

JULY 17, 1959

electronics

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VOL. 32, No. 29

PRICE SEVENTY-FIVE CENTS

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| Atomic Weight | 1.0086 | | | | | | | | | | |
| Electron Configuration | 1s ² | 1s ² 2s ¹ | 1s ² 2s ² 2p ⁶ 3s ² | 1s ² 2s ² 2p ⁶ 3s ² 3p ¹ | 1s ² 2s ² 2p ⁶ 3s ² 3p ² | 1s ² 2s ² 2p ⁶ 3s ² 3p ³ | 1s ² 2s ² 2p ⁶ 3s ² 3p ⁴ | 1s ² 2s ² 2p ⁶ 3s ² 3p ⁵ | | | |
| Periodic Table Data | <p>2 He 4.003</p> <p>10 Ne 20.183</p> <p>18 Ar 39.944</p> <p>36 Kr 83.80</p> <p>54 Xe 131.3</p> <p>86 Rn 222</p> | <p>3 Li 6.940</p> <p>11 Na 22.997</p> <p>19 K 39.101</p> <p>37 Rb 85.44</p> <p>55 Cs 132.91</p> <p>87 Fr 223</p> | <p>4 Be 9.012</p> <p>12 Mg 24.32</p> <p>20 Ca 40.08</p> <p>28 Ni 58.69</p> <p>38 Sr 87.62</p> <p>56 Ba 137.36</p> <p>88 Ra 226</p> | <p>5 B 10.81</p> <p>13 Al 26.98</p> <p>21 Sc 44.96</p> <p>29 Cu 63.54</p> <p>39 Y 88.91</p> <p>57 La 138.91</p> | <p>6 C 12.010</p> <p>14 Si 28.09</p> <p>22 Ti 47.90</p> <p>30 Zn 65.38</p> <p>38 Ni 58.69</p> <p>46 Pd 106.7</p> | <p>7 N 14.008</p> <p>15 P 30.975</p> <p>23 V 50.95</p> <p>31 Ga 69.72</p> <p>39 Y 88.91</p> <p>47 Lu 174.97</p> | <p>8 O 16.000</p> <p>16 S 32.066</p> <p>24 Cr 52.01</p> <p>32 Ge 72.60</p> <p>40 Zr 91.22</p> <p>48 Hf 178.6</p> | <p>9 F 19.00</p> <p>17 Cl 35.457</p> <p>25 Mn 54.93</p> <p>33 As 74.91</p> <p>41 Nb 92.91</p> <p>49 Ta 180.95</p> | <p>26 Fe 55.85</p> <p>24 Cr 52.01</p> <p>25 Mn 54.93</p> <p>26 Fe 55.85</p> <p>27 Co 58.94</p> <p>28 Ni 58.69</p> <p>44 Ru 101.7</p> <p>45 Rh 102.91</p> <p>46 Pd 106.7</p> | <p>58 Ce 140.13</p> <p>59 Pr 140.92</p> <p>60 Nd 144.27</p> <p>61 Pm 145</p> <p>62 Sm 150.43</p> <p>63 Eu 152.0</p> <p>64 Gd 156.9</p> <p>65 Tb 159.2</p> <p>66 Dy 162.46</p> <p>67 Ho 164.94</p> <p>68 Er 167.2</p> <p>69 Tm 169.4</p> <p>70 Yb 173.04</p> <p>71 Lu 174.99</p> | <p>90 Th 232.12</p> <p>91 Pa 231</p> <p>92 U 238.07</p> <p>93 Np 237</p> <p>94 Pu 242</p> <p>95 Am 243</p> <p>96 Cm 245</p> <p>97 Bk 249</p> <p>98 Cf 249</p> <p>99 Es 254</p> <p>100 Fm 255</p> <p>101 Md 256</p> <p>102 No 253</p> <p>103 Lr 258</p> |

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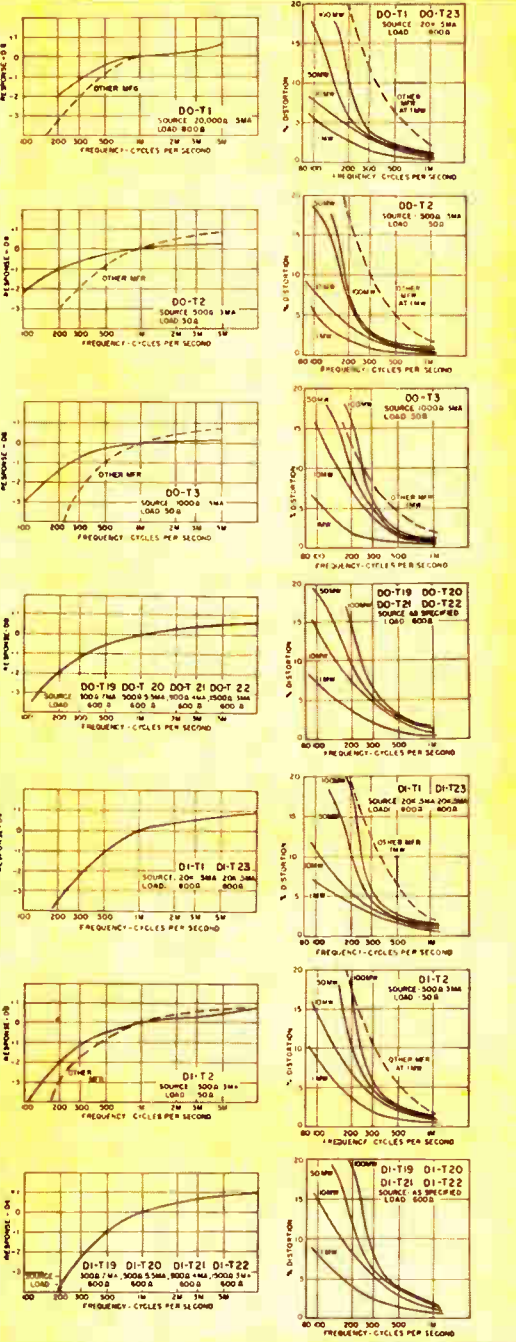
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| DO-T No. | MIL Type | Application | Pri. Imp. | D.C. Ma. in Pri. | Sec. Imp. | Pri. Res. DO-T | Pri. Res. DI-T | Level Mw. | DI-T No. |
|----------|-----------|---|------------------------|------------------|--------------------|----------------|----------------|-----------|----------|
| DO-T1 | TF4RX13YY | Interstage | 20,000 30,000 | .5 .5 | 800 1200 | 850 | 815 | 50 | DI-T1 |
| DO-T2 | TF4RX17YY | Output | 500 600 | 3 3 | 50 60 | 60 | 65 | 100 | DI-T2 |
| DO-T3 | TF4RX13YY | Output | 1000 1200 | 3 3 | 50 60 | 115 | 110 | 100 | DI-T3 |
| DO-T4 | TF4RX17YY | Output | 600 | 3 | 3.2 | 60 | | 100 | |
| DO-T5 | TF4RX13YY | Output | 1200 | 2 | 3.2 | 115 | 110 | 100 | DI-T5 |
| DO-T6 | TF4RX13YY | Output | 10,000 | 1 | 3.2 | 790 | | 100 | |
| DO-T7 | TF4RX16YY | Input | 200,000 | 0 | 1000 | 8500 | | 25 | |
| DO-T8 | TF4RX20YY | Reactor 3.5 Hys. @ 2 Ma. DC, 1 Hy. @ 5 Ma. DC | | | | 630 | | | |
| | TF4RX20YY | Reactor 2.5 Hys. @ 2 Ma. DC, .9 Hy. @ 4 Ma. DC | | | | 630 | | | DI-T8 |
| DO-T9 | TF4RX13YY | Output or driver | 10,000 12,000 | 1 1 | 500 CT 600 CT | 800 | 870 | 100 | DI-T9 |
| DO-T10 | TF4RX13YY | Driver | 10,000 12,000 | 1 1 | 1200 CT 1500 CT | 800 | 870 | 100 | DI-T10 |
| DO-T11 | TF4RX13YY | Driver | 10,000 12,000 | 1 1 | 2000 CT 2500 CT | 800 | 870 | 100 | DI-T11 |
| DO-T12 | TF4RX17YY | Single or PP output | 150 CT 200 CT | 10 10 | 12 16 | 11 | | 500 | |
| DO-T13 | TF4RX17YY | Single or PP output | 300 CT 400 CT | 7 7 | 12 16 | 20 | | 500 | |
| DO-T14 | TF4RX17YY | Single or PP output | 600 CT 800 CT | 5 5 | 12 16 | 43 | | 500 | |
| DO-T15 | TF4RX17YY | Single or PP output | 800 CT 1070 CT | 4 4 | 12 16 | 51 | | 500 | |
| DO-T16 | TF4RX13YY | Single or PP output | 1000 CT 1330 CT | 3.5 3.5 | 12 16 | 71 | | 500 | |
| DO-T17 | TF4RX13YY | Single or PP output | 1500 CT 2000 CT | 3 3 | 12 16 | 108 | | 500 | |
| DO-T18 | TF4RX13YY | Single or PP output | 7500 CT 10,000 CT | 1 1 | 12 16 | 505 | | 500 | |
| DO-T19 | TF4RX17YY | Output to line | 300 CT | 7 | 600 | 19 | 20 | 500 | DI-T19 |
| DO-T20 | TF4RX17YY | Output or line to line | 500 CT | 5.5 | 600 | 31 | 32 | 500 | DI-T20 |
| DO-T21 | TF4RX17YY | Output to line | 900 CT | 4 | 600 | 53 | 53 | 500 | DI-T21 |
| DO-T22 | TF4RX13YY | Output to line | 1500 CT | 3 | 600 | 86 | 87 | 500 | DI-T22 |
| DO-T23 | TF4RX13YY | Interstage | 20,000 CT 30,000 CT | .5 .5 | 800 CT 1200 CT | 850 | 815 | 100 | DI-T23 |
| DO-T24 | TF4RX16YY | Input (usable for chopper service) | 200,000 CT | 0 | 1000 CT | 8500 | | 25 | |
| DO-T25 | TF4RX13YY | Interstage | 10,000 CT 12,000 CT | 1 1 | 1500 CT 1800 CT | 800 | 870 | 100 | DI-T25 |
| DO-T26 | TF4RX20YY | Reactor 6 Hy. @ 2 Ma. DC, 1.5 Hy. @ 5 Ma. DC | | | | 2100 | | | |
| | TF4RX20YY | Reactor 4.5 Hy. @ 2 Ma. DC, 1.2 Hy. @ 4 Ma. DC | | | | 2300 | | | DI-T26 |
| DO-T27 | TF4RX20YY | Reactor 1.25 Hy. @ 2 Ma. DC, .5 Hy. @ 11 Ma. DC | | | | 100 | | | |
| | TF4RX20YY | Reactor .9 Hy. @ 2 Ma. DC, .5 Hy. @ 6 Ma. DC | | | | 105 | | | DI-T27 |
| DO-T28 | TF4RX20YY | Reactor .3 Hy. @ 4 Ma. DC, .15 Hy. @ 20 Ma. DC | | | | 25 | | | |
| | TF4RX20YY | Reactor .1 Hy. @ 4 Ma. DC, .08 Hy. @ 10 Ma. DC | | | | 25 | | | DI-T28 |
| DO-T29 | TF4RX17YY | Single or PP output | 120 CT 150 CT | 10 10 | 3.2 4 | 10 | | 500 | |
| DO-T30 | TF4RX17YY | Single or PP output | 320 CT 400 CT | 7 7 | 3.2 4 | 20 | | 500 | |
| DO-T31 | TF4RX17YY | Single or PP output | 640 CT 800 CT | 5 5 | 3.2 4 | 43 | | 500 | |
| DO-T32 | TF4RX17YY | Single or PP output | 800 CT 1,000 CT | 4 4 | 3.2 4 | 51 | | 500 | |
| DO-T33 | TF4RX13YY | Single or PP output | 1,060 CT 1,330 CT | 3.5 3.5 | 3.2 4 | 71 | | 500 | |
| DO-T34 | TF4RX13YY | Single or PP output | 1,600 CT 2,000 CT | 3 3 | 3.2 4 | 109 | | 500 | |
| DO-T35 | TF4RX13YY | Single or PP output | 8,000 CT 10,000 CT | 1 1 | 3.2 4 | 505 | | 500 | |
| DO-T36 | TF4RX13YY | Isol. or Interstage | 10,000 CT | 1 | 10000 CT | 950 | 970 | 500 | DI-T36 |

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Issue at a Glance

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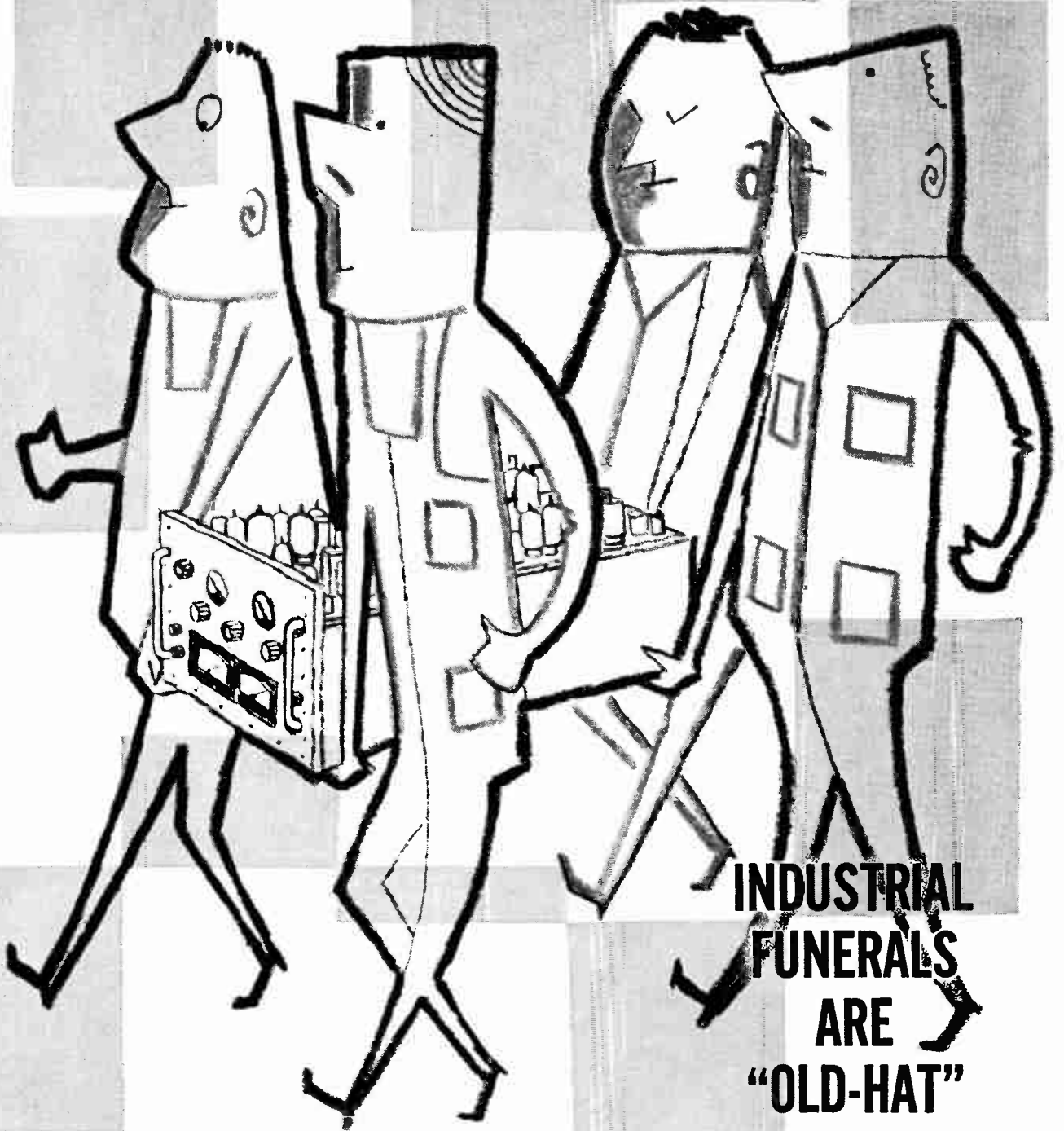
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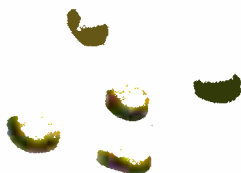
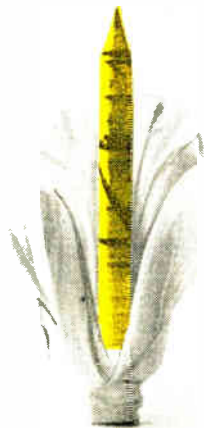


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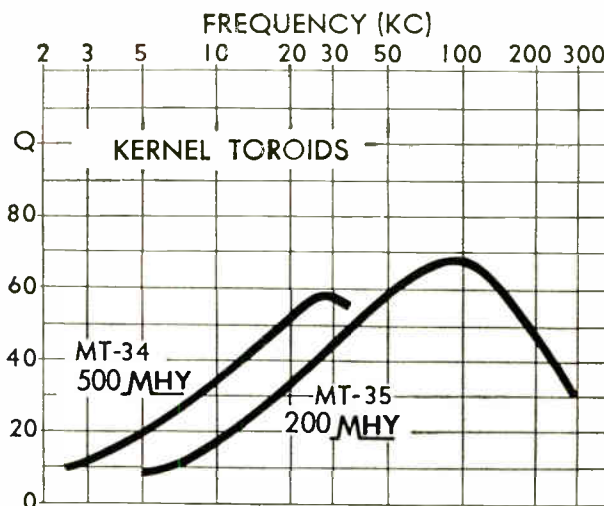
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WATCH THOSE SKELETONS. A turning point in development of a young electronics company comes when it first needs a substantial amount of capital for growth. Experience shows that few firms survive long in the embryonic stage. They go on to bigger things. Or they abort and become another part of the business-failure statistic.

