATIC ELECTRIC

Subsidiary of
GENERAL TELEPHONE & ELECTRONICS



CIRCLE 305 ON READER-SERVICE CARD

**AE
CAN
DO**



136

NEW PRODUCTS

VTVM

Has multipurpose probe



Peak-to-peak vtvm model VT-1 uses one probe that does the work of four. Called the Multi-Probe, it can be set to function as a dc, ac, low capacitance, or rf probe by means of a rotating head. Self-powered and portable, the VT-1 has a 6 in., 100 μ a D'Arsonval meter with 2% full scale dc and 5% full scale ac accuracy. It has dc ranges of 0 to 1.5, 6, 30, 150, 300, 600, and 1500 v and ac ranges of 0 to 3, 12, 60, 300, and 1200 v, and can measure 0 to 1 billion ohms.

Century Electronics Co., Inc., Dept. ED, 111 Roosevelt Ave., Mineola, N.Y.

CIRCLE 306 ON READER-SERVICE CARD



Photoflash Capacitors

Have 1 ma maximum leakage

For energy storage, welding, time delay, high current filtering, and other uses, these photoflash capacitors leak no more than 1 ma at full rated working voltage. They may be stacked.

Illinois Condenser Co., Dept. ED, 1616 N. Throop St., Chicago 22, Ill.

CIRCLE 307 ON READER-SERVICE CARD

Power Supplies

Plug-in

These plug-in, semiconductor voltage regulated power supplies have 0.1% line or load regulation and 2.5 mv maximum ripple. Of nonsealed construction, they feature variable supply frequency operation and full short circuit protection. They are usable from 60 to 400 cps.

Transistor Devices Inc., Dept. ED, 111 Hamburg Turnpike, Riverdale, N.J.

CIRCLE 308 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1959

Parametric Amplifiers

For 400 to 500 mc



Series HPA parametric amplifier cavities operate at fixed frequencies between 400 and 500 mc. Bandwidth is about 1% and gain is about 15 db when proper pump amplitude and frequency are provided. The units improve most receiving systems by 3 to 10 db.

Tapetone, Inc., Dept. ED, Webster, Mass.

CIRCLE 309 ON READER-SERVICE CARD

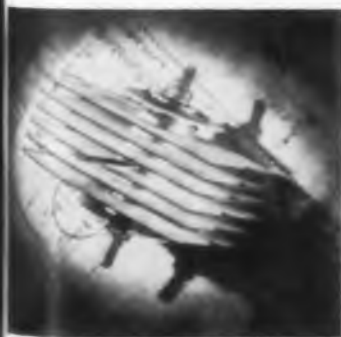
Telephone Relays

Weigh 2 oz

Series GT miniature telephone relays are rated 5 amp, 115 v, 60 cps, noninductive and come with contact arrangement up to 4pdt. Minimum contact pressure is 15 g; pull-in time, 7 to 9 msec; release time, 1 to 4 msec. Standard voltages are 6 to 230 v ac or dc. The units weigh 2 oz and measure 1-9/16 x 25/32 x 1-3/8 in. maximum.

Line Electric Co., Dept. ED, 271 S. Sixth St., Newark 3, N.J.

CIRCLE 310 ON READER-SERVICE CARD



Selenium Rectifier Stacks

Operate continuously for nine years

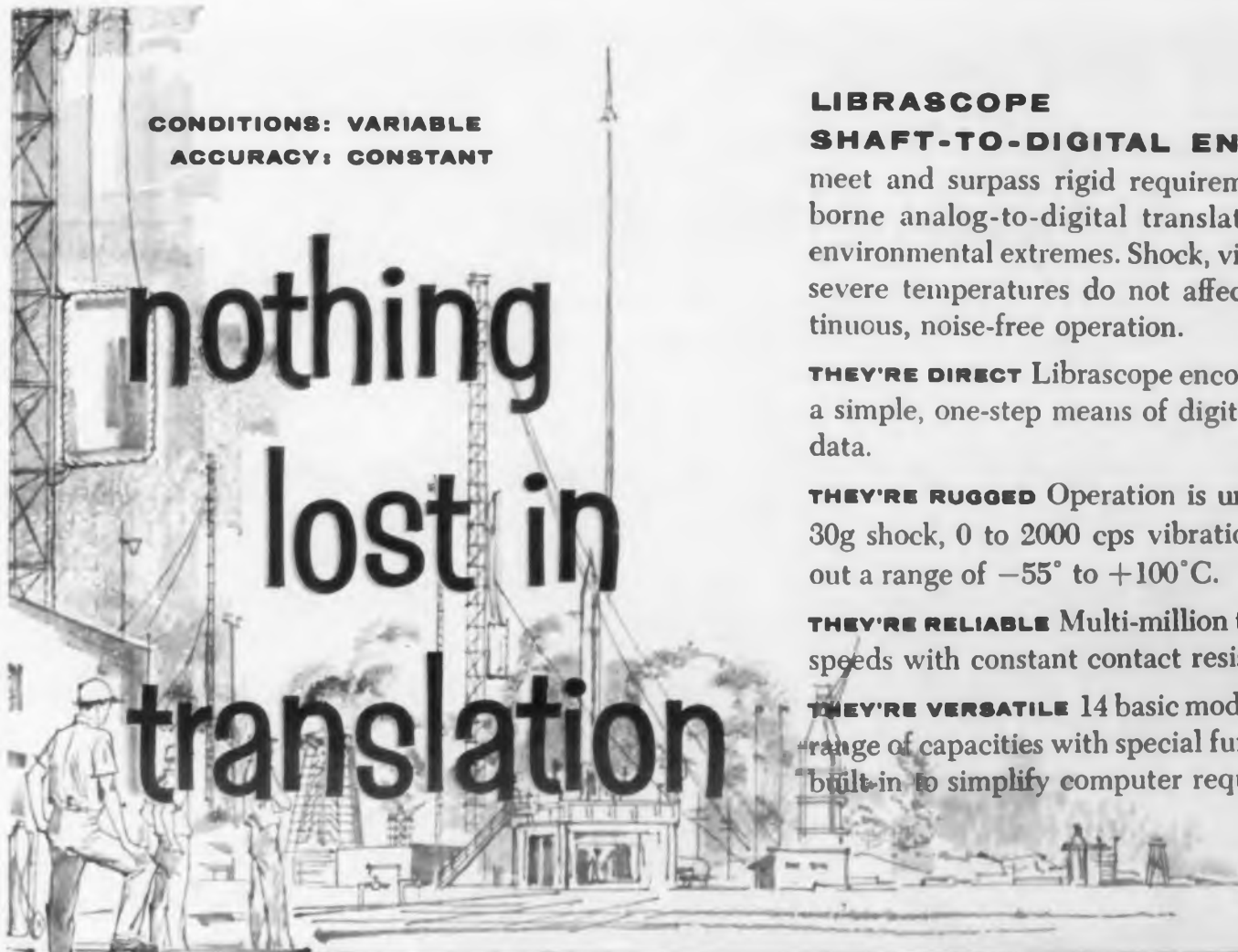
These improved large plate selenium rectifier stacks withstand surge currents 150% greater than former models. Their cup-washer design provides uniform cell temperature, allowing continuous operation for 70,000 hr. Cells are rated to 36 v per plate and range from 3-3/8 in. round to 5 x 6 in. with current ratings from 2 to 15 amp per cell.

General Electric Co., Semiconductor Products Dept., Dept. ED, Syracuse, N.Y.

CIRCLE 311 ON READER-SERVICE CARD

CONDITIONS: VARIABLE
ACCURACY: CONSTANT

nothing lost in translation



LIBRASCOPE

SHAFT-TO-DIGITAL ENCODERS

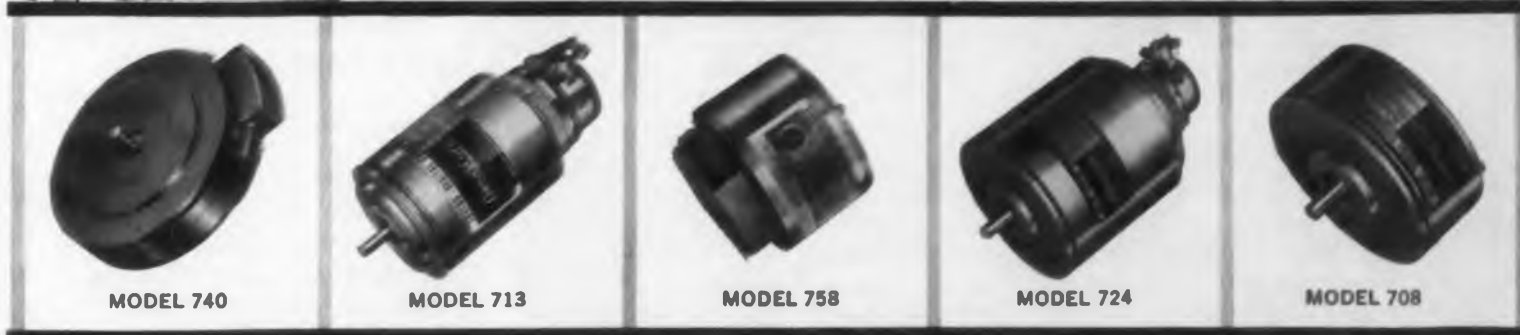
meet and surpass rigid requirements of airborne analog-to-digital translation despite environmental extremes. Shock, vibration, and severe temperatures do not affect their continuous, noise-free operation.

THEY'RE DIRECT Librascope encoders provide a simple, one-step means of digitizing analog data.

THEY'RE RUGGED Operation is unaffected by 30g shock, 0 to 2000 cps vibration, throughout a range of -55° to $+100^{\circ}$ C.

THEY'RE RELIABLE Multi-million turns at high speeds with constant contact resistance.

THEY'RE VERSATILE 14 basic models in a wide range of capacities with special function codes built-in to simplify computer requirements.



| OUTPUT CODE | MODEL NO. @ | TOTAL CAPACITY | RESOLUTION PER TURN | DIMENSIONS DIA. x LENGTH |
|--------------------------------|-------------|------------------------------------|---------------------|--------------------------|
| PARALLEL BINARY (LINEAR) | 740 | 10 bits (1024) | 1024 | 4 3/4" x 2 1/2" |
| | 743 | 13 bits (8192) | 128 | 2" x 3 1/2" |
| SERIAL BINARY (LINEAR) | 707 | 7 bits (128) | 128 | 2" x 2 1/4" |
| | 713 | 13 bits (8192) | 128 | 2" x 3 1/2" |
| | 717 | 17 bits (131,072) | 128 | 2" x 4 1/2" |
| | 719 | 19 bits (524,288) | 128 | 2" x 4 1/2" |
| SERIAL BINARY (SIN-COS) | 757† | 7 bits per quadrant* (4 quadrants) | 512 | 2 1/4" x 4 1/2" |
| | 758† | 8 bits per quadrant* (4 quadrants) | 1024 | 4 1/8" x 3 3/8" |
| BINARY CODED DECIMAL (8-4-2-1) | 723 | 2,000 | 200 | 3 1/8" x 4 3/8" |
| | 724 | 20,000 | 200 | 3 1/8" x 4 3/8" |
| | 733 | 3,600 | 200 | 3 1/8" x 4 3/8" |
| | 734 | 36,000 | 200 | 3 1/8" x 6 1/8" |
| | 735 | 360,000 | 200 | 3 1/8" x 6 1/8" |
| GRAY | 708 | 8 bits (256) | 256 | 3 1/8" x 1 1/8" |

@All models available with internally mounted isolation diodes for sequential multiplexing applications.