One of the ways a new firm can raise capital is to get it from a venture-capital house. The venture-capital house is a phenomenon of this high-tax era. Groups or individuals with money sometimes find it unprofitable to allow the money to earn interest. Rather, they choose to invest it in growth situations to take advantage of more favorable capital-gains tax provisions. Such venture-capital groups are looking for real growth potential. Today, electronics is a favored growth industry.

What do the proprietors of a small firm have to tell "the man" when they seek venture capital financing? Quite a lot, it turns out. In his article, "How to Impress Financial Men," Hardie Shepard tells what skeletons he looks for and in what closets he finds them.

Hardie has been doing just this for some time. He is a partner of Payson & Trask, a venture-capital firm that manages the money of Mrs. Joan Whitney Payson, sister of U. S. Ambassador to Great Britain J. H. Whitney.

Sincerity is the watchword. This article points out what venture-capital people need to know, and how to present the information to show yourself and your firm in the best possible light. See p 26.

BUYERS' GUIDE. Our annually-published *Buyers' Guide* will be in the mails to ELECTRONICS' subscribers before the end of July. We're a little late due to printing difficulties but, because the Guide contains new editorial material as well as reference material of long-lasting value, we think you will find it worth waiting for.

Coming In Our July 24 Issue . . .

SOVIET ELECTRONICS. Large crowds are milling around inside New York's Coliseum, drawn by the Soviet Exposition of science, technology and culture which opened June 30. Presented with this unique opportunity to study Soviet electronic equipment and components at close range, Managing Editor Carroll toured the exposition, talked at length with surprisingly amiable Soviet engineers who were responsible for the designs. From his story, you'll learn how the Russians are employing transistors, you'll hear about Russian progress in miniaturization, modular design, television. And there will be many exclusive photos of Russian equipment.

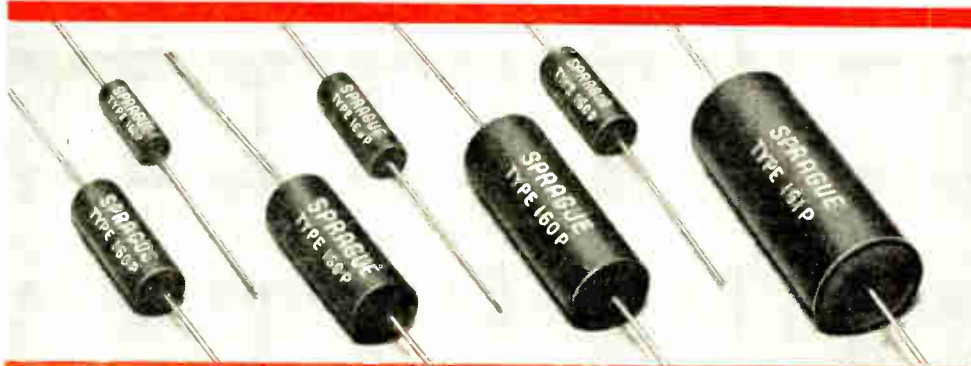
HOT-ROLLER CONTROL. Hot rollers are employed in various process industries, such as plastics and photographic processing. In these applications, temperature must be controlled within close limits. D. A. Senior, of England's National Research Development Corporation, has devised a unique hot-roller in which the drum is arranged to form the short-circuited single-turn secondary of a transformer. Heavy current flows in the drum, allowing it to serve as its own heating element.

STRAIN-GAGE AMPLIFIER. A serious problem with noise in strain-gage and thermocouple applications is caused by necessity of grounding at widely separated points in the system. An accurate chopper-stabilized amplifier with high common-mode rejection, and featuring a floating input and output, is described by R. S. Burwen of Minneapolis-Honeywell.

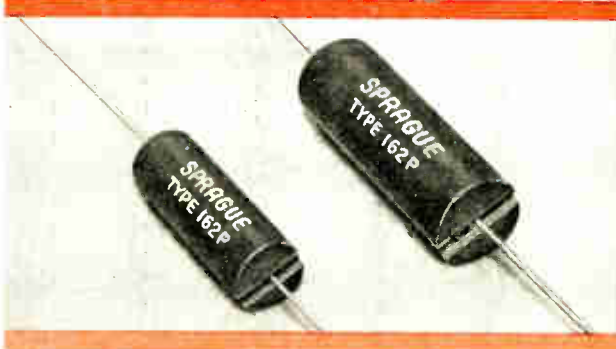
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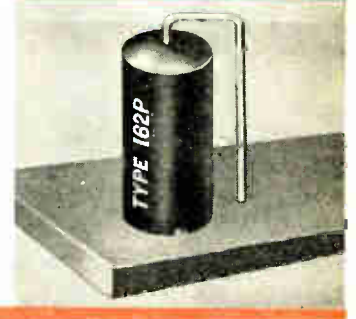
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exclusive Sprague hydrocarbon material which impregnates the windings, filling all voids and pinholes before it polymerizes. The result is a solid rock-hard capacitor section, further protected by an outer molding of humidity-resistant phenolic. *These capacitors are designed for operating temperatures ranging up to 105°C (221°F)... at high humidity levels... without voltage derating!*

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Manufacturing companies* now plan to spend a total of \$24.5 billion on modernization in the four years 1959-1962. This will be enough to replace roughly 70% of the obsolete facilities that were on hand at the beginning of 1959. But it will still leave us far short of our goal. It would take several years, at a higher rate of investment than is now planned, to wipe out obsolescence and give the U. S. a truly modern industrial plant.

These facts stand out from the 12th annual Survey of Business' Plans for New Plants and Equipment just completed by the McGraw-Hill Department of Economics. This new survey shows that industry has made a remarkable start on the modernization job that a previous editorial in this series described as "the most expensive task to be performed in America in this new year of 1959." The full cost of modernization has been found by the McGraw-Hill Department of Economics to be \$33.3 billion for manufacturing, and \$95 billion for all business.

For the past several months, McGraw-Hill publications have been devoting special attention to new developments in plant and equipment

that offer opportunities for modernization. Our special effort to help industry in this regard has been called "Plan '59": to modernize *now* for growth and profits. This editorial will summarize the progress made so far with "Plan '59" and point out some of the areas where business and public policies can do still more to accelerate the modernization drive.

A Good Start

Business investment in new plant and equipment has picked up sharply since the low point of the 1958 recession. Plans for 1959 now show a 7% increase over 1958 for total capital investment. And the increase in expenditures for modernization is much sharper. Moreover, companies already have substantial plans for the years after 1959. New orders for industrial machinery, which are a good index of modernization plans, also are running well ahead of last year.

For the four-year period 1959-1962, manufacturing companies expect, on the average, to devote 65% of their plant and equipment outlays to modernization. This is the highest proportion reported in a McGraw-Hill survey since 1950. In dollar terms, manufacturing companies plan to spend \$24.5 billion on modernization during the next four years.

This is an impressive figure, but it does not look so large when compared with the total need

*Excluding petroleum refining, which is reported as part of the oil industry in the data discussed in this editorial.

for modernization in manufacturing industries. As noted above, a previous McGraw-Hill study (conducted in August 1958) found that it would cost almost \$35 billion to replace all the facilities that manufacturing companies then considered obsolete. Thus, present plans for modernization are enough to wipe out only 70% of the backlog of obsolete facilities by 1962—and this makes no allowance for the additional facilities that will be made obsolete by new machines and new processes introduced during the next four years. When these new developments are considered, present plans for spending may represent only half the job that will actually need to be done.

How To Accelerate

What can be done to accelerate the drive to modernize our industrial plant and equipment? Two of the greatest aids would be:

(1) Improve present provisions under the tax law for depreciation, to help industry retain more of the money it needs to carry out this massive job of modernization;

(2) Contain inflation, to preserve the purchasing power of the money industry sets aside to replace obsolete facilities.

At first glance, the supply of funds from depreciation allowances appears to be more than adequate. For manufacturing as a whole, depreciation allowances—the primary source of cash for modernization—will total \$8.3 billion in 1959, compared with present modernization plans of \$6.4 billion. Thus some extra funds will be available to support a further step-up in modernization in 1960.

Unfortunately, however, these depreciation funds are not evenly distributed from industry to industry, or from company to company. For example, in several of the metalworking industries, the prospective flow of cash from depreciation during the next four years is much less adequate than for manufacturing as a whole. These are industries with relatively large modernization backlogs, and they also are industries made up mostly of small or medium-size companies that have difficulty tapping the public money market.

As a result of these industry and company differences, there are many individual cases where shortages of funds limit the amounts of modernization now planned. In the McGraw-Hill survey, nearly half of all companies participating said that they would spend more on new plants and equipment if the depreciation allowances permitted by the tax law were increased substantially over the next few years. Most of these were relatively small companies. Their answers suggest that revision of the tax rules on depreciation should receive the most careful consideration as a spur to faster modernization.

The problem is complicated also by the threat of further increases in the national price level, which would necessarily include prices of capital goods. If “creeping inflation” resumes its march during the next four years, depreciation allowances based on present costs will be much less adequate for future needs. This points up the importance of national economic policies to maintain price stability. Unless this can be maintained, industry’s dollars will not go far enough to do the modernization job that is needed.

Plan '59 Carries On

Industry’s drive to modernize is now well underway. It can make a key contribution to our national strength and prosperity in 1959 and the years ahead. But the biggest part of this job is before us. It is up to the policy makers—in both business and government—to see that the job is done.

This message was prepared by the McGraw-Hill Department of Economics as part of our company-wide effort to report on opportunities for modernization in industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

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Thermistors: Western Electric D166382, Victory Engineering Co. 32A3, 32A5, Narda 333, 334.

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-hp- 476A Bolometer Mount—Universal bolometer mount requiring no tuning, no adjustment. Frequencies 10 to 1,000 MC, instantaneous, automatic power readings 0.02 to 10 mw. SWR less than 1.15, 20 to 500 MC; less than 1.25, 10 to 1,000 MC. Uses four 1/100 amp fuses. Uses Type N rf connectors. \$85.00.



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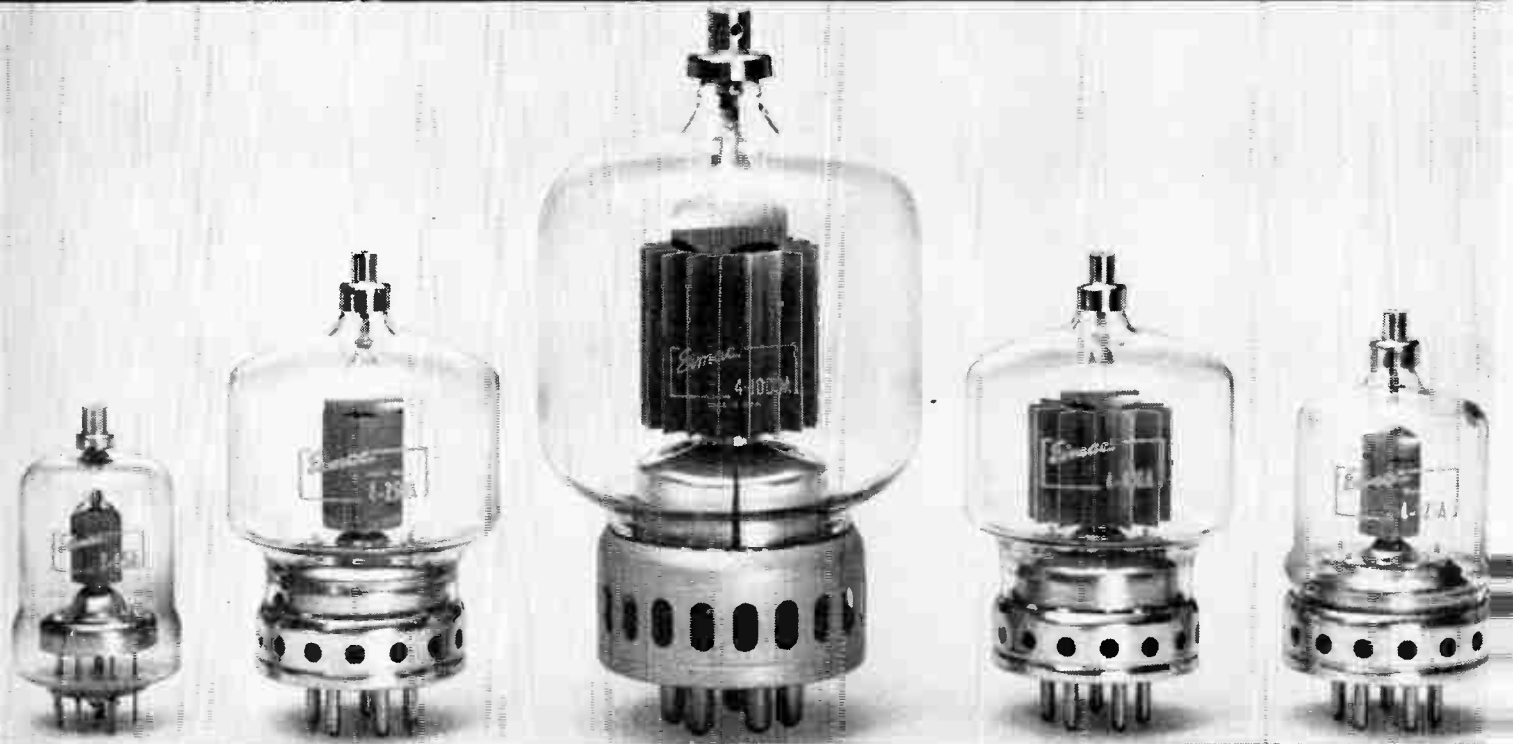
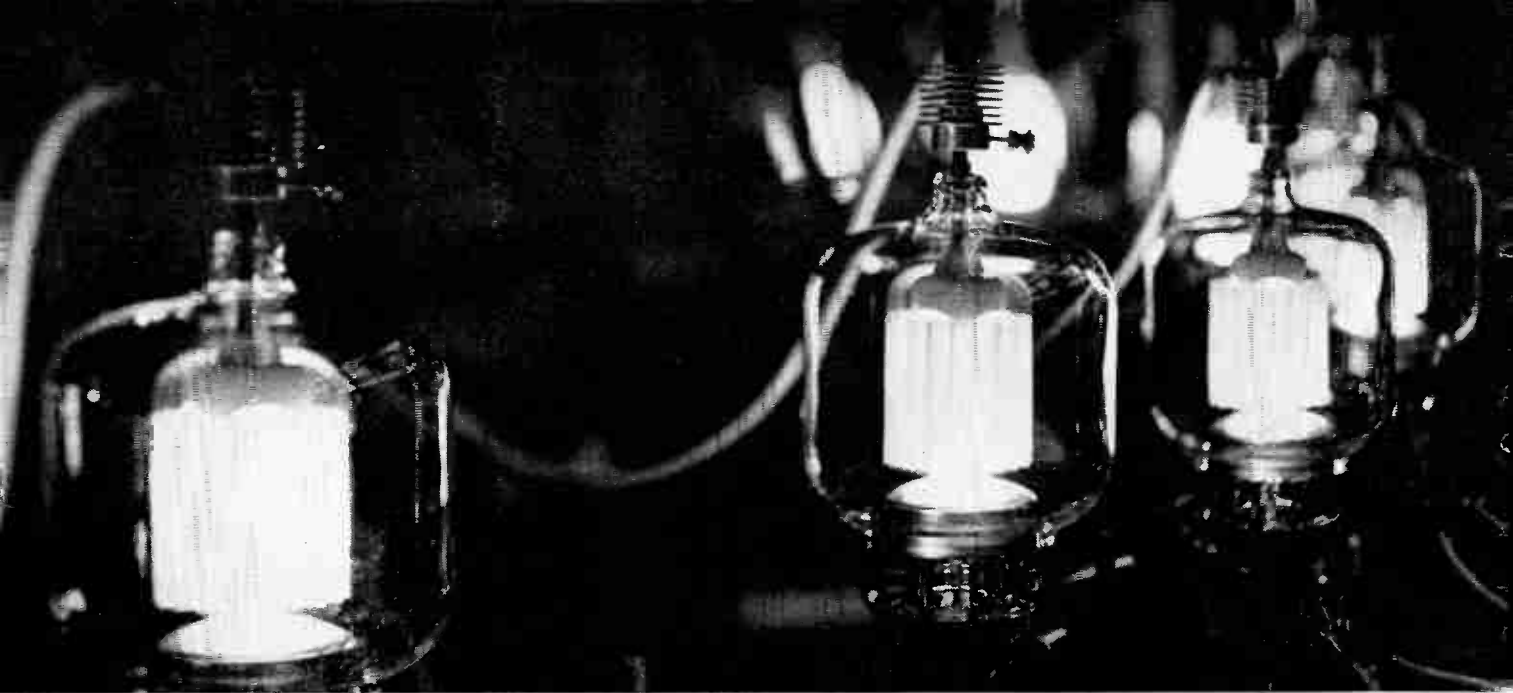
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ELECTRONICS NEWSLETTER