†Available in hermetically sealed servo-driven package as Models 757-S and 758-S.

*Including limit 1 and polarity information. Sine and cosine functions generated simultaneously and independently. One turn of shaft generates 4 quadrants of information.

For full details on Librascope shaft-to-digital encoders write for catalog E 11-1.

0001
0010
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LIBRASCOPE

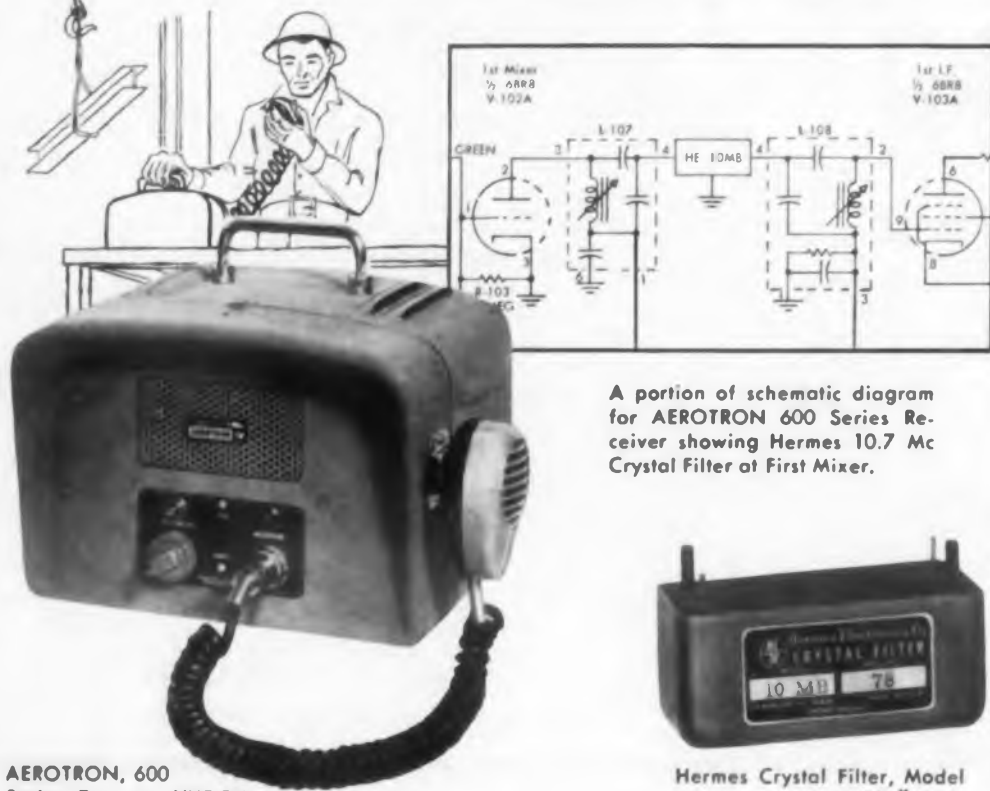
A
GENERAL
PRECISION
COMPANY

For information on career opportunities at Librascope, write Glen Seltzer, Employment Manager.

CIRCLE 312 ON READER-SERVICE CARD

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION
LIBRASCOPE, INC. 40 East Verdugo Avenue • Burbank, Calif.

FIRST 2-Way Crystal Filter Radio to Guarantee Lifetime Receiver Selectivity Uses HERMES CRYSTAL FILTERS



AEROTRON, 600 Series, Two-way VHF-FM Radio Communications Equipment

A portion of schematic diagram for AEROTRON 600 Series Receiver showing Hermes 10.7 Mc Crystal Filter at First Mixer.



Hermes Crystal Filter, Model 10 MB, measures 2 3/8" long x 1" wide x 1/32" high.

The AEROTRON, Model 600 Series, is the first commercially available two-way VHF-FM Mobile Radio Equipment to use a high frequency crystal filter to guarantee Receiver selectivity for the life of the equipment. This equipment is designed by Aeronautical Electronics, Inc. of Raleigh, North Carolina, for the new "split channel" frequency allocations where exceptional frequency stability and selectivity are imperative. The use of a Hermes Crystal Filter at the highest intermediate frequency eliminates any desensitization from very strong, adjacent channel stations and offers a very flat response throughout the bandpass of the filter.

Hermes crystal filters were selected because of their superior performance, small size, and immediate availability. Close cooperation between the engineering departments of the two companies contributed to the rapid development of this new Mobile Radio Equipment. Receiver characteristics include: *Frequency Stability:* $\pm 0.0005\%$ over -40 to $+75^\circ\text{C}$; *Sensitivity:* 0.6 microvolt or less for 20 db quieting; *Selectivity:* ± 7.5 kc at 6 db down; *Modulation Acceptance:* $\pm 1/2$ db throughout bandpass range of ± 6 kc.

Whether your selectivity problems are in transmission or reception, AM or FM, mobile or fixed equipment, you can call on Hermes engineering specialists to assist you in the design of your circuitry and in the selection of filter characteristics best suited to your needs. Write for Crystal Filter Bulletin.

A limited number of opportunities is available to experienced circuit designers. Send resume to Dr. D. I. Kosowsky.

The new name for HYCON EASTERN, INC. is

Hermes Electronics Co.

75 Cambridge Parkway • Dept. F • Cambridge 42, Massachusetts

CIRCLE 313 ON READER-SERVICE CARD

NEW PRODUCTS

PREPUNCHED TERMINAL BOARDS.—For fast circuit mounting in breadboard and permanent installations, Vectorboards are available in six patterns with 0.062 and 0.093 holes in XXXP phenolic, G-7 glass silicone, G-10 glass epoxy, and paper epoxy. Component wires and the company's push-in terminals can be quickly inserted in the boards.

Vector Electronic Co., Dept. ED, 1100 Flower St., Glendale 1, Calif.

CIRCLE 314 ON READER-SERVICE CARD

MINIATURE PANEL INDICATOR LIGHT.—Color-Lite model 102S is designed for front access and operates for 100,000 hr at 5 v or 60,000 hr at 6.3 v. It uses the company's series T-1 bulb which has an operating life of 8000 hr. Available in red, white, green, blue, or amber, the unit is 1/2 in. in diameter.

The Sloan Co., Dept. ED, 4029 Burbank Blvd., Burbank, Calif.

CIRCLE 315 ON READER-SERVICE CARD

COMPUTER CAPACITORS.—Type BPU capacitors have values to 150,000 μf at 3 wvdc and are available up to 1000 μf at 450 v dc. They are immersion and shockproof, have a long life, and operate over a wide temperature range.

Illinois Condenser Co. Dept. ED, 1616 N. Throop St., Chicago 22, Ill.

CIRCLE 316 ON READER-SERVICE CARD

SOLDERING TIPPLETS.—Type 823 pyramid and 824 chisel tipplets have a 3/16 in. diameter that affords effective heat transfer and fast heat recovery in production line soldering. Made of copper alloy, they are available unplated or iron clad. They are 1-1/4 in. long.

Ungar Electric Tools, Inc., Dept. ED, 4101 Redwood Ave., Los Angeles 66, Calif.

CIRCLE 317 ON READER-SERVICE CARD

TRANSCEIVER.—The Telescan multiplexes up to 28 signals over one pair of low-rate telegraph wires. Identical units transmit and receive both metering and control signals bidirectionally and in a loop. Transmission rate is 5 pps at 120 v dc and 1 ma. The unit can be used for industrial processing or remote public service control.

Automatic Control Co., Dept. ED, 999 University Ave., St. Paul 4, Minn.

CIRCLE 318 ON READER-SERVICE CARD

24 CARAT ACID BRIGHT GOLD.—A gold complex, Orosene 999 produces hard, ductile, mirror bright 24 carat gold electroplates in either tank or barrel plating. It contains no silver, antimony, or sulphur compounds and has high tarnish resistance.

Technic, Inc., Dept. ED, P.O. Box 965, Providence, R.I.

CIRCLE 319 ON READER-SERVICE CARD

DURANT

Electric "SP"

PREDETERMINED
COUNTER

(COUNTS ELECTRICALLY and CLOSES
SWITCH AT END OF PRE-SET COUNT)

C·O·U·N·T·S
ELECTRICALLY



COMPACT • RUGGED
FAST • ACCURATE

Eliminates costly over-runs or time consuming under-runs. Actuated by Photo Electric Cell, Tube, Relay, or Contact Switch. Counter can be located where desired. Predetermined count may be set at any figure to 99,999. Hundreds of applications in all phases of production and instrument work.

Send for Catalog No. 56

DURANT MFG. CO.

1953 N. Buffum St., Milwaukee 1.
93 Thurbers Ave. Providence 5, R.I.
Representatives in Principal Cities



PRODUCTIMETERS
SINCE 1879 Count Everything

CIRCLE 320 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1959

Miniature Accelerometer

Has range of ± 0.5 to ± 100 g

Range of the model GMA accelerometer is ± 0.5 to ± 100 g with natural frequencies of from 10 to 75 cps. Linearity is $\pm 1\%$ of full scale for balanced range instruments. Damping of the accelerometer is provided by the shearing of silicone fluid between closely spaced moving surfaces. The instrument is temperature compensated and will operate to specifications between -20 and $+250$ F. The unit can withstand vibrational accelerations of 10 g, 10 to 20,000 cps, on any axis, and shock accelerations of 50 g for 7 ms duration on any axis. It measures $1 \times 1 \times 1.75$

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

CIRCLE 321 ON READER-SERVICE CARD



Variable Capacitors

Have up to 4.4 μ f capacitance

Brad-Cap variable capacitors feature close tolerance adjustment over the full capacitance range; one continuous adjustability; accurate repeatability; and maximum capacitance to 4.4 μ f. Operating and storage temperature range is -20 to $+100$ C and voltage range extends to 200 v ac and 400 v dc. Applications include adjustable capacity standards; low and high pass filters; and LC, integrating, and ferro resonance circuits. Plastic Capacitors, Inc., Dept. ED, 2620 N. Elmhurst Ave., Chicago 14, Ill.