ATOMIC CLOCK, of the ammonia maser type, is being developed for a satellite by Hughes for the National Aeronautics and Space Administration. Once in orbit, the clock will transmit its time reading by radio to a ground station where the time will be compared to a similar clock. The clock is expected to weigh about 30 lb (complete with batteries to last three weeks) and will occupy about $\frac{1}{2}$ cu ft of volume. Contract amounts to \$200,000. The National Bureau of Standards is also under contract to NASA for an atomic clock known as an optically excited gas cell using rubidium atoms.

F-M/F-M AIRBORNE TELEMETRY systems for Minuteman test program will be designed, developed and built by United Electrodynamics for Boeing under \$ $\frac{1}{2}$ -million contract. This is the first major subcontract for work on a portion of the new solid propellant ICBM, according to Boeing.

Airborne guidance computers and associated test equipment for the Vega outer space rocket will be supplied by Hallamore Electronics under a \$ $\frac{1}{2}$ -million contract with the Jet Propulsion Laboratory.

RADIO-CONTROLLED LAWN MOWER will be marketed next year by a British firm, H. C. Webb & Co. of Birmingham. Mower is powered by a $\frac{1}{4}$ hp 24-volt battery-operated motor, remotely controlled by a two-switch miniature transmitter through a multistage receiver working on 27 mc. Receiver has integral relays, is actuated by varying audio-frequencies; range is up to one mile, speed is just under two mph.

SINGLE-SIDEBAND COMMUNICATIONS network for the Strategic Air Command will be expanded under a new \$5-million contract with Collins. Contract calls for furnishing and installing radio and control equipment, switching centers, consoles and antennas, installation of underground coaxial transmission lines to antennas and modification of buildings. The new stations will be in California and Massachusetts.

Electronic armanent control systems for Lockheed's F-104G Starfighters recently ordered by West Germany will be supplied by Autonetics div. of North American under an \$8-million contract.

DEVELOPMENTS DISCUSSED at the Third National Convention of Military Electronics in Washington recently included: advantages of an optical data-processing system over an electronic system—one asset being the large storage capacity of photographic film (University of Michigan); a high-speed data plotter that plots up to 4,000 data points per second and draws the co-

ordinate lines of the chart according to specifications (Lockheed); and new mathematical analysis techniques that will calculate orbital parameters of satellites more accurately while using identical doppler-radar equipment (Jet Propulsion Laboratory).

FLIGHT TESTING of Bendix's AMQ-15 electronic weather reconnaissance system will begin next month at Boeing's Renton, Wash., facility (ELECTRONICS, p 26, Jan. 16). The system includes a cloud bottom and top radar with two antennas, as well as a storm radar. The radar data is photographed on 35 mm film which is rapidly processed, analyzed by an automatic data processor and stored for later transmission to the ground—all in a matter of seconds. Preproduction units are scheduled for completion by late 1961.

LEBANON STARTS TV BROADCASTS this month on a regular commercial basis using French Thomson-Houston studio equipment. The Beirut station, owned and operated by a private firm, is the first commercial tv station in the Arab world. European 625-line scanning system is used.

New visual display system, called Iconorama, will allow observers to see the positions of air and surface vehicles thousands of miles away. It will be installed at the North American Air Defense Command headquarters with a direct line to the Strategic Air Command center. Contractor is Fenske, Fedrick and Miller, subsidiary of Temco.

NASA CONTRACTS AWARDED in May totaled \$21 million. Included were: 1. Jet Propulsion Laboratory, \$110,000, for a transmitter to be installed in JPL's Goldstone, Calif., tracking installation as part of NASA's passive communications satellite project. The project calls for an orbiting 100-ft inflatable plastic sphere off which radio signals would be bounced cross-country within the next year. 2. Yale University, \$110,000, to finance the use of a radio telescope to measure the doppler effect of the 21cm hydrogen line resulting from the orbit of the earth around the sun. 3. Army Ordnance Missile Command, \$560,000, for multifrequency radio beacons to be used in earth satellite investigations of the ionosphere. 4. University of Wisconsin, \$60,000, for design studies for an ultraviolet telescope system to go into a future orbiting space observatory. The telescope would examine the radiation emitted by stars. 5. JPL, \$300,000, for R&D on improved tracking and receiving equipment for deep space missions. 6. Massachusetts Institute of Technology, \$200,000, to assist NASA in making technical evaluations of facilities and instrumentation in tracking network for Project Mercury, the manned space flight program.

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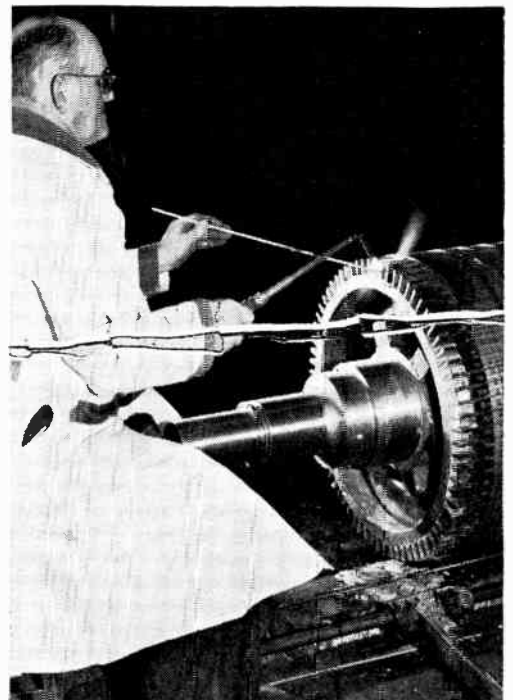
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WASHINGTON OUTLOOK

WASHINGTON—WHEN IS A GUIDED MISSILE an aircraft and when is it a piece of electronic equipment?

On the answer to this riddle will depend the Labor Dept.'s decision to leave minimum wage rates under the Walsh-Healey Act alone in the missile guidance part of our industry—or boost them roughly 20 percent to jibe with higher aircraft industry rates.

The aircraft industry has long pleaded with the Labor Dept. to boost missile guidance rates to bring about equality. There's been a lot of pulling and hauling. Here's where the controversy stands today.

The Pentagon has dispatched to the Labor Dept. the most comprehensive report ever made of companies with military contracts for missiles. The report is classified "for official use only" and has yet to be disclosed to industry. It covers contracts in fiscal years 1958 and 1959 and breaks down awards for missile end-items, electronic subsystems and other components by industry, company and dollar value.

The report will provide Labor with the basis for the first decision to be made in the prolonged government consideration of the aircraft industry's Walsh-Healey petition:

Whether to expand the aircraft industry's definition under the law to include missiles and "completed end-product electronics systems" (as the aircraft makers and their two major unions propose); whether to set up a new and separate missile classification or include missiles with electronics (as most electronics firms prefer); whether to make a compromise—lumping missile end-items under the aircraft industry but excluding electronic missile subsystems.

Several months back, the Labor Dept. drafted the third, or compromise, alternative as a proposed definition change with which to begin studying the case. As the case shapes up now, the outlook is for a decision incorporating a modified version of this proposal. The decision on a new aircraft and missile industry definition is expected to be made within the next six months by the Secy. of Labor.

Washington experts stress that the issue involves a "product in transition," that the case goes beyond the simple matter of missile contracts. It will also set the pattern for Walsh-Healey minimum wages covering the burgeoning volume of space vehicle contracts.

The definition issue is just the first step in the long drawn-out proceedings before a new minimum wage is put into effect. The second step: A six-month wage survey by the Bureau of Labor Statistics of the industry.

This will be followed by public hearings, a tentative decision, opportunities for aggrieved parties to object, and—finally—an official determination of what elements of the missile industry (if any) have to pay what minimum wage.

- Before the end of the year, a tentative Walsh-Healey ruling will be made on official minimum pay on government contracts for electronic tubes and related products. A Bureau of Labor statistics survey covering 157 plants with 60,591 workers has shown a prevailing median hourly rate of \$1.70.

Several months later, another tentative ruling will be made covering other basic electronic components. But labor officials say it will take at least a year before the two decisions become effective.

A third Walsh-Healey case had been planned this year covering electronic end-products on government contracts. But this is being shelved pending resolution of the aircraft-missile case.

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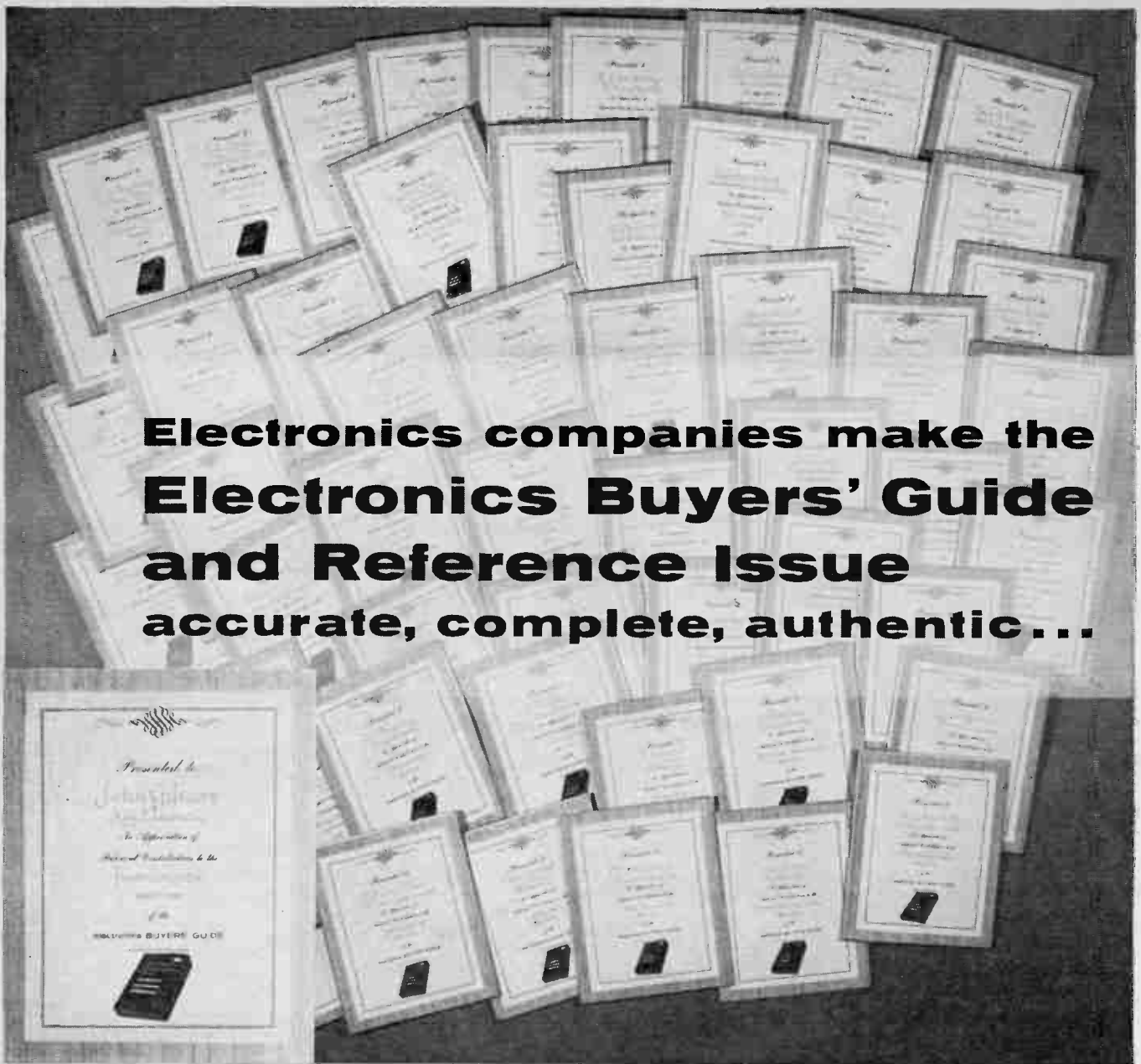
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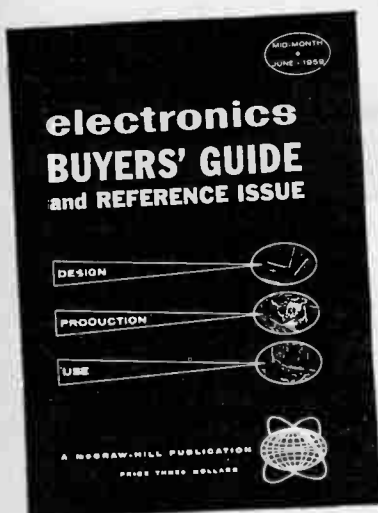
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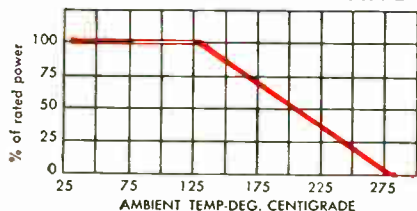
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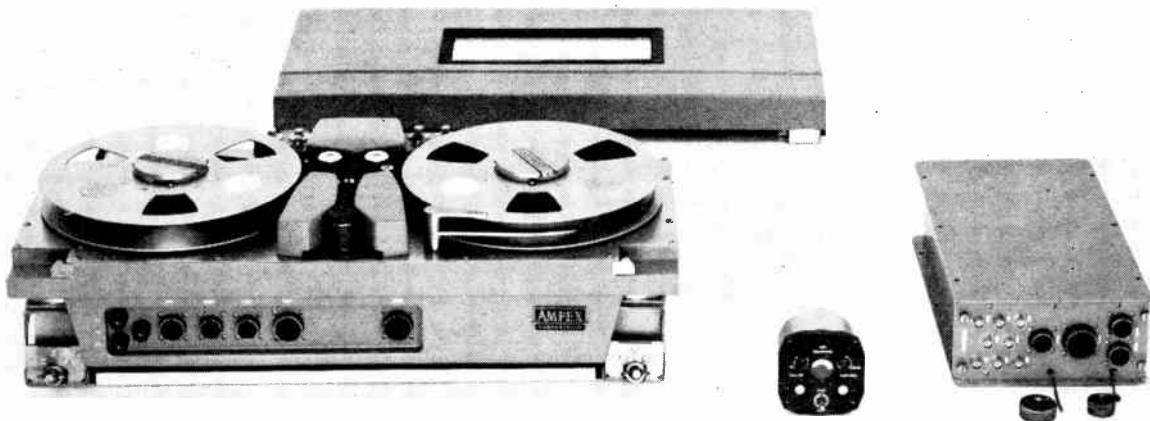
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You can depend on Dalohm, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