CIRCLE 322 ON READER-SERVICE CARD

Converter

Magnetic to paper tape

The Dykor D101 converter translates six-bit computer data on magnetic tape into corresponding form and standard Teletype paper tape. The printer is controlled without special computer programming. The unit provides a paper tape output of up to 240 characters per sec in standard five-level Teletype code.

Digitronics Corp., Dept. ED, Albertson Ave., Albertson, N.Y.

CIRCLE 323 ON READER-SERVICE CARD

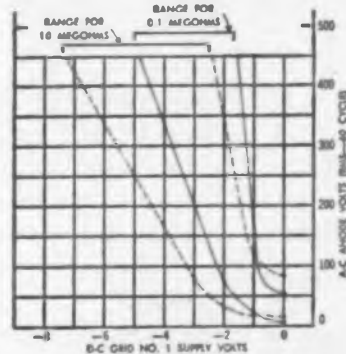
RUGGEDIZED THYRATRON

CONSTRUCTION FEATURES OF TUNG-SOL/CHATHAM

2050W

- * special silicone rubber cushion shock mounts 2050W in its own base
- * metal anode shield replaces glass pant leg found in prototype
- * ceramic insulators firmly support anode top and bottom
- * double micas, top and bottom
- * special tungsten mandril gives heater extra support

OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE*



*Ranges shown are for two values of grid resistor, 0.1 megohm and 10 megohm, and take into account initial differences between individual tubes and subsequent differences during tube life for a heater voltage range of 5.7 to 6.9 volts.

The outstanding reliability of the Tung-Sol Chatham 2050W has consistently been demonstrated in a wide variety of military and industrial applications.

Electrically, the 2050W is identical to its prototype, the 2050, for which it is a direct, plug-in replacement. Physically, the ruggedized 2050W embodies a number of construction features which assure long, trouble-free life under the most severe conditions of vibration,

shock and fluctuating temperatures.

If your application permits no compromise with quality and reliability, you certainly should investigate the Tung-Sol/Chatham 2050W ruggedized thyatron. Write for detailed specifications. For premium quality, special purpose tubes of all types . . . and for highly dependable semiconductors, see how well Tung-Sol can meet your requirements. Tung-Sol Electric Inc., Newark 4, New Jersey.



TUNG-SOL®

CIRCLE 324 ON READER-SERVICE CARD

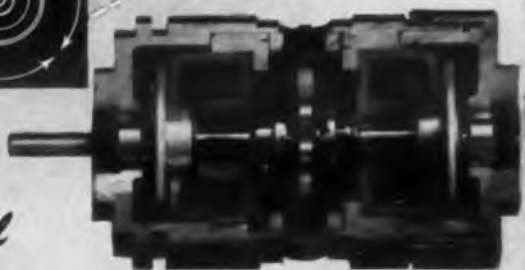
STEPPER MOTOR



PROVIDES

Bi-Directional

PROPORTIONAL SHAFT
ROTATION FOR A GIVEN PULSED INPUT



MODEL SM-300-1

- Angular increment per pulse — 36°.
- Stepping rate — up to 15/second.
- Voltage requirement — 28 V. D.C.
- Duty cycle — $\left(\frac{\text{on time}}{\text{on time \& off time}}\right)$ 56% max.
- Weight — 8 oz.
- Shock — 15 G's for 11 milliseconds duration each way along three major axes.
- Reliability — shall not fail to convert more than one pulse in 1,000,000 into equivalent angular rotation.

OTHER MODELS AVAILABLE WITH VARIATIONS FROM THE ABOVE SM-300-1 SPECIFICATIONS.

The two rotary solenoids contained in each motor produce the incremental motion of the output shaft in either direction. Energizing either of these solenoids produces a combination of linear and rotational motion which moves a ratchet gear axially into engagement with its rotating ratchet gear and thus imparts a constant amount of rotation to the output shaft. The detent roller assembly insures constant, reproducible angular shaft rotation increments in either direction and maintains the output-shaft position while the motor is at rest with the power off.

Stepper Motors are adaptable to routine jobs such as driving mechanical counters. They also find excellent use in positioning devices that will set up a controlling voltage and/or a phase shift such as potentiometers and autosyns. They are widely used as a positioner or guided missiles to adjust heading, fuel flow, altitude, and circuit sampling for telemetering purposes. In one adaptation as a heading controller, two Stepper Motors are used to position a differential autosyn in steps of either vernier degree or coarse degrees per input pulse, bi-directionally, through a suitable gear train.

Write for more details—available upon request.

STEPPER MOTORS CORPORATION

Subsidiary of California Eastern Aviation, Inc.

7443 West Wilson Avenue • Chicago 31, Illinois

CIRCLE 325 ON READER-SERVICE CARD

NEW PRODUCTS

INDUCTION VOLTAGE REGULATORS.—These Inductrol regulators are 15 to 50% lighter than previous models. For use where load voltage must be kept at a constant level despite a fluctuating supply or where a varying utilization voltage is needed with a fairly constant supply, the units are available in automatic, motor driven, or hand operated types.

General Electric Co., Voltage Regulator Product Section, Dept. ED, Pittsfield, Mass.

CIRCLE 326 ON READER-SERVICE CARD

ONE-WAY IMPULSE SWITCH.—Incorporating the company's type 10 basic switch, this unit provides simplified electrical control for solenoid valves and starter relays by eliminating the need for one-way actuators, interlocks, or delay devices.

Illinois Tool Works, Licon Switch Div., Dept. ED, 2501 N. Keeler Ave., Chicago 39, Ill.

CIRCLE 327 ON READER-SERVICE CARD

PHOTOELECTRIC READER.—The T877 scale reader provides accurate electrical signals at predetermined table angle increments by automatically reading the engraved markings of a precision table reference dial.

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 328 ON READER-SERVICE CARD

TENSILE TESTING FURNACE.—For operation at 2500 C in a vacuum of 0.01 to 0.05 microns, this furnace has a 1-1/2 in. diameter, 6 in. high tantalum heating element assembly that assures good temperature uniformity of the tensile specimen. A specimen can be assembled and disassembled to the grips without moving the furnace.

Richard D. Brew and Co., Inc., Vacuum Furnace Div., Dept. ED, Airport Rd., Concord, N.H.

CIRCLE 329 ON READER-SERVICE CARD

SELF-LOCKING CAP NUT.—Rust proof and anti-magnetic, the Relok is molded of Plaskon nylon. Inside, its deepest end is left unthreaded so that the forward end of the bolt taps itself in place. Available in a variety of colors.

Lehigh Metal Products Co., Dept. ED, 134 Alewife Brook Parkway, Cambridge, Mass.

CIRCLE 330 ON READER-SERVICE CARD

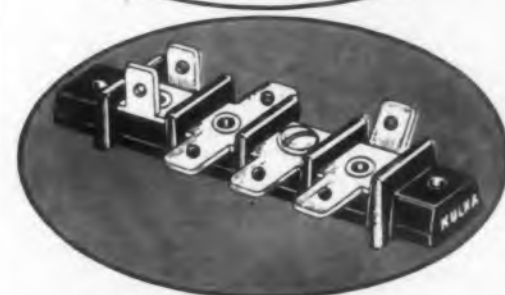
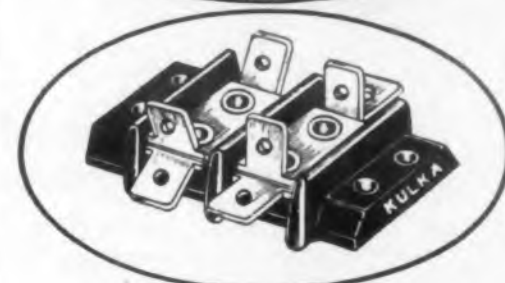
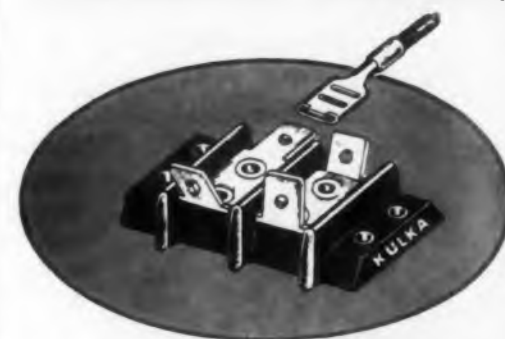
FLEXIBLE PLASTIC TUBING.—For missiles and electronic cabling systems, Aircon — 1010J— conduit has high tensile strength and walls 0.045 in. thick. It is waterproof and abrasive and flame resistant. ID's range from 1/8 to 4 in. in 1/8 in. increments; weight is 0.07 lb per in. ID ft length; and burst pressure is 70 psi.

Airconductors, Dept. ED, 367 E. Olive St., Gardena, Calif.

CIRCLE 331 ON READER-SERVICE CARD

"KLIPTITE"

THE HANDIEST CONNECT-DISCONNECT TERMINAL BLOCKS



Self-locking, quick connect-disconnect terminal blocks. Designed especially for use with female terminals made by AMP, Burndy, Kent, and Ark-les. Exceptionally wide application possibilities.

Tabs of brass. Suitably plated for low contact resistance. Rigidly eyeletted to block. Or tabs can be had separately to fasten under screws. Flat, 45° and 90° angled tabs in any combination to meet special requirements.

Write for detailed literature on "Kliptite" terminal blocks and other types in the extensive Kulka line.



CIRCLE 332 ON READER SERVICE CARD
ELECTRONIC DESIGN • July 8, 1959

Tong Ammeter

For small current measurements



Type PB tong test ammeter has a 10-0-10 amp dc and a 0 to 20 amp ac and dc range on one dial. For measurements, the tongs clamp around conductors up to 1/2 in. in diameter. They do not break the circuit or insulation.

Columbia Electric Mfg. Co., Dept. ED, 4519 Hamilton Ave., Cleveland 14, Ohio.

CIRCLE 333 ON READER-SERVICE CARD

Frequency and Pulse Rate Transducers

Have 0.5% full scale accuracy

Series ES expanded scale Maga-cyclers convert pulse rate to directly proportional dc voltage or current and may be used as adjustable frequency detectors and stable references. They have standard linearity and accuracy of 0.5% of full scale frequency. Typical is the ES 400, model 1000-W which has a mid-frequency range of 400 cps and supplies 0 to 1 v dc with 380 to 420 cps input signal variation.

Pioneer Magnetics Inc., Dept. ED, 5558 Wilshire Blvd., Los Angeles 38, Calif.

CIRCLE 334 ON READER-SERVICE CARD

Teflon Feedthrough Insulators

Hermetically sealed

Series CF-400 and CF-414 Teflon feedthrough insulators are designed for permanent and demountable applications, respectively. The CF-400 has a hermetic solder seal, while the CF-414 uses silicone rubber O rings.