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smaller packages
DALE PRODUCTS, INC.
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all-solid state
airborne and mobile
magnetic tape recorder*

AMPEX AR-200



For precise acquisition of data under extreme environments... maximum reliability with minimum size and weight... the complete 7-track AR-200 system above includes transport, amplifiers, power supplies, remote control, shock mounts and tape in three compact units... weight? just 90.5 pounds... volume? only 1.6 cubic feet... records 14 analog tracks or up to 32 digital tracks with new Ampex magnetic head configurations... your further inquiry is invited...
AMPEX INSTRUMENTATION DIVISION, 934 Charter Street, Redwood City  California

Incomes Keep Climbing

AS MID-YEAR PASSES, reports of first-quarter earnings indicate 1959 is living up to expectations of higher income as far as the electronics industry is concerned. Some recent reports show:

- **IMC Magnetics Corp.**, Westbury, L. I., reports net income during the 1958-59 fiscal year at nearly double that of the preceding year. Net income for the period was \$105,589, equal to 67 cents per common share. This compares with net income of \$57,948 for the previous fiscal year, equal to 37 cents per common share.

- **Avien, Inc.**, Woodside, N. Y., reports sales of \$5,991,000 for the nine months ended March 31, 1959. This is up 14 percent over the same period in the previous fiscal year. Earnings for the 1959 year were \$254,000, compared with \$94,000 for the '58 fiscal year, an increase of 170 percent.

- **Borg-Warner Corp.**, Bedford, Ohio, announces earnings of \$7,770,117 for the first three months of this year as compared with \$5,015,997 for first-quarter 1958. This represents 86 cents a share (common) for this year, in contrast to 56 cents a share in 1958. Net sales this year were \$149,713,748, compared with \$130,804,835 for 1958. The firm attributed the increase to higher sales and greater economies in overhead and production costs.

- **Ampex Corp.**, Redwood City, Calif., hit a sales record of \$43,808,807 for the fiscal period ended April of this year. This figure is up 45 percent from last year. Net profits of \$2,808,807 were up 85 percent over last year, with earnings per share at \$1.29. Sales for the forthcoming year are projected at \$60 million, with estimated earnings of \$3,900,000 or \$1.77 per share.

- **Airpax Electronics**, Ft. Lauderdale, Fla., reports net sales of \$921,127 for the first quarter of

this year. In the same period last year, this figure was \$580,875. Net income after taxes amounted to \$59,777 for this year. Earnings for 1959's first quarter were 16 cents per share of common stock.

- **Litton Industries**, Beverly Hills, Calif., announces sales of \$89,191,000 for the nine months ended April 30, 1959, an increase of 45 percent over the comparable period last year when sales totaled \$61,509,000. Profits after taxes for the present nine-month fiscal period were \$4,226,000. After payment of \$124,000 in preferred stock dividends, profits per share of common stock amounted to \$2.29, including a 39-cent amount as special income credit.

- **General Electric's** net sales billed came to \$976,568,000 for the three-month period ended March 31. During the same period in 1958 this figure was \$964,966,000. Net earnings per share for the first quarter of this year were 60 cents, up 4 cents from last year. Net earnings per dollar of sales were 5.4 cents for the 1959 term, 5.1 cents for the 1958 period.

25 MOST ACTIVE STOCKS

WEEK ENDING JULY 2

| | SHARES (IN 100'S) | HIGH | LOW | CLOSE |
|------------------|----------------------|---------------------------------|---------------------------------|---------------------------------|
| RCA | 1,151 | 70 ¹ / ₂ | 65 ¹ / ₄ | 69 ⁷ / ₈ |
| Sperry Rand | 821 | 26 ¹ / ₈ | 25 ¹ / ₈ | 26 |
| Univ Controls | 784 | 19 ⁷ / ₈ | 18 ¹ / ₄ | 19 ³ / ₄ |
| Int'l Tel & Tel | 749 | 41 | 38 ¹ / ₈ | 40 ¹ / ₄ |
| Raytheon | 730 | 60 ¹ / ₈ | 57 | 57 ³ / ₈ |
| Avco Corp | 677 | 15 ⁷ / ₈ | 14 ⁵ / ₈ | 15 ⁵ / ₈ |
| Burroughs | 567 | 38 ⁵ / ₈ | 35 ¹ / ₄ | 36 ³ / ₈ |
| Gen Tel & Elec | 493 | 70 ¹ / ₄ | 69 | 69 ³ / ₄ |
| Gen Dynamics | 461 | 56 ¹ / ₄ | 54 ³ / ₈ | 55 ³ / ₄ |
| Emerson Rad & Ph | 454 | 22 ¹ / ₈ | 18 ⁵ / ₈ | 21 ¹ / ₂ |
| Gen Electric | 379 | 80 ⁷ / ₈ | 79 ⁵ / ₈ | 80 ³ / ₄ |
| Int'l Resist | 343 | 19 ⁵ / ₈ | 17 ¹ / ₈ | 19 ¹ / ₂ |
| Elec & Mus Ind | 328 | 7 ⁵ / ₈ | 7 ¹ / ₄ | 7 ¹ / ₄ |
| Standard Coil | 317 | 20 ¹ / ₂ | 19 | 19 |
| Victoreen Inst | 310 | 15 ³ / ₈ | 13 | 15 ¹ / ₈ |
| Westinghouse | 287 | 95 ¹ / ₂ | 91 | 95 |
| Gen Instr | 286 | 33 ³ / ₈ | 31 ⁵ / ₈ | 32 |
| Dynamics Corp | 278 | 10 ³ / ₄ | 9 ³ / ₈ | 10 ¹ / ₄ |
| Philco | 266 | 32 ³ / ₈ | 30 ¹ / ₂ | 31 ¹ / ₄ |
| Admiral | 257 | 25 ¹ / ₄ | 23 | 24 ⁷ / ₈ |
| Hoffman Elect | 256 | 36 ⁷ / ₈ | 34 ⁷ / ₈ | 35 ³ / ₄ |
| Texas Inst | 256 | 153 ³ / ₄ | 144 | 148 ¹ / ₂ |
| Zenith | 230 | 129 ³ / ₄ | 125 | 125 ³ / ₄ |
| Motorola | 222 | 118 ¹ / ₂ | 108 ¹ / ₄ | 116 |
| Servo Corp Am | 212 | 34 ⁷ / ₈ | 30 | 31 ¹ / ₂ |

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

**DO
YOU
KNOW?**

**Valuable
BUYING DATA
Will Be Found
In This Year's
Reference Section**

The 1959-1960 Reference Section of the BUYERS' GUIDE contains market figures, market distribution data, a government agency buying guide, Mil-Jan specs, a materials' guide, etc. — information of permanent use to the buyer . . .

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advertisers and users of
the BUYERS' GUIDE
receive extra benefits
available in no other
place.**

**electronics
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Now 4 CHR High Temperature TEFLON[®] Tapes



Pressure-Sensitive TEFLON Tapes

*easy to apply in both electrical
and mechanical applications*

The electrical uses of Temp-R-Tape include slot lining, inter-layer and interphase insulation, harness bundling, wrapping for microwave components, transformer coils, capacitors and high voltage cables, etc.

As a low friction, non-stick facing, Temp-R-Tape applications range from facings for film guides in sensitive electronic instruments to the facing for heat sealing bars, forming dies, chutes, guide rails, etc.

Chemical resistant facing applications include masking tape in high temperature dipping operations.

All four of these pressure-sensitive Teflon tapes are available from stock in rolls and in sheet form. In addition to Teflon tapes, CHR also makes a fiberglass tape with thermal curing, pressure-sensitive silicone adhesive (Temp-R-Tape GV) and silicone rubber coated fiberglass tape with thermal curing, pressure-sensitive silicone adhesive (Temp-R-Tape SGV).

FREE SAMPLES and folder — write, phone or use inquiry service.

- -100°F to 500°F applications
- Class H and Class C insulation
- Non-stick and low friction facing
- Chemical resistant facing

TEMP-R-TAPE T is a .006" pressure-sensitive Teflon tape with -100°F to 400°F (-70°C to 200°C) temperature range. It has high dielectric strength, low power factor, negligible moisture absorption, high elongation, is non-corrosive and non-contaminating. Meets Class H Temperature requirements.

TEMP-R-TAPE TH is a .013" pressure-sensitive Teflon tape with -100°F to 400°F temperature range. It is similar to Temp-R-Tape T except that it is made of .010" Teflon film to which .003" silicone polymer adhesive has been added. Often used where a single, thicker dielectric barrier is desired or where a more rigid, abrasion resistant wrap is required.

TEMP-R-TAPE C is a .002" pressure-sensitive, thermal curing Teflon tape with -100°F to 500°F temperature range. It is made with a cast Teflon film which provides dielectric strength (2750 v/m) higher than any other type of Teflon film. When cured in place, it will operate at temperatures up to 500°F and will withstand much higher temperatures for short periods. Meets Class H and Class C temperature requirements.

TEMP-R-TAPE TGV is a thermal curing, pressure-sensitive Teflon impregnated fiberglass tape with -100°F to 500°F temperature range. Although it is used extensively for mechanical and electrical applications, its dielectric strength is lower than other Temp-R-Tapes.

CHR products include:

COHRLastic Aircraft Products — *Airframe and engine seals, firewall seals, coated fabrics and ducts*

COHRLastic Silicone Rubber Products — *Silicone rubber moldings and extrusions, silicone rubber sheets, silicone sponge rubber*

Temp-R-Tapes — *Pressure sensitive, thermal curing Teflon and silicone tapes*

Allied Products — *COHRLastic silicone cements and conductive gasketing*



Leader In Fabrication of Silicone Rubber

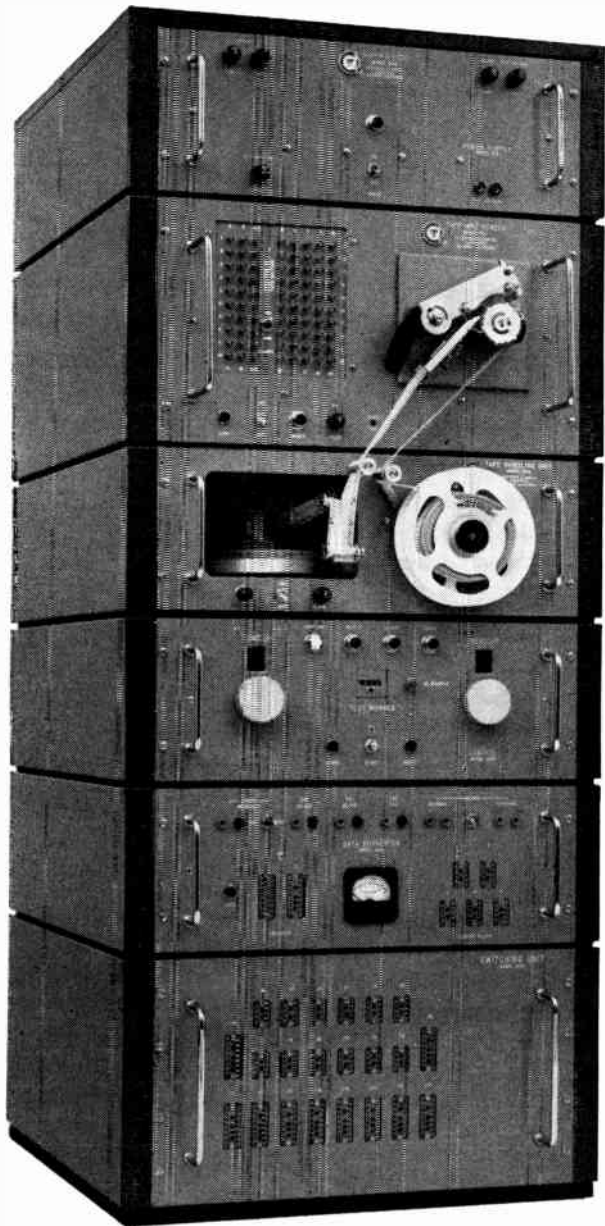
CONNECTICUT HARD RUBBER COMPANY

Main Office: New Haven 9, Connecticut

Electronic test and maintenance costs

REDUCED 90%

with the Tape-Programmed SUPERTESTER®



Drastically reduced test costs, increased equipment reliability and quality, incipient failures located during routine maintenance, decreased down time for vital equipment, production bottlenecks eliminated, no time wasted overhauling good units and needlessly replacing good components, exceedingly valuable in ground support—these are a few of the many reasons that CTI Supertesters are so widely used for all types of electronic and electrical testing from production to field maintenance. In making complete static and dynamic measurements on constituent circuits or in analyzing performance of entire systems, Supertesters have demonstrated time and again their advantages over other test methods.

Proved in over one year of use, the Model 180 Tape-Programmed Supertester is bringing a new versatility into automatic testing. With the accessory Tape Punch and Tape Duplicator, identical or revised copies of tapes can be made in seconds, an important feature where numerous design changes are of concern. Copies of tapes used by the original equipment manufacturer can be supplied for field use, always assuring that equipment is meeting the latest design specifications. In addition, lengthy test specifications are eliminated and the test instruments for a large variety of units are kept to a minimum—one CTI Supertester.

Write for complete specifications on the Model 180. A brief outline of your test requirements will enable us to advise you in more detail on the application of our testers to your needs. Related CTI products are the Model 165 Cable-Harness Analyzer, Model 176 card-programmed Component Tester, and Model 100 Supertester.

See this equipment at WESCON — BOOTHS 2209, 2210
San Francisco, August 18-21

The new Model 180 Tape-Programmed Supertester has the same outstanding features that have made CTI automatic test equipment the leader in the field—high accuracy, go/no-go bridge measurements, widest scope of tests and auxiliary operations, and complete customer confidence in test results through fail-safe circuitry and self-testing ability.

Engineers: Career opportunities are currently available at CTI



CALIFORNIA TECHNICAL INDUSTRIES

DIVISION OF TEXTRON, INC.

BELMONT 8, CALIFORNIA

Foremost in Automatic Testing

MARKET RESEARCH

ADVANCED RESEARCH PROJECTS AGENCY'S ESTIMATED OBLIGATIONS

| | FY 1959 | of | FY 1960 |
|---|----------------|----|----------------|
| | (Millions | | Dollars) |
| BALLISTIC MISSILE DEFENSE | | | |
| Missile Flight Phenomena | \$ 25 | | \$ 44.65 |
| Missile & Satellite Identification and Kill | 10 | | 17.6 |
| Missile Acquisition, Tracking, and Data Reduction | 23 | | 35.25 |
| Feasibility Investigations and Exploratory Research | 22 | | 30.6 |
| Subtotal | \$ 80 | | \$128.7 |
| MILITARY SPACE TECHNOLOGY | | | |
| Sentry | 95 | | 100 |
| Communications | 15 | | 40 |
| Precision Navigation | 4.5 | | 12 |
| Very Early Warning | 12 | | 18 |
| Cloud Cover Surveillance | 10 | | - |
| Manned Satellite | 8 | | - |
| Discoverer* | 100 | | 60 |
| Hi-energy Upper Stage | 15 | | - |
| Clustered Engine Booster | 19 | | 50 |
| Tracking & Data Acquisition | 17 | | 17 |
| Feasibility Investigations and Exploratory Research | 13.4 | | 10 |
| Scientific Space Investigations | 22.8 | | - |
| Subtotal | \$331.7 | | \$307 |
| Total | \$411.7 | | \$435.1 |

More Space Business Coming

RIISING VOLUME of obligations scheduled by the Advanced Research Projects Agency points to increased sales for electronics manufacturers. Today's obligations become tomorrow's expenditures.

Obligated funds for fiscal 1959 in ARPA's missile defense and military space technology programs have been estimated at \$80 million and \$331.7 million respectively, or \$411.7 million in all. Projects towards which ARPA will apply funds are: reconnaissance, communications, navigation and early warning of ballistic missile attack.

Estimated obligations for fiscal 1960 will amount to \$435.1 million, an increase of 5.7 percent over 1959. During 1960 fiscal period, ARPA plans to obligate \$128.1 million for missile defense and \$307 million for its military space technology program.

Budget Rises 60%

Greatest increases in appropriations scheduled fall within the ballistic missile defense category: budget shows overall rise of 60.1 percent during fiscal 1960 in estimates of future commitments.

Program summary (see above table) indicates heavy increases in ARPA's second-year obligations

for missile flight phenomena—scheduled to rise 79 percent in 1960; missile and satellite identification and kill, up 76 percent; missile acquisition, tracking, and data reduction, up 53 percent; feasibility investigations and exploratory research, up 39 percent.

• **International Rectifier Corporation** foresees an industry-wide sales potential of \$100 million by 1964 for silicon controlled rectifiers.

• **John F. McAllister**, general manager of General Electric's Power Tube department, claims power tubes, used for a host of commercial and military electronics applications, constituted a \$225 million business in 1958. GE estimates its share of the market was slightly under 10 percent.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

| (Source: EIA) | June 26, 1959 | May 29, 1959 | Change From One Year Ago |
|-------------------|---------------|--------------|--------------------------|
| Television sets | 110,300 | 109,239 | +42.7% |
| Radio sets, total | 238,041 | 250,224 | +78.1% |
| Auto sets | 126,022 | 122,227 | +117.5% |

STOCK PRICE AVERAGES

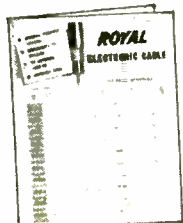
| (Standard & Poor's) | July 1, 1959 | June 3, 1959 | Change From One Year Ago |
|---------------------|--------------|--------------|--------------------------|
| Electronics mfrs. | 100.02 | 91.11 | +86.7% |
| Radio & tv mfrs. | 115.26 | 113.28 | +134.0% |
| Broadcasters | 104.75 | 100.88 | +67.3% |

ROYAL COAXIAL CABLES*

Whatever your coaxial cable needs—for electronic equipment, for military applications, or for community TV installations—Royal's electronic cable production lines are ready to fill your requirements NOW.

For a quick look at the Royal Coaxial Cable line, request Bulletin No. 4C-3-L.

* Formerly manufactured by Federal Telephone & Radio Company



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See it at the Insulation Conference!

second annual
**NATIONAL
CONFERENCE ON
THE APPLICATION
OF ELECTRICAL
INSULATION**



**HOTEL SHOREHAM
DEC. 8-10
WASHINGTON, D. C.**

Now, for the first time, you'll see the new **SECRET** type electrical insulation that will **SECRET** all night long! There'll be 14 **SECRET**, the first time they have ever been assembled all in one hotel room! You won't believe it until you see it!

But all kidding aside, you will learn a lot at the 2nd Annual National Conference on the Application of Electrical Insulation (often referred to as "The Conference"). You'll hear the latest data on high and low temperature insulations . . . new methods and techniques . . . as well as see the best exhibits by leading suppliers. Just ask the man who went last year.

Limited Offer! If you will be kind enough to send in the coupon at the bottom of this space, we'll give you the privilege of **NOT** waiting in line for registration . . . *guaranteed to save you five minutes!* We'll also send you complete information on conference schedule fees, tours, etc. Send in the coupon today! And be sure to put the date and location on your desk calendar . . . December 8-10 at the Hotel Shoreham in Washington, D. C.!

P. S. If you manufacture (your company, that is) electrical insulating materials, maybe your products should be exhibited at the show. Check the extra special box in the coupon for all the information.

National Conference on the Application
of Electrical Insulation
30 East 42nd Street, New York 17, N. Y.

2

I WANT THOSE FIVE MINUTES!

Please send me all the information about the 2nd annual National Conference on the Application of Electrical Insulation. I'll be there!

Name _____
PLEASE PRINT

VIP. in charge of _____

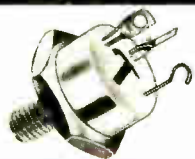
Company _____

Address _____

Yeh! send info on exhibit. I'll pass it along!

5 EXCITING NEW SILICON TRANSISTOR

1. HI-POWER STUD-MOUNTED SILICON TRANSISTOR



| Type | V _{cb} Max. Volts | I _c max. Amps | B Typical | R _{cs} Typical (Ohms) |
|--------|----------------------------|--------------------------|-----------|--------------------------------|
| 2N1208 | 60 | 5 | 35 | 1.5 |
| 2N1209 | 45 | 5 | 40 | 1.5 |
| 2N1212 | 60 | 5 | 25 | 2.5 |

APPLICATIONS Regulated Power Supplies . . . High Current Switching . . . High Frequency Power Amplifiers

Send for Bulletin No. 1355M

2. CORE SWITCH



| Type | V _{cb} Max. Volts | (β) Min. | Typ. Input Voltage (Volts) | Typ. Saturation Resistance (Ohms) | Switching Characteristics (μsec) |
|--------|----------------------------|----------|----------------------------|-----------------------------------|---|
| ST4100 | 60 | 15 | 2.5 | 10 | t _r .2 t _s .2 t _f .2 |

APPLICATIONS . . . magnetic core memory . . . high level multivibrators . . . buffer amplifiers . . . clock source

Send for bulletin 1355X

3. 150mc VERY HIGH FREQUENCY TRANSISTOR



TYPE
2N1139

| | | Min. | Typical | Max. | Test Conditions |
|-----------------------------------|-----------------|------|---------|--------|--|
| D.C. Current Gain | h _{FE} | 20 | 40 | — | I _C = 10ma, V _{CE} = 6V |
| D.C. Collector Saturation Voltage | V _{CE} | — | .5 | 0.7V | I _C = 10ma, I _B = 1ma |
| Collector Cutoff Current | I _{CO} | — | 2 | 5 μa | V _{CH} = Rating |
| Output Capacitance | C _{ob} | — | 8 | 12 μμf | V _{CH} = 6V, I _E = 0 mA |
| High Frequency Current Gain | h _{fe} | 5 | 7.5 | — | F = 20mc, V _{CE} = 6V I _E = 10 mA |
| Delay Time | t _d | — | 6 | — | mμsec. |
| Rise Time | t _r | — | 12 | — | mμsec. |
| Fall Time | t _f | — | 10 | — | mμsec. |

Send for bulletin TE1355 B2

4. UNIVERSAL 50mc LOGIC TRANSISTOR



| Type | Typ. Alpha Cutoff (Mc) | Beta Typical | C _o (Typical) (μμf) | Max. (Volts) | Typ. Saturation Resistance (ohms) |
|--------|------------------------|--------------|--------------------------------|--------------|-----------------------------------|
| ST3031 | 70 | 50 | 2 | 20 | 40 |

APPLICATIONS . . . flip-flops . . . IF and video amplifiers . . . transistor logic . . . pulse amplifiers

Send for bulletin 1353X

5. STABISTOR COUPLED LOGIC TRANSISTOR



| Type | Beta Typical | V _c max. (Volts) | Typical Saturation Resistance (ohms) | Typ. Alpha Cutoff (Mc) | Switching Characteristics (μsec) |
|--------|--------------|-----------------------------|--------------------------------------|------------------------|--|
| ST3030 | 12 | 15 | 40 | 50 | t _r .05 t _s .20 t _f .10 |

APPLICATIONS . . . designed specifically for SCTL and DCTL circuits (write for descriptive paper on SCTL)

Send for Bulletin 1353Y

A rugged package — easier to mount, with greater strength and lower thermal resistance. Has good beta linearity and switching characteristics good high frequency betas, low saturation voltage. Ratings up to 100 volts available.

Improved switching speed and input characteristics. High-current capabilities with good power handling ability (5w @ 100°C). Rated and tested at 60v.


New silicon logic transistor with speed surpassing the fastest silicon types, plus unusual power handling ability. Technical breakthrough now provides minimum and typical DC current gains of 20 and 40 respectively.


This transistor features universal application (replaces 2N337, 2N338, 2N1005, 2N1006) and high frequency response, with low saturation resistance, low input impedance, low capacitance.


Designed to provide minimum storage times under severe base overdrive conditions in transistor logic circuitry. Tightly controlled input characteristics provide interchangeability; low R_{cs} assures reliable operation at high temperature.


DEVELOPMENTS FROM TRANSITRON...added to THE INDUSTRY'S MOST COMPLETE LINE


SILICON TRANSISTORS

| JAN TRANSISTOR | | Minimum Current Gain (β) | Maximum Collector Voltage (Volts) | Typical Cut-off Frequency (Mc) | Maximum I _{co} @ 25°C and V _c Max. (μa) | FEATURES |
|--|-----------|--------------------------|-----------------------------------|--------------------------------|---|-------------------------------|
|  | JAN-2N118 | 10 | 30 | 10 | 1 | • Only Jan Silicon Transistor |

| SMALL SIGNAL | | Minimum Current Gain (β) | Maximum Collector Voltage (Volts) | Typical Cut-off Frequency (Mc) | Maximum I _{co} @ 25°C and V _c Max. (μa) | FEATURES |
|--|-------|--------------------------|-----------------------------------|--------------------------------|---|---|
|  | 2N333 | 18 | 45 | 7 | 50 | • Low I _{co} • Operation to 175°C • 200 mw Power Dissipation |
| | 2N335 | 37 | 45 | 10 | 50 | |
| | 2N480 | 40 | 45 | 11 | .5 | |
| | 2N543 | 80 | 45 | 15 | .5 | |
| | ST905 | 36 | 30 | 10 | 10 | |

| HIGH SPEED SWITCHING | | Typical Cut-off Freq. (Mc) | Maximum Collector Voltage (Volts) | Maximum Collection Saturation Resistance (ohms) | Max. Power Dissipation @ 100°C ambient (mw) | FEATURES |
|---|--------|----------------------------|-----------------------------------|---|---|--|
|  | ST3030 | 50 | 15 | 60 | 50 | • High Frequency Operation • Low Saturation Resistance • Low I _{co} |
| | ST3031 | 70 | 20 | 65 | 50 | |
| | 2N1139 | 150 | 15 | 70 | 500 | |
| | 2N337 | 20 | 45 | 150 | 50 | |
| | 2N338 | 30 | 45 | 150 | 50 | |

| MEDIUM POWER | | Max. Power Dissipation @ 25°C Case (Watts) | Maximum Collector Voltage (Volts) | Minimum DC Current Gain (β) | Typical Rise Time (μsec) | Typical Storage and Fall Time (μsec) | FEATURES |
|--|--------|--|-----------------------------------|-----------------------------|--------------------------|--------------------------------------|--|
|  | ST4100 | 5 | 60 | 15 | .2 | .4 | • Fast Switching • High V _c • Rugged Construction |
| | 2N545 | 5 | 60 | 15 | .3 | .5 | |
| | 2N547 | 5 | 60 | 20 | | | |
| | 2N493 | 4 | 100 | 12 | | | |
| | 2N551 | 5 | 60 | 20 | | | |
| | 2N1140 | 1 | 40 | 20 | .2 | .2 | |

| HIGH POWER | | Maximum Power Dissipation @ 25°C Case (Watts) | Minimum DC Current Gain (β) | Typical Collector Saturation Resistance (Ohms) | Maximum Collector Voltage (Volts) | FEATURES |
|--|--------|---|-----------------------------|--|-----------------------------------|---|
|  | ST400 | 85 | 15 @ 2 Amps | 1.5 | 60 | • High Current Handling Ability • Low Saturation Resistance • Rugged Construction |
| | 2N389 | 85 | 12 @ 1 Amp. | 3.5 | 60 | |
| | 2N424 | 85 | 12 @ 1 Amp. | 6.0 | 80 | |
| | 2N1208 | 85 | 15 @ 2 Amps | 1.5 | 60 | |
| | 2N1209 | 85 | 20 @ 2 Amps | 1.5 | 45 | |
| | 2N1212 | 85 | 12 @ 1 Amp. | 2.5 | 60 | |

Write for Bulletins: TE-1353 and TE-1355

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Trading floor of the N. Y. Stock Exchange is goal of many young electronics companies. To get there, a firm must know . . .

How to Impress Financial Men

An investment specialist active in electronics gives some advice on how a company can put its best foot forward when seeking new capital

By **HARDIE SHEPARD**, Partner, Payson & Trask, New York, N. Y.

THE WAY in which an electronics firm impresses venture capital groups or investment bankers is of growing importance during this period of industry expansion.

Management of the firm seeking capital should keep in mind that investment groups do not seek displays of colored brochures and elaborate prospectuses. Of greater interest are simple facts describing technical and financial operations of the firm in as much detail as possible. Doing this well is probably the most important single factor in the impression that is created.

Know Your Competition

Potential investors, like any other group of people, are interested in knowing what competition they will encounter in a new venture. A company presenting details on its own operation should make certain to gather as much data as possible on competing products or operations. This enables the investors to make sound judgments in the industry area they are investigating. Comparisons and differences should be clearly outlined from both technical and sales points of view.

Company-management having

outside related holdings should consolidate these before presenting information to investment groups. For example, establishing a manufacturing firm on a publicly-owned basis, but retaining private control of research facilities related to the manufacturing process, is considered a very unsound practice.

Past history is of great value in judging a company, and financiers are very likely to place great emphasis on this. Full financial information for the past five years should be presented. This should include audited annual statements. If the company is not five years old, the information should still cover the company's entire history.

ABOUT THE AUTHOR

TWENTY YEARS' EXPERIENCE in the financial community, combined with a thorough knowledge of the electronics industry, gives Hardie Shepard a unique vantage point. He is a partner in the New York venture capital firm of Payson & Trask, which specializes in electronics and instrumentation firms

Sales and earnings are a main determining factor in judging the successful operation of a firm. Full records on this should accompany the audited financial statements.

Keep It Real

Precautions should be taken against marking up physical assets in presenting a financial image. Patents, good will and research and development assets must also be kept to realistic figures. Attempts to dress up the balance sheet and overstate earnings always come to light under a thorough investigation and are sure to hurt.

It is wiser to indicate a token amount for patent values if exact figures cannot be stated. Good will should be listed only if part of an expenditure in acquiring the assets of another firm.

Footnote explanations to information may be used to good advantage in painting a company's portrait. If, for certain tax reasons, a company has been inventorying its research and development expenditure and amortizing it over a long period of time, or expending funds on the production of instruments, the facts of the case may be

OVER 500 HOURS AT HOT SPOT TEMPERATURES

summed up in a footnote. This is particularly true where instruments purchased for development programs are involved. An explanation should be given as to how much of this instrumentation represents equipment that will be sold and how much is for development prototypes.