Fluorocarbon Products Inc., Dept. ED, Camden 1, N.J.

CIRCLE 335 ON READER-SERVICE CARD

CIRCLE 336 ON READER-SERVICE CARD

TRIMPOT® MODEL 220

As many as 17 of these compact units can be mounted in a space of just one cubic inch. Designed for printed circuits and modular assemblies, Trimpot Model 220 measures less than 3/16" x 5/16" x 1". Power rating is 1 watt and maximum operating temperature is 175°C. This Potentiometer meets or exceeds Mil-Specs for humidity, salt spray, fungus, sand and dust, as well as acceleration, vibration and shock. Self-locking 15-turn shaft insures sharp, stable settings...exclusive Silverweld® fused-bond termination and ceramic mandrel provide extreme temperature stability. The Model 220 is available in a wide variety of resistance ranges and a choice of two terminal types—gold-plated Copperweld wire or insulated stranded leads.

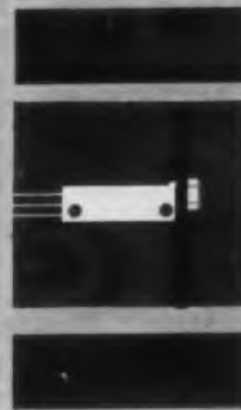
Stocked by leading electronic distributors across the nation, these units are ready for immediate delivery. Write for complete technical data and list of stocking distributors. AVAILABLE AS PANEL MOUNT UNIT (illustrated at right) with same specifications. *Trademark

Exclusive manufacturers of Trimpot®, Trimit®. Pioneers in potentiometer transducers for position, pressure and acceleration.



ACTUAL SIZE

Subminiature ...
Proven Reliability



**BOURNS
Inc.**

P.O. Box 2112C, Riverside, California
Plants: Riverside, California
and Amos, Iowa

In Canada: Douglas Randall (Canada), Ltd., licensee

marion
advancement
in instrument
design

**INDUCTION
SOLDERING
UNIT**



Model PM 1

FOR SMALL PARTS AND ASSEMBLIES
Simplifies, improves and speeds up
component production. Provides local
heat to otherwise inaccessible spots.
Safe and simple. Max. power input
775 watts, 100 watts standby, 115
volts, 60 cycles. 15 3/4" x 21 1/2" x 15".
150 lbs. Bulletin on request. Marion
Instrument Division, Minneapolis-Honey-
well Regulator Company, Manchester,
N. H., U. S. A.

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marion
"WHERE ELECTRONICS MEETS THE EYE"
meters



CIRCLE 337 ON READER-SERVICE CARD

**MAXIMUM
SENSITIVITY**



X BAND MODEL MMX

with LEL's

**MATCHED
MIXER-PREAMPLIFIERS**

A new series of matched mixer-preamplifier units,
provides superior performance by designing the
microwave and I.F. preamplifier as an integrated
assembly. Each unit is designed for gain and selec-
tivity, and is adjusted for minimum noise figures.
Standard units are available with output frequen-
cies of 30 or 60 mc. Integrated mixer-amplifier
assemblies are available for X, C, S, KA and KU
bands, which include pre-selector and local oscil-
lator if desired.

LEL

380 OAK STREET
COPIAGUE, L.I., N.Y.

CIRCLE 338 ON READER-SERVICE CARD

NEW PRODUCTS

TEST POINT JACK.—Type SKT-27 will accept a
probe 0.45 in. long and 0.093 in. in diameter. It has
a leakage path of 0.187 in. or more and may be used
from -55 to +200 C. The contact member is ma-
chined beryllium copper with gold flash over silver
plate finish.

Seaelectro Corp., Dept. ED, 610 Fayette Ave.,
Mamaroneck, N.Y.

CIRCLE 339 ON READER-SERVICE CARD

COLOR TV CAMERA CABLE.—Suitable for indoor
or outdoor use, type 8283 cable is light and compact,
contains 82 conductors, and has an aluminum-Mylar
shield. Available in any length from 25 to 1500 ft.

Belden Mfg. Co., Dept. ED, 4647 W. Van Buren
St., Chicago 80, Ill.

CIRCLE 340 ON READER-SERVICE CARD

MICROWAVE SHEET MATERIAL.—Thin sheet
materials of controlled surface resistivity, dielectric
constant, and dissipation factor, Eccosorb SC-50,
SC-200, SC-377, and SC-1000 are based on woven
fabric, while Eccosorb SC-VF is flexible plastic
sheet. The material may be used to line the interior
of a cavity to lower Q or applied to a radiating sur-
face to prevent the flow of high frequency currents.
Wedges or tapers can be made and applied to the
interior of waveguides as terminations, and antenna
patterns can be modified by applying the material to
elements or reflector surfaces.

Emerson & Cuming, Inc., Dept. ED, 869 Washing-
ton St., Canton, Mass.

CIRCLE 341 ON READER-SERVICE CARD

MECHANICAL RELAY INTERLOCK.—Supplied in
kit form, this interlock fits the existing space between
already mounted relays. It can be used with any
combination of the company's horizontally mounted,
four-pole-wide PM and PMA relays, either single
or double deck. Easily installed, the interlock pre-
vents one relay from closing when the other is closed.

Clark Controller Co., Dept. ED, 1146 E. 152nd
St., Cleveland 10, Ohio.

CIRCLE 342 ON READER-SERVICE CARD

BRONZE ALLOY.—For electrical contacts, Alloy
828 has good spring properties and high conduc-
tivity. It is especially suited for small parts which
may become overheated.

Bridgeport Brass Co., Dept. ED, 30 Grand St.,
Bridgeport 2, Conn.

CIRCLE 343 ON READER-SERVICE CARD

ELECTRONIC DRAFTING SYMBOLS.—Symbol
sheets 5011 through 5026 provide a wide selection of
electronic part and component symbols on clear, thin,
adhesive backed acetate.

The Craftint Mfg. Co., Dept. ED, 1615 Collamer
Ave., Cleveland 10, Ohio.

CIRCLE 344 ON READER-SERVICE CARD

**A Match
for any
Gyro's
Torque!**

Each matched pair of
MPB spin bearings is
precisely duplexed to
keep motor speed
constant and torque
low even under severe
thrust loads. Noiseless
operation . . . life-long
lubrication. Interested?
Details from MPB, Inc.,
907 Precision Park,
Keene, N. H.



MPB helps you perform miracles in miniaturization

MPB

MINIATURE PRECISION BEARINGS INC.
CIRCLE 345 ON READER-SERVICE CARD



Get
Diamond's
new
catalog
on
**ROTARY
JOINTS!**

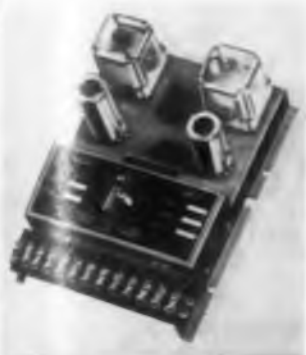
Diamond can offer the solution to your rotary
joint problems — waveguide or coaxial . . .
high power . . . inline . . . broadband . . . multi-
channel — whatever they may be.

Send for your free copy of Diamond's
new Rotary Joint Catalog — R-959.



DIAMOND
ANTENNA & MICROWAVE
CORPORATION
7 North Avenue • Wakefield, Mass.

CIRCLE 346 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 8, 1969



Electronic Timers

For on-off operation

Electronic timer models T-1 and T-3 are designed for on-off timing in product life tests, for proportioning controls, and for repeat timing of a variety of processes and machines. The T-1 has one relay and one time control knob; the T-3 has two relays and two knobs. They are available in open panel mounting, with NEMA 1-A enclosures, or with NEMA X11 oil and water tight enclosures. Webster Electric Co., Dept ED, Racine, Wis.

CIRCLE 347 ON READER-SERVICE CARD



Relay

Hermetically sealed

Style 520 is a miniature, general purpose, 6pdt relay designed to MIL-R-5757C, MIL-R-25018, and MS24115-6. At 25 C, coil resistance is 240 ohms, maximum operating time is 10 msec at 26.5 v, and drop-out time is 7 msec at 26.5 v. The hermetically sealed unit operates from -65 to +125 C and withstands 15 g, 2000 cps vibration and 50 g, 11 msec shock.

Price Electric Corp., Dept. ED, Frederick, Md.

CIRCLE 348 ON READER-SERVICE CARD



Miniature Power Rectifiers

6 and 35 amp

Rated 6 and 35 amp at 150 C case temperature, these miniature silicon power rectifiers are packaged in stud mounted hex base configurations of 7/16 and 11/16 in., respectively. Both series have ratings from 50 to 600 piv.

Transitron Electronic Corp., Dept. ED, 168 Albion St., Wakefield, Mass.

CIRCLE 349 ON READER-SERVICE CARD

HOW TO MEASURE ATTENUATION



This microwave bench set-up is for the measurement of attenuation by the RF SUBSTITUTION method. Other techniques could have been shown, but this represents one of the simplest, easiest to use methods known.

The one main point we would like to stress is: regardless of the kind of measurements made, the quality of the test equipment used is of the utmost importance. That's why PRD has concentrated on producing the widest range of the most precise microwave test equipment available anywhere in the world.

In the RF SUBSTITUTION method, the PRD 195-B Precision Gauge Attenuator is used as a standard and calibrated for the frequency at which the attenuation is to be measured. The PRD 195-B is set at some value of attenuation greater than the unknown. Its reading and the output power level of the line shown on the PRD 650-B Power Bridge are both recorded. The unknown is then inserted into the line thereby changing the output level, and the PRD 195-B is readjusted to return the power level to its original value. The attenuation of the unknown is simply the difference between the two readings of the PRD 195-B.

Sound Simple? Sure it is, but even more important it's accurate. The PRD 195-B has a guaranteed calibration accuracy of ± 0.2 db.

The precision and ease of operation of all of the products shown in this example are typical of each of over 300 PRD microwave test instruments currently produced. For detailed specifications of the products shown in the measurement bench, write:



TEST INSTRUMENTS USED IN THIS X-BAND ATTENUATION BENCH

- 1-703 Shielded Tube Mount, catalog page F-8
- 2-809 Klystron Power Supply, catalog page F-10
- 3-303-A Slide Screw Tuner, catalog page B-14
- 4-1203 Waveguide Ferrite Isolator, catalog page A-21
- 5-535 Frequency Meter, catalog page D-12
- 6-195-B Precision Gauge Attenuator, catalog page A-5
- 7-UNKNOWN represented by a 140 Fixed Waveguide Attenuator, catalog page A-11
- 8-203-D Slotted Section, catalog page B-11
- 9-250-A Broadband Probe, catalog page B-12
- 10-277-A Standing Wave Amplifier, catalog page E-7
- 11-303-A Slide Screw Tuner, catalog page B-14
- 12-643 Waveguide Thermistor Mount, catalog page E-9
- 13-650-B Power Bridge, catalog page E-13
- 14-159-A Level Set Attenuator, catalog page A-17

MICROWAVE ENGINEERS-SCIENTISTS

Positions offering stimulating challenges with unlimited potential are now open at PRD. Please address all inquiries to Mr. A. E. Spruch, PRD, 202 Tillary Street, Brooklyn 1, New York.



Polytechnic Research and Development Co., Inc.

202 Tillary Street, Brooklyn 1, New York. Telephone: ULster 2-8800

West Coast Office: 2639 So. La Cienega Blvd., Los Angeles 34, California. Telephone: TEexas 0-1940

Special problems in attenuation and other related measurements? Contact our Applications Engineering Department.

CIRCLE 350 ON READER-SERVICE CARD

Electronic Products **NEWS**

by **CARBORUNDUM**

Registered Trade Mark



"QUAIL" Contact Arc Suppression Problems solved with GLOBAR[®] silicon carbide varistors

Less publicized than its more spectacular cousins, the "Quail" decoy missile, shown above, nevertheless represents an important development of the missile art. It is designed for air launching from bombers such as the B-47 and B-52 and, once in flight, is under continuous radio control. The Quail is powered by a GE J-58 engine and is manufactured for the Air Force by McDonnell Aircraft of St. Louis.

The electronic control circuits involve many relays. Contact arc suppression and suppression of RF in-

terference are achieved with GLOBAR silicon carbide varistors. Choice of these components results from their extreme ruggedness, small size, reliability and excellent performance characteristics — all essential in missile applications.

Catalogs on types, ratings and other characteristics of varistors and other forms of silicon carbide resistors are obtainable by writing to Globar Plant, Refractories Division, Dept. EDR-39, The Carborundum Company, Niagara Falls, N. Y.

Circle 712 on Reader-Service Card

NEW HIGH TEMPERATURE RESISTORS handle up to 25 watts at 1000F. with no de-rating

Limited quantities of high temperature resistors developed by Carborundum are now available. These answer a definite need in many defense and possible commercial electronic applications. They may be well suited to equipment where nuclear

radiation is present, since the materials from which they are made have relatively low sensitivity to induced radio activity.

RESISTANCE RANGE

| Watts | Size | Resistance Range |
|-------|-----------------------------|------------------|
| 0.5 | 3/8" x 1/8" | 0.2 - 2 K |
| 1.0 | 1/2" x 1/8" | 0.4 - 4 K |
| 2.0 | 3/4" x 1/8" | 0.8 - 8 K |
| 5.0 | 1 1/4" x 3/8" (i.d. .0168") | 0.1 - 1.8 K |
| 10.0 | 2" x .4125" (i.d. .288") | 0.2 - 2.3 K |
| 25.0 | 4" x 1/2" (i.d. 3/8") | 0.1 - 1.1 K |

Terminations are suitable for spot welding or brazing. Fuse clip terminations are also offered in the larger sizes. Write to Globar Plant, Refractories Division, Dept. EDM-39, The Carborundum Company, Niagara Falls, N. Y.

Circle 713 on Reader-Service Card



CERAMIC PARTS AND METALLIZED ASSEMBLIES GLASS-TO-METAL SEALS KOVAR ALLOY CERAMIC RESISTORS VARISTORS THERMISTORS

CIRCLE 712-715 ON READER-SERVICE CARD

High Purity MgO Swaging Tubes for Thermocouple Insulation



Insulation of thermocouple wires, used in such equipment as gas turbines and nuclear reactors, involves stringing them through a tube of sintered magnesium oxide, inserting in a stainless steel sheath and then swaging.

For correct packing of the MgO insulation, which is crushed in the swaging operation, close tolerances apply to diameters and location of the holes in the swaging tubes. MgO must be of high purity, particularly for nuclear work.

These tubes are typical of the many examples of magnesia, alumina and zirconia insulating ware made by Carborundum and widely used in electronic components. For information, write Latrobe Plant, Refractories Division, Dept. EDM-39, Carborundum Company, Latrobe, Pa.

Circle 714 on Reader-Service Card

NEW BOOKLET AVAILABLE ON GLASS-TO-METAL SEALS



Glass-to-metal seals are essential in many types of electronic equipment. This is a complete catalog of types, specifications and applications. For your copy, write Latrobe Plant, Refractories Division, Dept. DS-39, Carborundum Co., Latrobe, Pa.

Circle 715 on Reader-Service Card

NEW PRODUCTS



Relative Humidity Cabinets

Have cam type programmer-recorder-controller

These Counter-Flow relative humidity cabinets have a cam type programmer-recorder-controller for automatic performance of time-temperature-humidity programs. They have a room to 85% dry bulb range, a 20 to 99% humidity range, and a 0 to 200 F temperature range.

Blue M Electric Co., Dept. ED, 138th and Chatham St., Blue Island, Ill.

CIRCLE 351 ON READER-SERVICE CARD



VU Meter

Illuminated

The model AR-331 is a 3900 ohm, illuminated vu meter with a 3 in. scale that reads -20 to +30 v on the upper calibration and 0 to 100% modulation on the lower, with 0 vu corresponding to 100%. Useful frequency response is from 20 cps to 20 kc; accuracy is 2% of full scale.

Argonne Electronics Mfg. Corp., Dept. ED, 165-11 South Rd., Jamaica 33, N.Y.

CIRCLE 352 ON READER-SERVICE CARD

Band Pass Filter

For multiplex telegraph systems

This band pass filter provides continuous frequency coverage with 170 cps spacing. A low drift, hermetically sealed receiving filter for multiplex telegraph systems, it offers 18 channels with high interchannel attenuation, flat pass bands, and good harmonic rejection. Center frequencies are from 425 to 3315 cps. Frequency response is 0 db at f_0 , down 1 db at ± 25 cps, 5 db at ± 70 cps, and 40 db at ± 145 cps. Dimensions are 2-11/16 x 3-3/4 in.

Hermetic Seal Transformer Co., Dept. 555, N. Fifth St., Garland, Tex.

CIRCLE 353 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 1959

AC Ammeter

2-3/4 x 4-1/4 x 1-3/16 in.



The model 307 ac ammeter has five ranges covering 0 to 1, 2.5, 5, 10, and 25 amp. With the company's model 10 clamp-on ammeter, its ranges can be extended to 0 to 6, 12, 30, 60, 120, and 300 amp. The 2-3/4 x 4-1/4 x 1-3/16 in. unit has a built-in transformer for use on 60 cps.

Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.

CIRCLE 354 ON READER-SERVICE CARD



RF Transformers

Broadband

Broadband rf transformer models 1211A and 1211B cover 200 kc to 4 mc and 3 to 100 mc, respectively. They are hermetically sealed in 1-15/16 x 1-5/16 x 1-1/8 in. packages. Impedance ratio is 600 to 75 ohms.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

CIRCLE 355 ON READER-SERVICE CARD



Switching Commutator

Miniature

This miniature switching commutator offers low noise, low torque, long life, and 10 min angular accuracy. It is suited for programming, data processing, selecting, telemetering, high speed sampling, and analog-to-digital conversion.

Airflyte Electronics Co., Dept. ED, 535 Ave A, Bayonne, N.J.

CIRCLE 356 ON READER-SERVICE CARD



An exceptional new tool
for lab or industry!

WESTON

Zero Load

ELECTRONIC MILLI-VOLT/ AMMETER

Check these outstanding features and exclusives:

- ✓ Measurement, amplification and transduction of a wide span of D-C current and voltage ranges — 10 to 1000 microamps and 1 to 1000 millivolts full scale — in a single 5½-pound unit.
- ✓ Unique INDUCTRONIC® servo-amplifier provides extreme high gain and full feedback — for accuracy and stability unaffected by variations in line voltage or frequency, condition of tubes, or other variables.
- ✓ Model 1477 is a true D-C meter with zero-drift comparable to a permanent magnet moving coil instrument. No mechanical switches or choppers are used.
- ✓ Essentially zero power-drain from the source being measured.
- ✓ Power-gain is sufficient to drive indicating meter plus any external load up to 5,000 ohms. Power output is available at terminals in rear of unit.
- ✓ Knife-edge pointer and 7.2-inch mirror scale provide unmatched readability.
- ✓ Gain stability and output linearity are both within 0.1% at ranges above 1 millivolt or 200 microamps.
- ✓ Resolution capability is within 2 microvolts or .02 microamps.
- ✓ Power requirements: 115 volts A-C, 50 to 1600 cycles, 35 watts.
- ✓ Less expensive than competing instruments offering lower stability.

For full information, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.

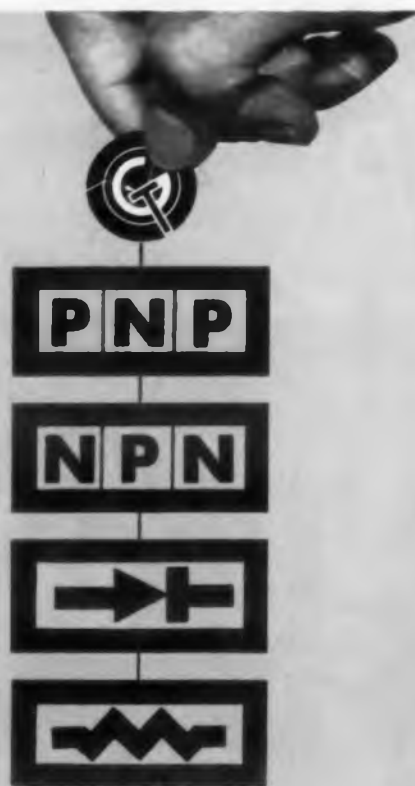
WESTON



Instruments

WORLD LEADER IN MEASUREMENT AND CONTROL

CIRCLE 357 ON READER-SERVICE CARD



Here's **HOW** General Transistor does it **NOW**

GT know-how **NOW** gives you high-quality semiconductor devices in production quantities for prompt delivery

"If it's a high-quality device and you need it—regardless of quantity—General Transistor will produce and deliver it as promised."

That's the GT policy...and here's how it was made to work:

PROCESS ENGINEERING—From the very beginning of the company, a process engineering program was devoted to the continuous improvement of high-quality, high-speed, mass-production techniques. The results were increasingly rewarding to our growing list of customers; GT became their most dependable supplier, meeting every emergency.

QUALITY CONTROL—Intensive efforts were also applied to innovating techniques for quality control during production. OUR AIM: To supply only high-quality semiconductor devices.