The next important part of the financial presentation is a complete backlog of orders broken down by types of equipment, as well as a factual presentation of business under negotiation. A statement of the probabilities of contracts under negotiation ending up in orders or contracts should be made.

The company also should work out a sales and earnings budget for at least the coming year. These sales should be easily substantiated by the backlog and the business under negotiation. It is important that the profit margins estimated should be realistic in light of the profit margins of previous years. From this budget the company should also present a proforma balance sheet for the coming twelve months, indicating the need for additional capital and the timing of this need.

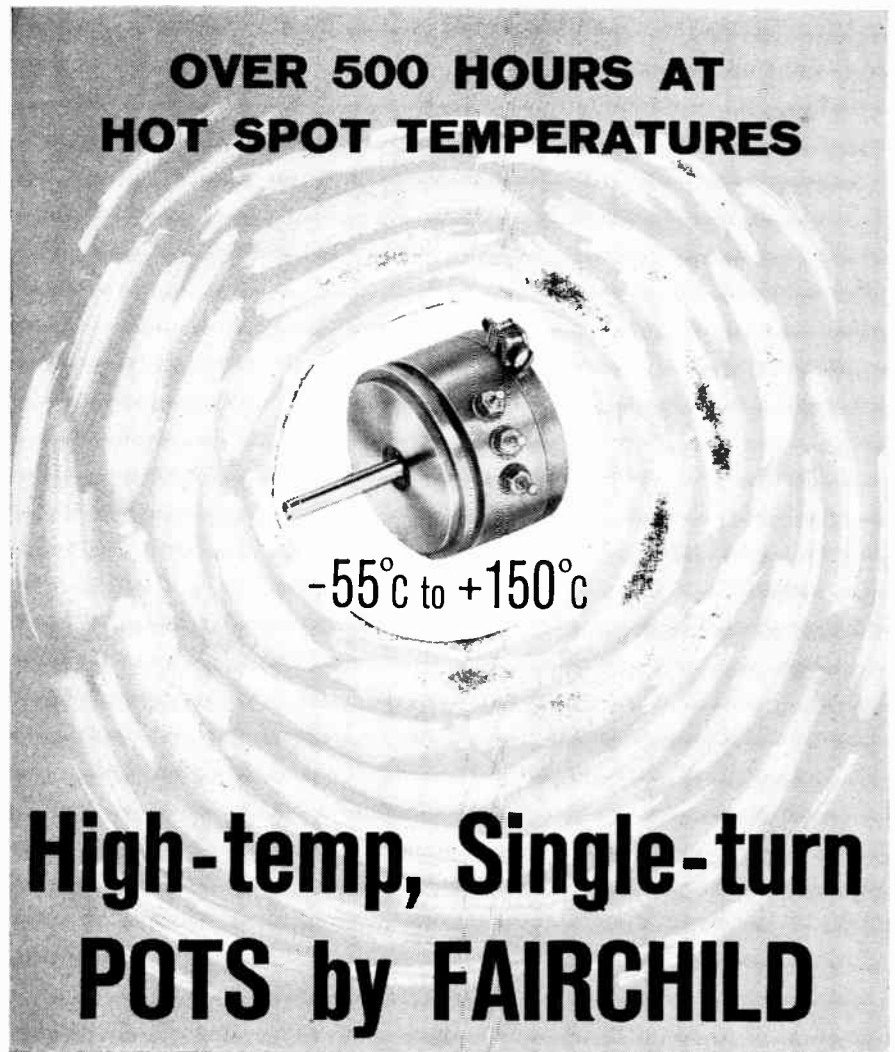
Name Your Key Men

The company should have ready at this time a written resume of the principal executives and key technical personnel, along with a list of its main customers. Also listed should be individuals involved in the various branches of the Armed Forces with whom the company has contact—if the company has or is negotiating government contracts.

Along with this the company should present a list of all patents and patent applications. If this is not an important aspect of the business, the firm should be prepared to make a good verbal presentation of why the company has a proprietary position, whether through exceptional production techniques or technical know-how.

One of the primary interests of the venture capitalist or investment banker is the overall size of the market to which the company sells and also the possible degree of future expansion there may be in that market. If the company has

(Continued on p 31)



-55°C to +150°C

High-temp, Single-turn POTS by FAIRCHILD

Conservatively rated for load life in excess of 500 hours' exposure to hot spot temperatures, Fairchild high temperature, high reliability precision potentiometers are designed for functional accuracy and reliability under operating ambient temperatures ranging from -55°C to $+150^{\circ}\text{C}$.

The excellent life of these low-noise, high resolution pots is made possible by the following outstanding construction features:

- Welded terminal and taps.
- Machined metal case.
- Precious metal resistance wires.
- Precious metal contacts.
- One-piece wiper construction.
- Clamp bands capable of withstanding high torque.
- Precision stainless steel ball bearings.

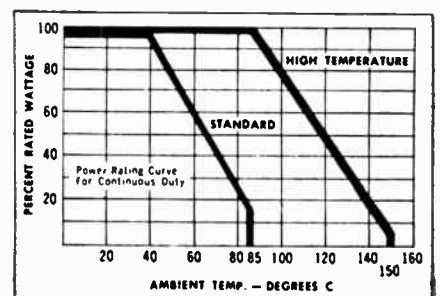
These high temperature, high reliability pots are available in $\frac{3}{8}$ ", $1\frac{1}{8}$ ", $1\frac{3}{4}$ ", and 2" diameter single-turns, and in $\frac{3}{8}$ ", 1" and 2" multi-turns. They are conservatively rated for load life in excess of 500

hours' exposure to hot spot temperatures. They meet or exceed Mil-E-5272A environmental specifications.

This series is also available in standard models for temperatures up to $+85^{\circ}\text{C}$.

Fairchild also offers $\frac{3}{8}$ ", $1\frac{1}{8}$ " and 2" diameter infinite resolution Film Pots with operating temperature ranges from -55 to $+225^{\circ}\text{C}$.

For more information write to Dept. 3E.



FAIRCHILD

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COMPONENTS DIVISION

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POTENTIOMETERS
ACCELEROMETERS

FORD MOTOR COMPANY DIVISION-AERONUTRONIC, FOR THE

Ford Motor Company,

THE AMERICAN ROAD
DEARBORN, MICHIGAN

We are pleased to announce the establishment of a new division of Ford Motor Company.

On July 1, 1959, Aeronutronic Systems, Inc., a subsidiary, will be merged with the Company, and its operations will be carried on by Aeronutronic, a Division of Ford Motor Company.

Aeronutronic was organized in 1956 with the goal of large-scale participation in the nation's space and missile programs. Over the past three years, the subsidiary has achieved an excellent reputation and record of accomplishment and we are happy to welcome the new operating end-product division of the parent company.

As a division of the company, Aeronutronic will continue to have as its objective the development and manufacture of advanced technical products for both military and commercial purposes in the areas of weapon systems and space systems, missile range systems and instrumentation, advanced electronics, data processing systems and computers.

The merging of Aeronutronic into Ford Motor Company will permit more effective Company support of Aeronutronic programs and thus facilitate the undertaking of more extensive projects than have been feasible in the past.

Kenneth R. Broun
Chairman of the Board

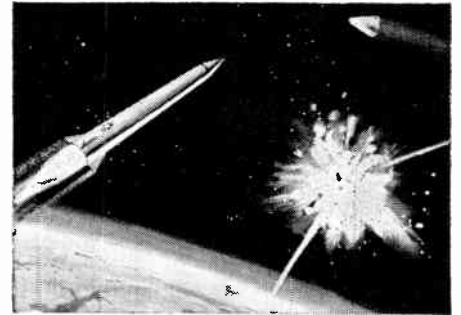
Henry Indis
President

AERONUTRONIC - MEETING THE REQUIREMENTS OF THE

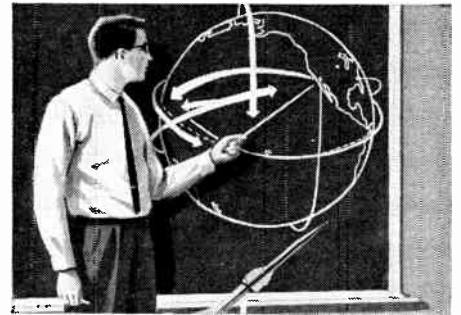
ANNOUNCES A NEW SPECIALIZING IN PRODUCTS SPACE AGE



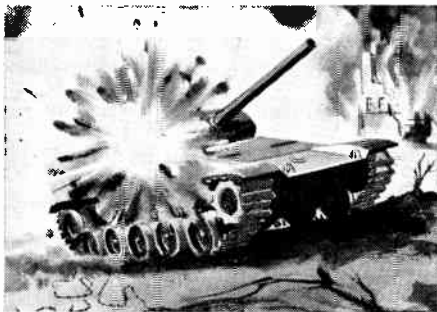
NEW 200-ACRE ENGINEERING AND RESEARCH CENTER. An artists' concept of Aeronutronic's new 20-million dollar Research Center under construction at Newport Beach in Southern California. Here, Ford resources provide the finest facilities for carrying out complete engineering, research and prototype manufacturing operations on advanced projects. Over 40 government and commercial programs are now underway at the new Center and at other Aeronutronic facilities nearby.



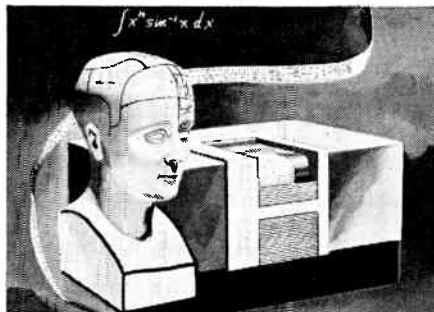
OFFICE OF ADVANCED RESEARCH. Basic research is conducted in areas of long-range company interests, with special emphasis in the fields of atomic and molecular physics, physical chemistry and atmospheric physics.



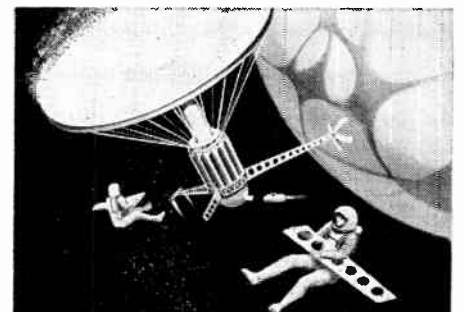
RANGE SYSTEMS OPERATIONS provides total capability to study and plan missile range instrumentation and to staff and manage complete missile range operations for U. S. military and civilian agencies.



TACTICAL WEAPON SYSTEMS OPERATIONS. The function of TWSO is to research, develop and manufacture tactical weapons for the military services. Under development now is the Army's \$23-million SHILLELAGH surface-to-surface guided missile system.



COMPUTER OPERATIONS is engaged in research, development, manufacturing and marketing of computer components and communications systems for military and commercial use. New products developed are revolutionizing present data processing techniques.



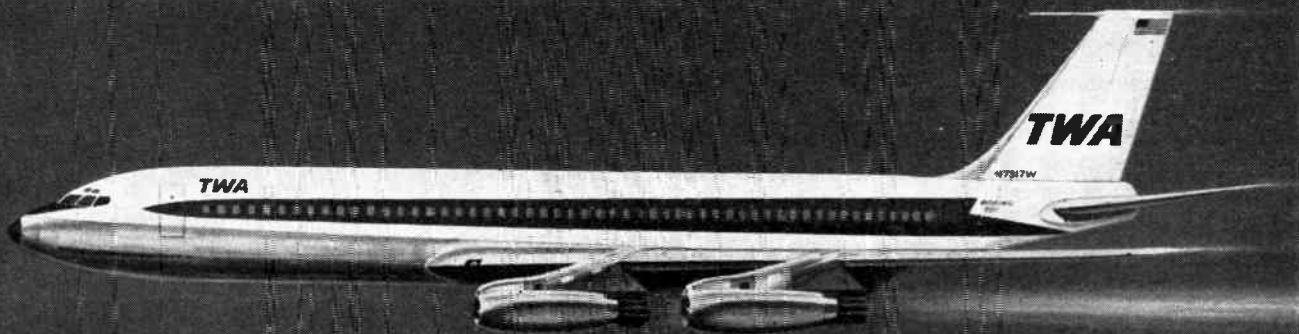
SPACE TECHNOLOGY OPERATIONS is devoted to solving problems dealing with man's new frontier. Typical development programs include satellite communication, ICBM detection, space vehicle design and research rockets, such as Project Far Side.

For information regarding interests, facilities, products or positions, write to
Aeronutronic, a Division of Ford Motor Company,
Ford Road, Newport Beach, California.

Ford Motor Company

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Our congratulations to you—the scientific planners, engineers and technicians of the great United States electronics industry! Thanks to your skill, the magnificent **TWA BOEING 707** is the fastest airliner in the world. And now it brings you the wonders of pure-jet freight service... at no increase in rates!

Your consignment travels half a mile every three seconds between major U. S. markets. You can ship bigger, heavier orders. Send more to more customers on a single Jet flight. And the **TWA BOEING 707s** advanced new electronic system assures proper climatic conditions for perishable shipments!

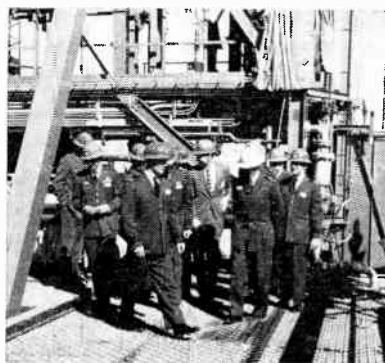
SHIP THE FASTEST WAY... SHIP **TWA** **TRANS WORLD AIRLINES**

Fledglings Study Electronics

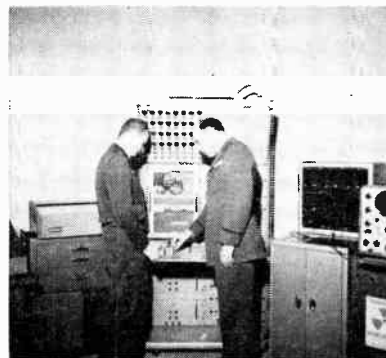
Cadets who one day may direct U. S. Air Force progress in space . . .



delve into circuits . . .



visit missile sites . . .



study analog computers

DENVER—LINGERING ECHOES of the class of '59's cheers at the Air Force Academy's first commencement still haunt the brand new

Rocky Mountain campus. It's not all memory, however. Most of it, appropriately, is on magnetic tape.

Electronics is a prominent part of the training the more than 200 cadets of the first class, and all lower classmen, are required to take during their four-year stay.

Curriculum

The Department of Electrical Engineering has two prescribed courses and six special courses, offering a total of 24 credit hours. A staff of 10 professors and instructors give all E.E. courses. The curriculum starts with the introduction to electronics — use of high-vacuum and gas tubes, electronic circuits and amplifiers, oscillators, multivibrators and wave-shaping circuits, modulation, radio transmitters and receivers, transmission lines and antennas.

The special courses include those in circuit analysis, electrical machinery and advanced electronics. In addition to detailed analysis of vacuum tube circuits, an introduction to transistors and magnetic amplifiers is included.

A special course in servomechanisms gives an introduction to basic techniques.

And Field Trips

The advanced course in fundamental radar system design considerations provides an understanding of problems facing the radar engineer. The course includes a critical analysis of the

parameters of the radar range.

One of the top special courses is on analog computer techniques, as applied to the solution of differential equations arising in engineering problems.

Field trips to such installations as SAC headquarters, Martin-Denver and overseas bases give cadets on-the-spot observation of electronic equipment and its use.

Add Up to Competence

Each cadet's qualification as an Air Force navigator gives him command of grid directional reference and gyro principles; use of present and future radar navigation systems. Approximately 40 per cent of loran training is conducted in the laboratory. Advanced navigational techniques emphasize electronic and inertial systems used to guide and position aircraft and missiles.