LARGE PRODUCTION FACILITIES—Today GT is a major producer; GT production facilities are larger than those of many suppliers in the semiconductor field. Meeting high-quality specifications, in quantity, is never a problem.

LOGISTIC RELIABILITY—GT's earned reputation for high-quality devices in production quantities is a precious one. It's worth protecting. Therefore, "wild" claims are avoided. This leads to logistic reliability. When GT says: "We will deliver"—that is a fact on which other plans may be based.

GT never announced a major research breakthrough until the result was available in production quantities. When GT publishes specifications, tolerances, etc., it is done with the full knowledge that they can be substantiated to every decimal point in production quantities... not merely in sample lots.

GT's place in the industry is that of a primary supplier of high-quality devices in production quantities for prompt delivery. This is know-how **NOW**.

That's why you can depend on General Transistor. It's the company with **NOW-HOW**.



GENERAL TRANSISTOR CORPORATION

81-27 138th Place, Jamaica 35, New York

NEW PRODUCTS

Integrating Acceleration Switch

Has 20 to 55 g range



Acceleration switch model 1374-1 is a compact, hermetically sealed, second order integrating switch which closes two normally open contacts when a carrier vehicle has accelerated to a specified distance from its starting point. It is rated at 2 amp, 28 v dc, resistive and has a 20 to 55 g operating range which can be modified for other values. The unit meets MIL-STD-202A tests for corrosion and shock, operates from -65 to $+165$ F, and withstands 20 to 2000 cps vibration at 6 ± 1 g. It weighs less than 90 g.

Raymond Engineering Lab, Inc., Dept. ED, Smith St., Middletown, Conn.

CIRCLE 359 ON READER-SERVICE CARD

DC Operational Amplifier

Plug-in



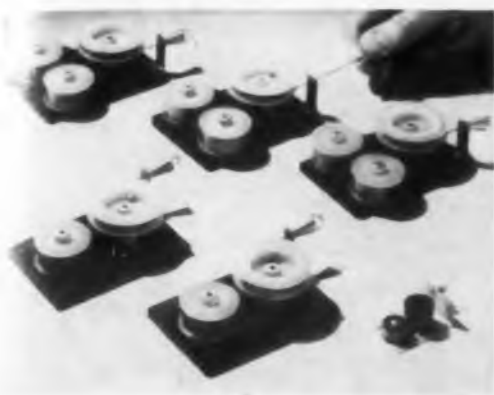
Designed for military use, the model K2-WJ plug-in dc operational amplifier is built from JAN parts and measures $4.5/16 \times 1.1/8 \times 2.1/8$ in. Design center dc open loop gain is 15,000, and at 500 kc the open loop gain is typically greater than 2. Maximum design output range is ± 7.5 v at 1 ma.

George A. Philbrick Researches, Inc., Dept. ED, 285 Columbus Ave., Boston 16, Mass.

CIRCLE 360 ON READER-SERVICE CARD

Spring Motors

Constant torque



These model B Neg'ator spring motors have constant output torques of 2.33, 3.12, and 3.9 lb-in. throughout 15 revolutions of the output drum. They provide a constant retracting force of 3, 4, and 5 lb through the full 6 ft cable extension. All units are 3 in. wide and 1.2 in. high, mounted on a 2.5 x 3.75 in. base.

Hunter Spring Co., Dept. ED, 1 Spring Ave., Lansdale, Pa.

CIRCLE 361 ON READER-SERVICE CARD



Frequency Standards

Square wave

Series RK 200 encapsulated solid state standards provide any single pulse rate from 120 cps to 100 kc and any square wave frequency from 60 cps to 50 kc. Stability is ± 40 ppm for either 25 ± 3 v dc or 15 to 45 C and ± 20 ppm for both 52 ± 0.05 v dc and 22 ± 5 C. Frequency is set between ± 0.03 and $\pm 0.01\%$. Pulse output is 1 v minimum into 5 K and square wave output is 5 v peak into 50 K. Power input is 28 ± 3 v dc at 0.5 w and 115 v ac at 7 w average. An external tuned amplifier can produce a sinusoid.

Arkay Engineering, Inc., Dept. ED, 225 Santa Monica Blvd., Santa Monica, Calif.

CIRCLE 362 ON READER-SERVICE CARD

DC Motor

Rated 0.5 hp at 7600 rpm

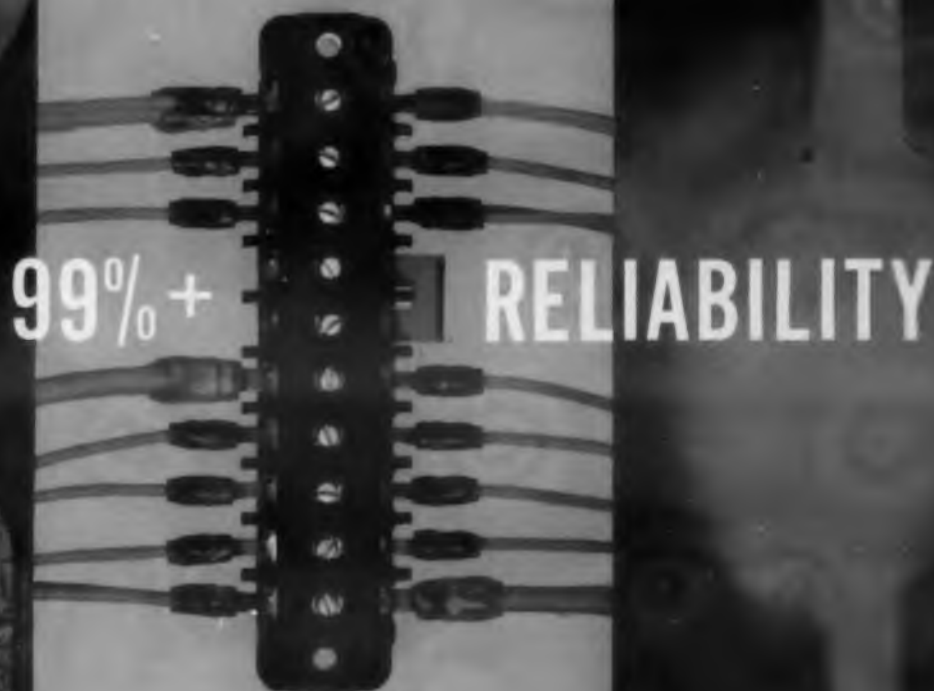
The 28 v dc model C-1360 motor is rated 0.33 hp at 8400 rpm and 0.5 hp at 7600 rpm. Enclosed in an explosion proof case 6.5 x 2.875 x 3.125 in., the unit weighs 5 lb. It is designed to MIL-M-8609 and MIL-E-5272A.

Hoover Electric Co., Dept. ED, 2100 S. Stoner Ave., Los Angeles 25, Calif.

CIRCLE 363 ON READER-SERVICE CARD



Now—the
TERMINAL BLOCK
with...



What makes a good terminal block?
Two things. One is quick connection.
The other is absolute dependability.
You get both in a Twin Lock Terminal Block.

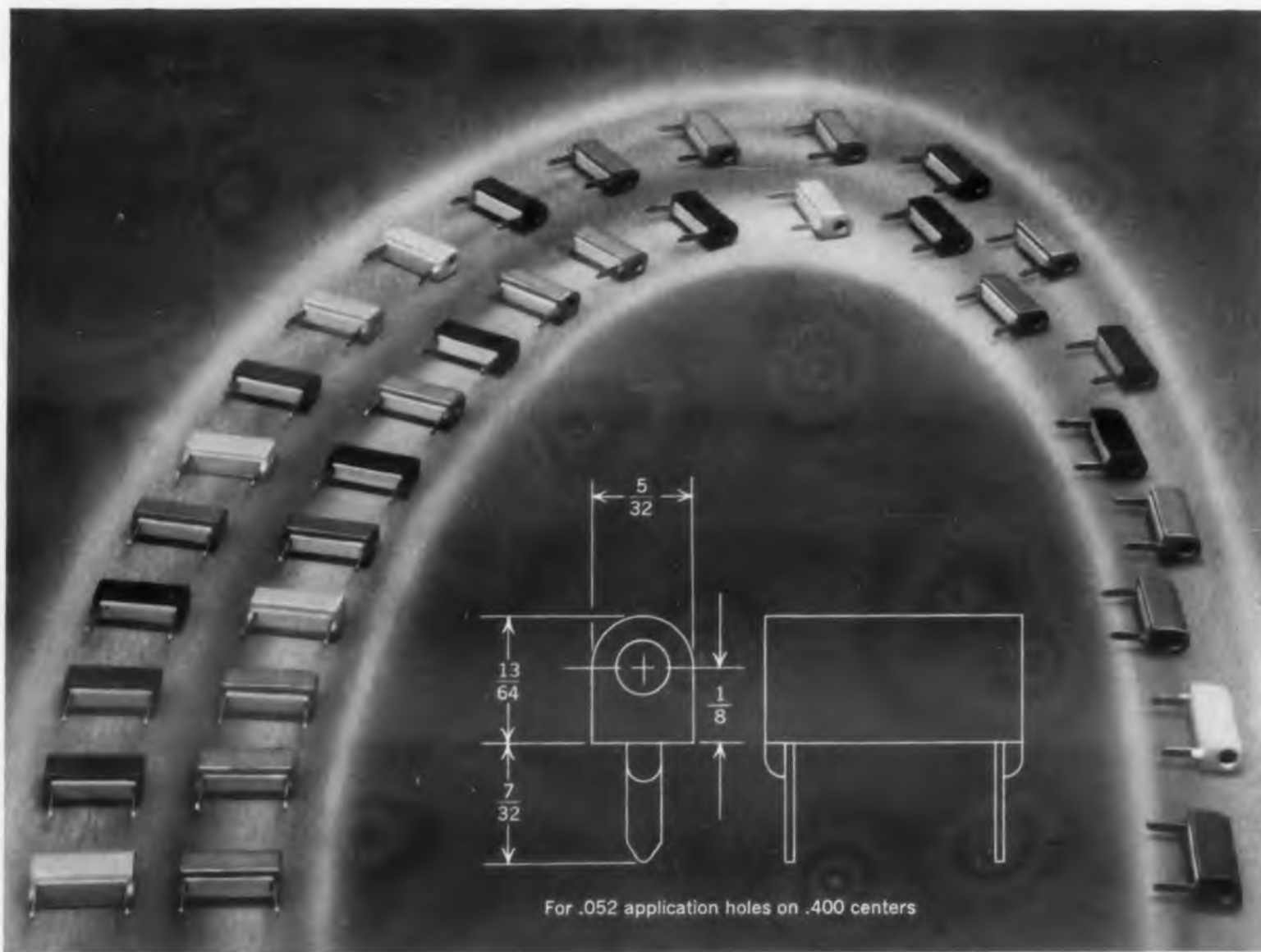
Plug in the terminal lug and the
connection is made and locked. One
twist of the set screw and it's double
locked. Fast? It's done in seconds.
Strong? It takes a hundred pounds
of force to pull a lug out of its socket.
Positive? It has the least resistance
of any mechanical connection.

Write for complete engineering data.



1024 West Hillcrest Blvd. Inglewood, California
Telephone: ORegon 8-4773 • TWX INGL 8194
Coliseum Tower, 10 Columbus Circle New York 19, N.Y.
Telephone: Circle 5-8170 • TWX NY 14987

CIRCLE 364 ON READER-SERVICE CARD



New Test Jacks for Printed Circuits

Designed for permanent assembly to printed circuit boards, these new test jacks by Ucinite are easily accessible to standard .080 test probes and eliminate the need for individual adaptor boards.

Simple, economical construction ensures reliability and reasonable cost. Gold-over-silver-plated beryllium copper contacts provide dependable, low-resistance connections. Nylon bodies are available in eleven standard code colors specified as follows: Part number (119437) plus letter suffix . . . A-Opaque

White, B-Red, C-Black, D-Brown, E-Green, F-Orange, G-Blue, H-Yellow, J-Gray, K-Violet, L-White translucent.

With an experienced staff of design engineers plus complete facilities for volume production of metal and plastic parts and assemblies, Ucinite is capable of supplying practically any requirement for fasteners, connectors, switches and other small metal and metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

Manufactured by

The UCINITE COMPANY

Division of United-Carr Fastener Corporation, Newtonville, Mass.



NEW PRODUCTS

Relay Socket Assembly Miniature

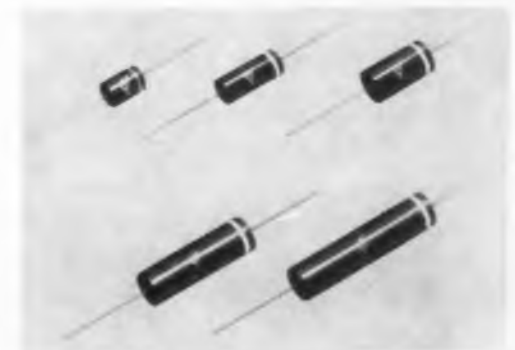


Designed for use with miniature relays conforming to MIL-R-5757, this socket assembly features unit packaging of socket and holding clip. The clip is available with either beryllium copper alloy 25 per QQ-C-533 or annealed carbon steel SAE 1065 per MIL-S-17919. Both clips are cadmium plated per QQ-P-416A. The assembly is available with an antirotate tab.

Augat Bros., Inc., Dept. ED, 33 Perry Ave., Attleboro, Mass.

CIRCLE 366 ON READER-SERVICE CARD

Silicon Rectifiers High voltage, high current



Silicon rectifier types 1N2382 through 1N2385 have piv ratings of 4, 6, 8, and 10 kv, respectively. At 25 C, the first two have maximum rectified current ratings of 150 and 100 ma; the last two, 70 ma. The units are assembled in nonmetallic cases with a dielectric strength of 400 v per mil and a resistivity of over 10^{14} ohm-cm. The 4 kv units are 1 in. long; the 6 and 8 kv units, 1-1/2 in.; and the 10 kv, 2 in. All have 1/2 in. diameters and 1-1/4 in. leads.

Pacific Semiconductors, Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.

CIRCLE 367 ON READER-SERVICE CARD

Miniature Relay All welded construction

This 1 oz, 4pdt relay is assembled by the arc welding process which minimizes contact resistance.

ELECTRONIC DESIGN • July 8, 1959

amina n and hermetically seals the header to
 the car Rated 2 amp at 26.5 v dc or 115 v ac, it
 operat from -65 to +160 C, lasts for 200,000
 cycles. and withstands 30 g vibration at 2000 cps
 and 5 shock for 11 msec. Operate and release
 times e 6 and 4 msec, respectively, including
 bounce and pickup power is 400 mw. The termi-
 nals are on 0.2 in. centers; the mounting holes, on
 1.2 in. centers.

General Electric Co., Dept. ED, Schenectady
 5 N.Y.

CIRCLE 368 ON READER-SERVICE CARD

Cathode Ray Tube

Dual beam



For aircraft, oscilloscope, and indicator use, the
 type 5BFP cathode ray tube is a dual beam unit
 with fast writing rates. It incorporates linear post
 acceleration and operates at altitudes to 70,000 ft.
 The unit has a flat faceplate, an integral mu-metal
 shield, and an aluminized screen. It is available in
 P1, P2, P7, and P11 phosphors, or with any
 JEDEC registered screen. Typical operating volt-
 ages are post accelerator, 13.25 kv; accelerator,
 2.75 kv; and focusing electrode, 600 to 900 v.

Allen B. Du Mont Labs, Inc., Electronic Tube
 Sales Dept., Dept. ED, 750 Bloomfield Ave.,
 Clifton, N.J.

CIRCLE 369 ON READER-SERVICE CARD

Percent-Limit Bridge

10 ohm to 11.1111 meg range

Percent-limit bridge model 617-07 measures
 resistance values up to six significant figures with
 $\pm 0.2\%$ accuracy. It has a range of 10 ohms to
 11.1111 meg in 10 ohm steps. Two percentage
 selectors of ± 1 , 2, 5, 10, and 20% can be individ-
 ually adjusted for any plus or minus tolerance
 spread from the nominal value. The unit pro-
 vides a rapid means of testing resistors on a per-
 centage tolerance go, no-go basis and may also
 be used as a conventional six dial Wheatstone
 bridge. Its null indicator is an electronic galva-
 nometer.

Shallcross Mfg. Co., Dept. ED, Selma, N.C.

CIRCLE 370 ON READER-SERVICE CARD

*Compliments
 of a friend...
 send for it!*

Electrical Wire Division
 John A. Roebling's Sons Corp.
 Trenton 2, New Jersey

Please send my free copy of Roebling's new
 Magnet Wire Fact Book.

Name _____
 Company _____
 Street _____
 City _____
 State _____

ROEBLING
 Branch Offices in Principal Cities
 Subsidiary of The Colorado Fuel and Iron Corporation

CIRCLE 371 ON READER-SERVICE CARD



Pencil-thin slides increase valuable chassis space

CHASSIS-TRAK slides, with a new design improvement which increases the bearing area, are stronger and more rigid . . . yet as thin as a pencil (.250")!

This ultra-thin design allows up to 3" more in important chassis space and makes your electronic equipment more accessible with smoother sliding action—even on heavy-duty chassis.

Because of the thin design, you can fit a standard 17" chassis into a standard 19" panel rack. Thus you can cut engineering costs in half by using standard stock racks and chassis.

Slides are available in eight different lengths on both the "Detent,"

which locks in 7 positions (45°, 90° and 105° up, down, and horizontal), and the "Basic," which tilts upward but has no tilt-lock assembly.

Before making a slide selection, consider the advantages of the CHASSIS-TRAK *ultra-thin* design.

"Detent" model, locked in one of seven positions.



Write today for complete specifications and prices.

525 South Webster, Indianapolis 19, Indiana

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HR-92 X-Y

RECORDER



- Flat bed — Full Chart visibility
- Unitized Construction
- Critically damped response
- Simplified control panel
- Clip-on pen — Interchangeable for multicolor traces
- Standard 8½ x 11 paper
- Unconditionally guaranteed for one year.

RUGGED "All Purpose" X-Y RECORDER

The HR-92 is a null-seeking servo-type plotter designed to draw curves in Cartesian coordinates on regular 8½ x 11 graph paper. It employs conventional chopper amplifiers, 2-phase motors and a potentiometer rebalance. Reference voltages are furnished by mercury cells. Control panel has zero set and continuously-variable attenuator for each axis. Separate standby and power switches are provided. Two axes are electrically and mechanically independent. By moving an internal jumper lead, a high impedance potentiometer input can be made available.

SPECIAL FEATURES:

- Amplifiers easily removed if servicing ever becomes necessary. Electrical connections all contained in two plugs for each amplifier.
- Each amplifier channel (including transformer power supply) independent of rest of system.

WRITE FOR:
New X-Y Recorder Circular #717-3
showing complete specifications and photographs.

houston instrument corporation

1717 Clay Ave. • Houston 3 CA 5-6964

CIRCLE 373 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 8, 1959

... IT GLOWS when
the FUSE BLOWS!

NEW INDICATING 3AG FUSE POSTS

EXAMINE THESE FEATURES



ACTUAL
SIZE



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

SPECIFICATIONS:



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

Maximum current rating 20 amps.

PHYSICAL CHARACTERISTICS—Overall length 2¾" with fuse inserted • Front of panel length 1½" • Back of panel length 1½" • Panel area front 1½" dia. • Panel area back 1½" dia. • Mounting hole size (D hole) 5/8" dia. flat at one side.

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

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

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

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

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



LITTELFUSE

DES PLAINES, ILLINOIS

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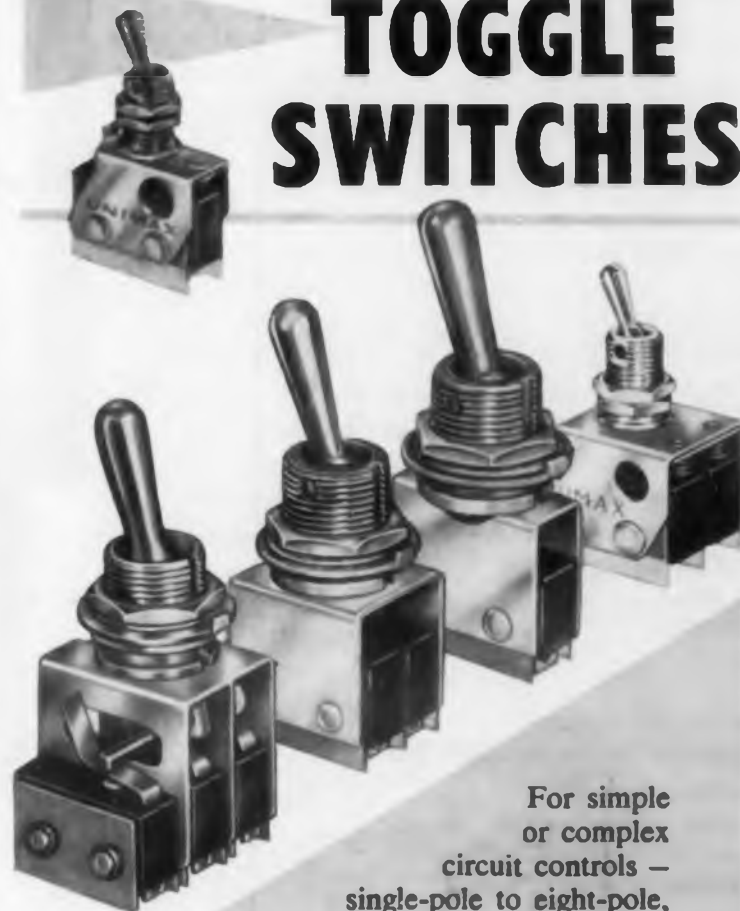
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SUBMINIATURE TOGGLE SWITCHES



For simple
or complex
circuit controls —
single-pole to eight-pole,
double throw.