A newly-created department of astronautics provides instruction in the elements of that field. Teaching encompasses ballistic missiles, satellites and space vehicles. This includes trajectory characteristics, rocket power plants, terminal trajectory stabilization and control, guidance, survey of test techniques, and weapon systems case studies on rocket vehicles.

The advanced studies in astronautics cover the design and operation of guidance systems, inertial and radar; design of control systems; quantitative studies of planetary exploration experiments.

Financial Men . . .

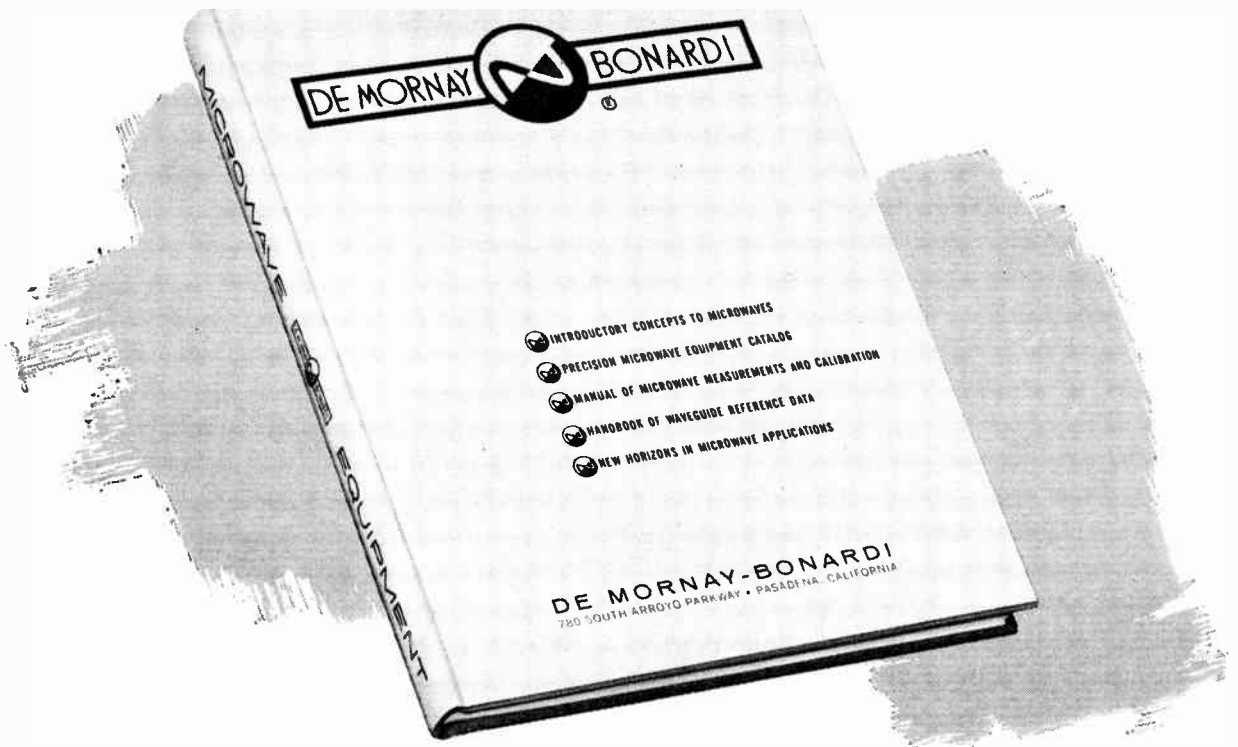
(Continued from p 27)

made any market survey, either formal or informal, this should be presented.

It cannot be overemphasized that a company should be most conservative in its presentation of future markets and equally conservative in its forecasts and budgets.

It must be remembered that a capable venture capital or investment banking firm will run a thorough investigation of the company, its business and its markets. If their findings agree closely with those presented by the company, an extremely favorable impression is made. Financial people place a great deal of importance on conservative management estimates, particularly in an industry where they are not likely to have much technical experience or knowledge.

If the investigation on the part of the venture capital or investment banking firm confirms the estimates of the company, the enthusiasm for the financing will increase and greatly help in getting a financing offer on a most favorable basis.



for every microwave engineer...

THE NEW 1960 D-B CATALOG -320 PAGES OF HELPFUL DATA

This latest D-B catalog—a hard-cover book—gives you complete information on making microwave measurements. You get comprehensive theory, plus practical help on applications. You'll find actual drawings of test setups, and instructions on test procedures, using units in the D-B line of precision test equipment—largest line available today.

Expanded handbook section gives the latest tabulations on available microwave tubes and their characteristics... on conversion factors, and other daily-used design data. There are dimension draw-

ings of all commonly-used AN flanges. There's all the information you need for assembling D-B Building-Block components.

New 140 KMC instrument section gives listings on a complete line of Ultramicrowave® equipment—units which can greatly enlarge your scope of microwave activity. There's also a special section on "New Horizons in Microwave Applications."

Write for a copy of the 1960 D-B catalog on your company letterhead. Ask for Catalog No. C4.



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ALSiMAG[®] 243

... for LOW LOSS ... for HERMETIC SEALING

Parts Shown
Approximately
One Half Size

Impervious

**Thermal Expansion compatible
with glass-sealing alloys
(nickel-iron series)**

Unusually high Te Value

**Low Loss especially
at high frequencies**

Note These Advantageous Properties

| PROPERTY | UNIT | ALSiMag 243 |
|---|---|---|
| Water Absorption | % | 0 to .02 Impervious |
| Specific Gravity | ----- | 2.8 |
| Density | Lbs. per cu. in. | .101 |
| Standard Body Colors ^a | ----- | Buff |
| Softening Temperature | °C. °F. | 1 440 2 624 |
| Safe Temperature at Continuous Heat | °C. °F. | 1 000 1 832 |
| Hardness | Mohs' Scale ^b | 7.5 |
| Thermal Expansion Linear Coefficient | Per °C. 25-300°C. 25-700°C. | 10.0 x 10 ⁻⁶ 11.2 x 10 ⁻⁶ |
| Tensile Strength | Lbs. per sq. in. | 10 000 |
| Compressive Strength | Lbs. per sq. in. | 85 000 |
| Flexural Strength | Lbs. per sq. in. | 20 000 |
| Resistance to Impact (1/2" rod) | Inch-Lbs. | 4.0 |
| Thermal Conductivity ^c (Approximate Values) | g. cal. x cm. thick cm ² x sec. x deg. C. | .008 |
| Dielectric Strength (step 60 cycles) Test discs 1/4" thick | Volts per mil | 240 |
| Volume Resistivity at Various Temperatures | 25°C. 100°C. 300°C. 500°C. 700°C. 900°C. | Ohms per centimeter cube > 10 ¹¹ 5.0 x 10 ¹¹ 7.0 x 10 ¹¹ 1.2 x 10 ¹¹ 1.0 x 10 ¹⁰ 3.0 x 10 ⁹ |
| Te Value ^d | °C. °F. | > 1 000 > 1 832 |
| Dielectric Constant ^e | 60 Cycles 1 MC. 100 MC. 10,000 MC. | 6.3 6.2 6.1 5.8 |
| Power Factor ^e | 60 Cycles 1 MC. 100 MC. 10,000 MC. | .0014 .0004 .0003 .0010 |
| Loss Factor ^e | 60 Cycles 1 MC. 100 MC. 10,000 MC. | .009 .002 .002 .0058 |

The low loss, Te value and thermal expansion characteristics of Forsterite ceramics are not equalled by any other impervious ceramic. This is especially important when high frequencies or sealing to metals or glasses is involved.

These properties have created a steadily increasing demand for ALSiMag 243. In the past two years major improvements have been made on this material and its fabrication. We are now producing components formerly unattainable in this material and the number of applications is constantly increasing.

If your application requires the favorable characteristics of ALSiMag 243, why not send us your blue prints and outline your operating conditions? If it is possible that your requirements can be met, we will be glad to work with you at reasonable cost on prototypes for your practical tests. Test discs approximately 1/2" x 3/32" are available with our compliments.

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★★★★★ ★★★★★

IN EVERY FIELD, THERE IS ONE
FOREMOST NAME . . . IN SONIC
ENERGY, THAT NAME IS BENDIX

SONIC ENERGY CLEANING SYSTEM

*Pays for itself in
6 months!*

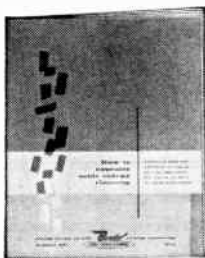
If you've heard people say that the results of Sonic Energy Cleaning can be spectacular, here's an example of what they mean:

A nationally known aircraft parts manufacturer had to remove dirt, grease, sludge, metal chips and abrasives from assembly components of a 4-stage aircraft compressor. Optimum cleanliness was vital. Previous methods were costly and unreliable.

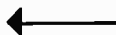
Using the Bendix Sonic Energy Cleaning System with an inexpensive, non-flammable, nontoxic detergent solution, in a one-minute cleaning cycle—all traces of contamination—including both soluble and insoluble soils—were removed, even from blind holes, interstices, crevices, screw-threads, porous surfaces.

And the best part—direct labor costs were reduced 50%; expensive solvents were eliminated; rejects due to contamination were eliminated; and the complete Bendix Sonic Energy Cleaning System was fully amortized in six months.

To help you determine if results like these are possible in your cleaning operation (and sometimes they're not), Bendix® maintains a complete Applications Laboratory to go with the industry's most complete line of Sonic Energy Cleaning equipment.



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REPORT ON SONIC
ENERGY CLEANING



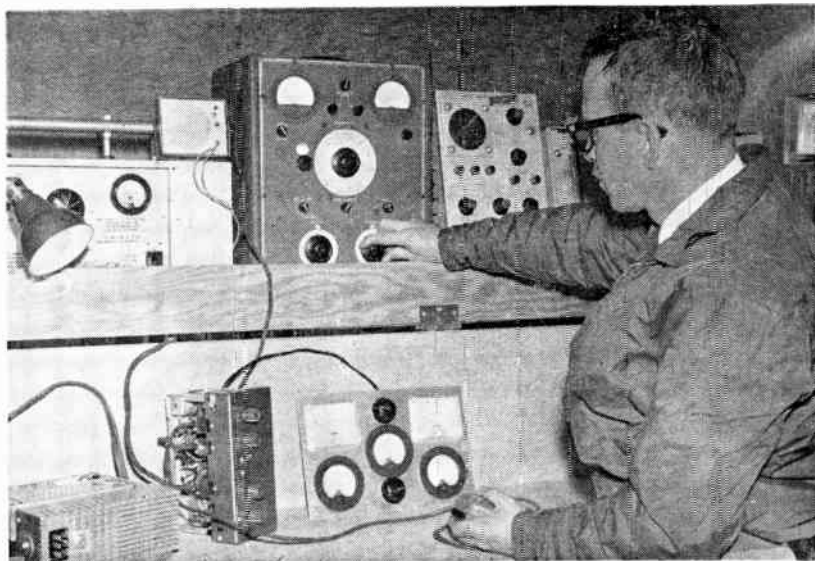
All the facts at your fingertips. Processes detailed . . . test results analyzed . . . and a Five-step Plan to help you determine if Sonic Energy Cleaning will be economically advantageous for you. Send for your free copy today. PIONEER-CENTRAL DIVISION, BENDIX AVIATION CORPORATION, 2728 HICKORY GROVE ROAD, DAVENPORT, IOWA.



SONIC ENERGY CLEANING

More Transistors for

Sales will go up as sizes go down, say makers of two-way radios. Two models are already out



Off the test bench and on to the market, transistorized radios like this GE model are seen as a factor in doubling sales by 1968

GROWING INTEREST in reduced size and power drain of two-way vehicular radios promises increased emphasis on transistorized gear in the year ahead.

Manufacturers' opinions on how big the market will be are still kept under wraps as far as exact numbers are concerned. An estimate last year by National Mobile Radio System, a user organization, was that the market for two-way radio gear would hit \$14 million by 1968. That would be double the market's present size.

Growth Factors

Other factors have come into play since this figure was stated, so the growth may go beyond NMRS' estimate. Among these are the Business Radio Service (ELECTRONICS, p 18, May 30, 1958) and the Local Government Radio Service (ELECTRONICS, p 7, June 20, 1958). Both these yearling markets are showing great promise, as are the growing police, public utilities, building trade and transportation markets.

Motorola presented its unit a few months ago. The equipment measures 3 in. high, 11 in. wide and 17 in. long. Its receiver is completely

transistorized. So is its power supply. The transmitter uses tubes, although a transistor has been used to replace a tube in the audio amplifier stage.

In all, 21 transistors are used in the entire unit.

Rated power drain of the unit while on standby is 1.82 amp, about one-third that of conventional two-way radios. The unit is available in the 24-54 mc and 147-174 mc bands. It provides 25 watts of output power in the high band and 30 or 50 watts in the lower frequencies. The receiver has an audio output of 5 watts.

A recently concluded contract provides for purchase of 78 of the new units by a large interstate trucking concern.

Market Prediction

A report to FCC by the manufacturer indicates greater optimism than was expressed a year ago by NMRS. The manufacturer predicts the number of mobile radio users will multiply four times in the next 10 years, and eight times within the next 20. Figures on present sales and production of the manufacturer units are still kept classified, al-

Mobile Radio

though one company spokesman told **ELECTRONICS** "We're shucking them out like potato chips." The firm expects to pick up "a sizable portion" of the new market.

The present per-unit price is about \$850.

Another contender for the market appeared during the middle of last month in General Electric's equipment. The unit is 8½ in. wide, 12 in. long and 4 in. high. It is available in models having 10-, 30- and 75-watt output power. The 10-watt model contains only three tubes, the two higher-powered models contain four. In standby operation, the unit draws 0.04 amp, in receive it draws 1.8 amp and 14 amp during transmission. The unit is designed to be left in standby position when the vehicle's motor is not running.

The equipment is designed to permit inclusion of selective calling features. A spokesman tells **ELECTRONICS** that the gear will be priced in the \$700 range.

Other Entries

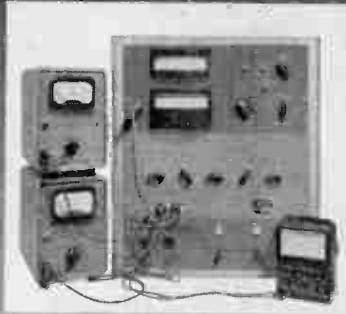
Among firms planning to enter the transistorized two-way radio market is Bendix Radio division of Bendix Aviation. Company officials report that immediate plans will center about a transistorized radio (20 in. x 10½ in. x 7 in.) for railroad use, and subsequently concentrate additional effort on the vehicular market.

Spokesmen tell **ELECTRONICS** that the firm's present market for conventional two-way gear is between \$3 and \$4 million.

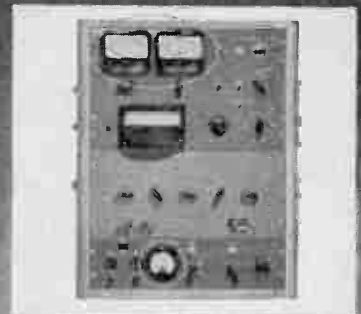
The railroad gear, which will be brought to market by year's end, will share certain common features with the proposed vehicular radios. The receiver will most likely be transistorized, as will the power supply. The transmitter modulator will also be transistorized. Output power will be in the 50-60 watt range. The unit will measure about 8½ x 13 x 5 in.

As the year goes on and new marketing data become available, other companies will probably enter this field.

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B Series ruggedized single-range AC VTVMs \$160.



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COMMERCIAL



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Model 109 1 low-level multi-range AC VTVM \$199.



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Model 125-1 Null Meter \$125.