Choice of
two-, three-, or five-position toggles
in various combinations
of momentary and
maintained actions.

Basic switches
meet MIL-S-6743
and MS-25085-1.



Electrical Ratings

- 3 amps. 30 v.d-c,
inductive
- 5 amps. 30 v.d-c.
resistive
- 5 amps. 125/250
volts a-c.

Free
Catalog 159
describes
complete line
of UNIMAX
subminiature
switches.



UNIMAX SWITCH

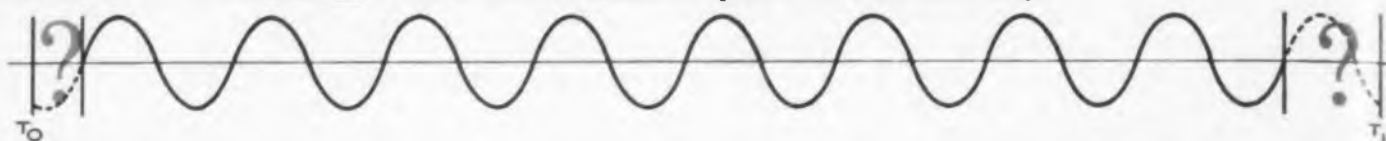
IVES ROAD, WALLINGFORD, CONNECTICUT

CIRCLE 375 ON READER-SERVICE CARD

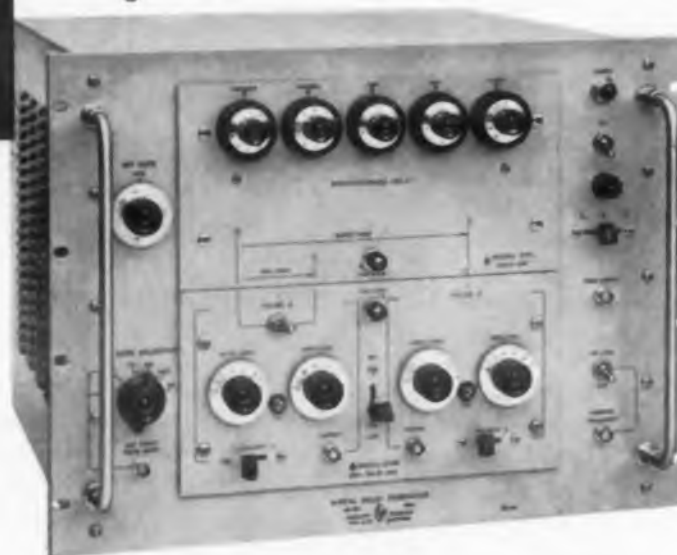
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± 1 COUNT AMBIGUITY ELIMINATED!

OLD WAY X counts ± 1 count due to unknown phase at start and stop.



NEW -hp- 218A X counts exactly—timing wave starts with sync pulse and only full cycles counted!



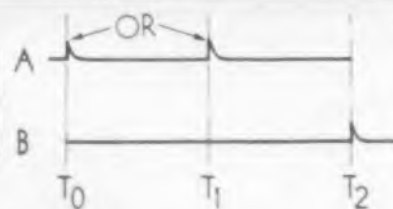
Time measurement and pulse simulation in radar, loran, Tacan, DME, oscilloscopes, computers, fast gates, pulse code systems—almost any fast circuit double pulse measurement with any kind of delay may now be made quickly and accurately with the new -hp- 218A Digital Delay Generator.

Constructed along rigid military standards, the -hp- 218A is basically a pulsed crystal oscillator synchronizable in constant phase with an initial trigger pulse (zero time) and two positionable terminating pulses. Time is counted with a 1 MC preset counter, and two independent output pulses (T_1 and T_2) are available in any relationship. For utmost present

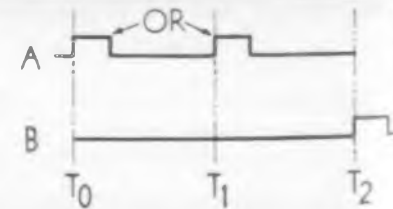
and future versatility, output pulses are generated through -hp- 219A series plug-in units.

Model 218A is a direct slave to an external trigger, 0 cps to 10 KC, or may be triggered internally over a 10 cps to 10 KC range. A push-button manual trigger is also provided. The two delay pulses are *separately and digitally adjustable* from 1 to 10,000 μ sec with interpolation 0 to 1 μ sec. Timing accuracy is $\pm 0.1 \mu$ sec $\pm 0.001\%$; time interval and pulse characteristics are directly selected on front panel controls.

Brief specifications appear alongside; for complete details see your -hp- representative or write direct. Also request -hp- Journal, Vol. 9, No. 8.



-hp- 219A Dual Trigger Unit contains two blocking oscillators supplying positive polarity trigger pulses to control auxiliary equipment. Pulse A available at T_0 or T_1 ; pulse B at T_2 . Pulse characteristics identical to sync output pulse of -hp- 218A. (See "Specifications") \$100.00.



-hp- 219B Dual Pulse Unit contains two pulse generators providing digitally delayed, fast rise time, high power pulses. Positive or negative polarity, amplitude variable 0 to 50 V, pulse width variable 0.2 to 5 μ sec, rise time 0.06 μ sec. Pulse A available at T_0 to T_1 , pulse B at T_2 . Internal impedance is 50 ohms. \$450.00.

hp offers the world's most complete selection

This new -hp- 218A Digital Delay Generator produces pulses accurately spaced in time, with spacing controlled by a crystal oscillator. The 218A is a perfect slave to any beginning or synchronizing pulse, even though random, and locks in constant phase during each counting period.

se, speed and 0.1 μ sec accuracy on time measurements

SPECIFICATIONS

-hp- 218A DIGITAL DELAY GENERATOR
(Plug-in necessary to operate)

Time Interval Range: 1 to 10,000 μ sec, T_0 to T_1 and T_1 to T_2 . Accuracy: $\pm 0.1 \mu$ sec $\pm 0.001\%$ of time interval selected.

Digital Adjustment: 1 μ sec steps, 1 to 10,000 μ sec.

Interpolation: Continuously variable, 0 to 1 μ sec.

Input Trigger: Internal, 10 cps to 10 KC, 3 decade ranges. External, 0 to 10 KC. Pos. or neg. pulses 2 to 40 v peak. Delay between external trigger and T_0 is 0.25μ sec $\pm 0.05 \mu$ sec.

Jitter: 0.02 μ sec or less.

Recovery Time: 50 μ sec or 10% of selected interval, whichever is larger.

Sync Output: 50 v pos. pulse, 0.1 μ sec rise time (from 50 ohm source). Available at T_0 , T_1 or T_2 .

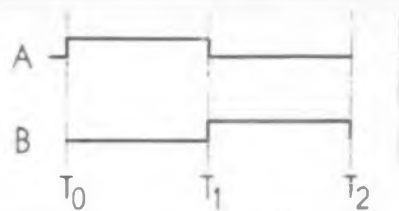
1 MC Output: 2 volt 1 MC pulses (from 500 ohm source) available at panel connector when counting on internal 1 MC oscillator.

Power: 115/230 v $\pm 10\%$, 50/60 cps, 525 watts.

Size: 14" high, 19" wide, 24" deep. Weight 75 lbs.

Price: -hp- 218A (cabinet) or -hp- 218AR (rack mount), \$2,000.00.

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



-hp- 219C Digital Pulse Duration Unit produces a high power pulse with digitally controlled delay and duration. Pulse duration either T_0 to T_1 , or T_1 to T_2 . Both polarities available simultaneously; amplitude variable 0 to 20 v (from 90 ohms impedance) or 100 v (from 500 ohms). Rise or decay time 0.03 μ sec (90 ohms). \$350.00.

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"NEW LOOK" in RCA Display-Storage-Tubes. New, superior space-saving electro-mechanical design. No flying leads. Developmental designs can be "integrally potted" to meet your specifications.



IN DISPLAY STORAGE TUBES...

RCA provides the widest selection!

World leader in display-storage-tube development and manufacture, RCA offers industry an extensive line of display-storage-tube designs.

For example, RCA offers display-storage-tube types that can provide displays having high brilliance, high contrast, and very good half-tone shading. There's a choice of types with single writing or multiple writing guns, and with overall or selective erasure. And there's a choice of either magnetic or electrostatic deflection. Writing speed can be tailored to your specific application.

So regardless of your display-storage-tube application, remember this about RCA Display Storage Tubes: Commercial types are readily available; in addition, a variety of developmental types can be obtained on a sampling basis. If you are an equipment manufacturer, get in touch with your RCA Field Representative for complete details.

| RCA TYPE | BULB DIAMETER inches | DISPLAY DIAMETER inches | DEFLECTION TYPE | NUMBER OF GUNS in addition to viewing gun | TYPICAL CHARACTERISTICS | |
|----------------------|----------------------|-------------------------|-----------------|---|-------------------------|-------------------------|
| | | | | | WRITING SPEED in. sec | BRIGHTNESS footlamberts |
| 7183 | 5 [■] | 4.0 | Magnetic | 1 writing | 50000 | 1500 |
| 7315 | 5 | 3.8 | Electrostatic | 1 writing | 3000 | 2750 |
| 7448 | 5 | 3.8 | Electrostatic | 1 writing | 300000 | 2750 |
| C-73788 [•] | 7 | 5.2 | Electrostatic | 1 writing | 50000 | 750 |
| C-73904 [•] | 5 | 3.8 | Electrostatic | 2 writing | 75000 | 2750 |
| C-73922 [•] | 7 | 5.2 | Electrostatic | 1 writing 1 erasing | 8000 | 750 |
| C-73931 [•] | 7 | 5.2 | Electrostatic | 2 writing | 50000 | 750 |
| C-73938 [•] | 5 | 3.8 | Electrostatic | 1 writing 1 erasing | 12000 | 2750 |
| C-73963 [•] | 5 [■] | 3.8 | Electrostatic | 1 writing | 300000 | 2750 |

[•]Developmental type
[■]Has flying leads for screen and backplate
^{••}Has integral external magnetic shield. Max. tube diameter is 5.6 inches.
 Information on types similar to those listed above but with writing speed tailored to your requirements will be furnished on request. In types with 2 writing guns, the writing speed of one gun can be different from that of the other.

Your RCA Field Representatives are here to help you
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