By building-in trio labs' panel-mounting instruments you . . . customize test systems, set-ups and instruments; save space (average model is 4½" x 4" x 4"), save time with at-a-glance monitoring; save money; make monitoring foolproof ("go-no go"); improve system reliability; increase overall design freedom. Choose from many "standard" or "special" models — or consult us for new designs for your needs. Write for free "how to" Engineering Guide to Dept. E-7



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the answer to
your silicon
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Du Pont . . . manufacturer of Hyperpure Silicon offers the services of technical specialists

When you specify Du Pont HYPERPURE Silicon, you get a product of highest dependability as well as expert technical assistance, when needed. Experienced Du Pont Technical Specialists will gladly discuss techniques of crystal growing and materials processing with you. What's more, you can take advantage of Du Pont's new \$3,000,000 Technical-Service Laboratory designed for researching customer problems.

Floating zone single crystals of Du Pont HYPERPURE Silicon are available in a wide range of resistivities. Du Pont HYPERPURE Silicon is also supplied in densified cut rods . . . and rods suitable for float zone refining. They're offered in several grades with care-

fully controlled purity levels.

Here's more news: Du Pont's new Brevard, N. C., plant has a capacity of 70,000 lbs. of HYPERPURE Silicon per year. That means you're assured of a prompt supply of high-purity silicon in the form you need. For more information, write Du Pont . . . pioneer producer of semiconductor-grade silicon.



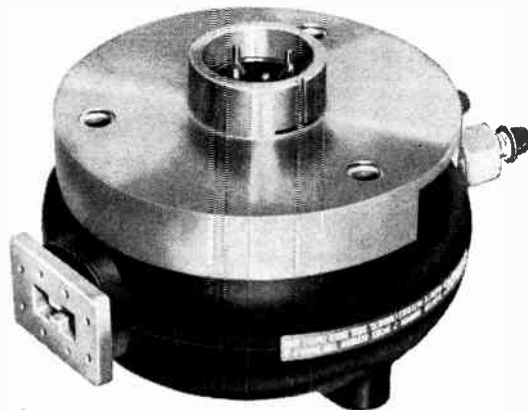
Free booklet is available upon request. It describes the manufacture, properties and uses of HYPERPURE Silicon. E. I. du Pont de Nemours & Co. (Inc.), Pigments Dept., Silicon Development Group, Wilmington 98, Delaware.

HYPERPURE SILICON



BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

SMALLEST LIGHTEST CARCINOTRONS



with wide band sole tuning

Though it has just recently made its debut into the high society of Litton microwave tubes, this M-Type carcinotron (our model L-3298) has already been commended by the military for its exceptionally clean design. Every engineer concerned with upgrading the performance of ECM equipment will surely find much of interest in this medium-power tube, with which Litton takes a major stride toward truly simultaneous noise-jamming capability by affording faster tuning rates than any previously attainable.

The Litton family of eight electrically-compatible carcinotrons is the first to incorporate the critical capability of wide band sole tuning without frequency or power holes when the tube is operated into as much as a 2-to-1 mismatch. Litton carcinotrons are the first to use wider-than-normal-band RF output couplers, minimizing many system components such as antennae, waveguide plumbing, and load isolators.

We cite these firsts not for glory's sake, but rather for their meaningful contribution to more efficient system design, smaller size and lighter weight.

The notable suitability of these carcinotrons is not limited to ECM. You can also consider them for other military applications such as drivers for communications links—in fact, wherever medium-power tubes with extremely rapid tuning and low tuning power are required. And while you are considering, remember: these versatile tubes are not just drawing-board products—you can order them now.

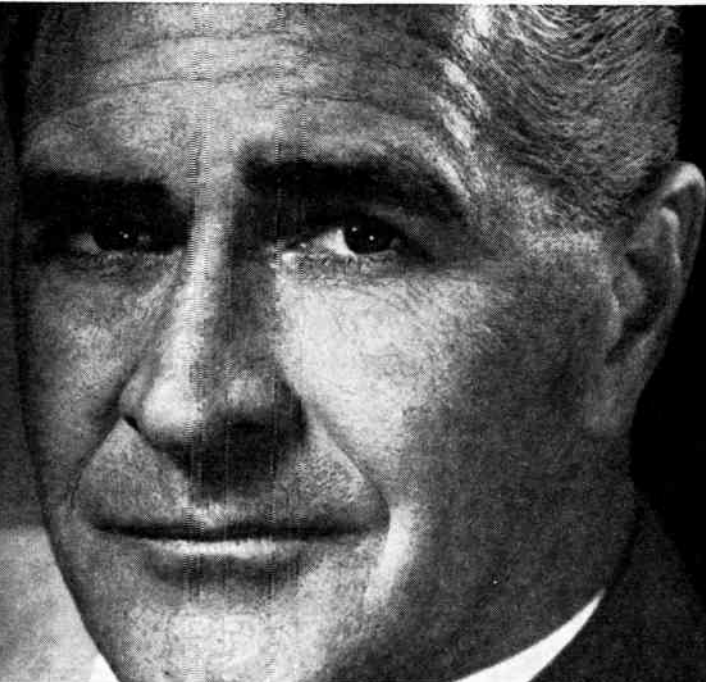
Feel free to lodge your inquiry about voltage-tuned power oscillators of whatever nature with us at Litton Industries Electron Tube Division, Office E17, 960 Industrial Road, San Carlos, California. Your request for our newest catalog or for answers to your specific questions will be honored promptly.



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PLANNING**



3.5-millimicrosecond risetime

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**TWO NEW
OSCILLOSCOPES**



TYPE 581

The Tektronix Type 581 is a new laboratory oscilloscope with many of the capabilities needed in the current rapid advancement of the electronic art. Its 3.5-m μ sec risetime, 0.1-v/cm sensitivity, and 0.01- μ sec/cm sweep time are excellent features for modern high-speed pulse applications. In addition to these unique features, the Type 581 also has the slow sweeps, versatile triggering, and dc-coupled vertical-deflection system needed for most general-purpose laboratory work. A new series of Tektronix plug-in preamplifiers promises outstanding signal-handling versatility for an oscilloscope with a vertical passband of dc to approximately 100 mc.

With the Type 80 Plug-In Preamplifier and Type P80 Probe the basic vertical-deflection factor is 0.1 v/cm with input impedance of 10 μ f paralleled by 100 kilohms. Five snap-on probe attenuator heads provide deflection factors of 0.2, 0.5, 1, 2, and 5 v/cm at input impedances ranging up to 1.5 μ f paralleled by 5 megohms. A fixed balanced delay line is incorporated in the main vertical amplifier.



The cathode-ray tube is a lumped-constant traveling-wave type with 10-kv accelerating potential.

The wide sweep range of the Type 581 includes sweeps fast enough to take advantage of its risetime capabilities. Calibrated range is 0.05 μ sec/cm to 2 sec/cm in 24 steps, with 5-x magnifier to increase calibrated range to 0.01 μ sec/cm. Sweep time is continuously adjustable between steps. Versatile triggering includes amplitude-level control, and preset stability for operating convenience. Lockout-reset circuitry provides for one-shot sweep operation.

TYPE 585

The Tektronix Type 585 has, in addition to the identical general specifications of the Type 581, a second time base generator. This time-base generator, designated TIME BASE B, acts as a delay generator, providing a wide range of calibrated sweep delay. Two modes of sweep delay are available—triggered (delayed sweep is started after the

delay period by the signal under observation), and conventional (delayed sweep is started at the end of the delay period by the delayed trigger). Calibrated sweep delay is continuously variable over the range of 1 μ sec to 10 sec. Color-correlated controls eliminate confusion, making this new high-performance oscilloscope easy to operate.

PRICES

| | |
|--|--------|
| TYPE 581, without plug-in units. | \$1375 |
| TYPE 585, without plug-in units. | 1675 |
| TYPE 80 Plug-In Preamplifier. | 50 |
| TYPE P80 Probe, with 5 attenuator heads. | 100 |

(Both Preamplifier and Probe are needed to operate the Type 581 and Type 585.)

Other Plug-In Preamplifiers are currently in development. prices f.o.b. factory

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Components Pass 600 F Test

AIEE Pacific meeting hears details on Air Force's high-temperature equipment program

SEATTLE—Electronic components are now available for circuits required to operate in the 600 to 650 F ambient temperature range, declared K. A. Teumer of Sundstrand Aviation at a recent AIEE meeting here.

He made the statement at a session on high-temperature equipment dealing with the Air Force program being undertaken to develop gear capable of operating at 600 F temperatures.

"System Feasible"

J. J. Pierro of North American Aviation reported "there is little doubt that a 600-F generating and distribution system is feasible."

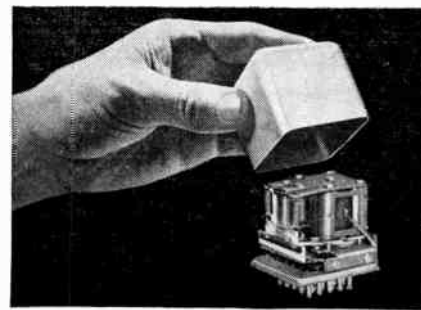
W. F. Bonwitt and H. Buttner of the Burndy Corp. said "terminals

and splices will be of the crimp type, made of copper or nickel."

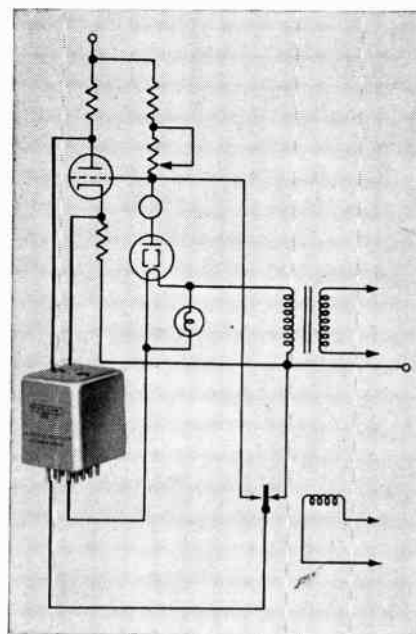
Electronics figured prominently in the program of the AIEE's Pacific general meeting.

Model Generator

Niles F. Schuh, manager of the Westinghouse Space Technology Engineering department, and Ralph Tallent, research engineer with the Boeing Airplane Co., showed a working model of a solar-powered thermoelectric generator and discussed findings that indicate the system is a practical source of electric power in space. Weighing three lb and measuring 20 in. in length, the model is capable of converting the sun's energy into 2.5 watts of power, they said.



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down to $\pm 0.05\%$
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The sensitive yet rugged REGOHM controls input voltage to eliminate the power-source variations which cause premature tube failure. Automatic and precise, this plug-in unit assures constant voltage input.

More and more designers are including REGOHM in circuits, because of its:

- STEPLESS CONTINUOUS CONTROL
- WIDE FREQUENCY RANGE
- PERMANENT ADJUSTMENT
- FREEDOM FROM MAINTENANCE
- RUGGED DESIGN
- LIGHT WEIGHT
- LONG LIFE
- LOW COST

Design data, performance specs and case histories of those applications you wish to explore will be sent on request.

REGOHM

ELECTRIC REGULATOR CORPORATION
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Reins for 6,000,000 Horses



Automatic dispatch system built for Chicago's Commonwealth Edison by General Electric regulates production of electricity in ten generating stations with combined capacity of over 4.6 million kilowatts (over 6 million horsepower). Computer-controller, pictured, selects which of 37 turbine generators can produce additional required power most economically, conversely cuts most costly units first when reducing power. Computer determines needed increment and translates it into cost-of-power bid; control equipment assigns load. Minute-to-minute load variations can exceed 50,000 kw. Cost of control system: about \$700,000

BIRD

"ThruLine" DIRECT READING Directional RF WATTMETER

MODEL 43

An insertion type instrument used to measure forward or reflected power in coaxial transmission lines in the frequency range 25 to 1000 mc. Directional selectivity is accomplished by fingertip rotation of element to point arrow in direction of power to be measured. Calibration charts or full scale meter adjustments are not needed for this direct reading instrument.

The lightweight and portable Model 43 may be used on mobile or fixed equipment. It is recommended for accurate measurement of forward or reflected power...transmission line loss...insertion loss of components, such as filters, connectors, switches, relays, etc... antenna matching work...continuous monitoring of transmitter output and...VSWR in complete systems in operation.



S P E C I F I C A T I O N S

Each model 43 Directional Wattmeter is made up of a line section, an indicating meter and plug-in measuring elements all contained in an aluminum case.

ELEMENTS: Available in the combinations of power and frequency ranges listed below:

FREQUENCY RANGE: 25 to 1000 mc in five ranges: (25-60mc) (50-125mc) (100-250mc) (200-500mc) (400-1000mc)

POWER RANGE: 10 to 500 Watts in six ranges: (10W) (25W) (50W) (100W) (250W) (500W)

ACCURACY: $\pm 5\%$ of full scale
VSWR: Below 1.05 for complete unit and two connectors.

QUICK-CHANGE CONNECTORS: Two TYPE "N" FEMALE connectors which mate with UG/21/8 are supplied **UNLESS OTHERWISE SPECIFIED.** Optional: (Male or Female "HN") (Male or Female "C") (Male "N") and (Female UHF: SO-239)

WEIGHT: 4 pounds
DIMENSIONS: 7" x 4" x 3"
Complete Specifications BULLETIN #436 Sent on Request.

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MEETINGS AHEAD

July 30-31: Computers & Data Processing, Denver Research Inst., Stanley Hotel, Estes Park, Colo.

Aug. 4-5: American Astronautical Society, Western National Meeting, Ambassador Hotel, Los Angeles.

Aug. 17: Ultrasonics, National Symposium, PGUE of IRE, Stanford Univ., Palo Alto, Calif.

Aug. 18-21: Western Electronics Show and Convention, WESCON, Cow Palace, San Francisco.

Aug. 23-26: Electrical Conf. of the Petroleum Industry, AIEE, Wilton Hotel, Long Beach, Calif.

Aug. 23-Sept. 5: British National Radio & Tv Exhibition, British Radio Industry Council, Earls Court, London.

Aug. 31-Sept. 1: Elemental and Compound Semiconductors, Tech. Conf., AIME, Statler Hotel, Boston.

Aug. 31-Sept. 2: Army-Navy Instrumentation Program, Annual Symposium, Douglas Aircraft and Bell Helicopter, Statler-Hilton, Dallas.

Sept. 1-3: Association for Computing Machinery, National Conf., MIT, Cambridge, Mass.

Sept. 7-12: Machine Searching and Translation, International Conf., Western Research Univ., Rand Devel. Corp., Western Reserve Univ., Cleveland.

Sept. 14-16: Quantum Electronics, Resonance Phenomenon, Office of Naval Research, Shawanga Lodge, Bloomingburg, N. Y.

Sept. 15-17: Electronic Exposition, Twin Cities Electronic Wholesalers Assoc., Municipal Auditorium, Minneapolis.

Sept. 17-18: Nuclear Radiation Effects in Semiconductors, USASRD, Western Union Auditorium, N. Y. C.

Sept. 21-25: Instrument-Automation Conf. & Exhibit, ISA, International Amphitheater, Chicago.

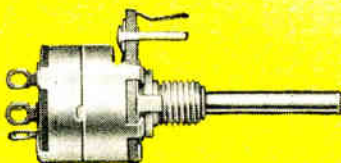
Oct. 12-15: National Electronics Conference, IRE, AIEE, EIA, SMPTE, Sherman Hotel, Chicago.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 78.

5/8" DIA.

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When the "package" calls for something smaller . . . when the circuit calls for dependability . . . Stackpole **F-Series Controls** lead the way. Used on everything from transistor auto sets and pocket portables to electronic organs, these fully-proved miniature variable resistors provide quiet, reliable operation.

Stackpole F Controls are conservatively rated at 0.3-watts. They're available with threaded bushings, fold-tab, or twist-tab mounts as well as with standard lugs, printed wiring or solderless-wrap terminals.

DP-ST and SP-ST "B"-Series Switches perfectly complement the small size of F Controls and give the tease-proof, positive feel and audible "click" only a true snap-action switch can provide. They're U.L. Inspected for 1 ampere at 125 volts ac-dc; 4 amperes at 25 volts dc.

For those who have no miniaturization problems, however, Stackpole also produces a complete line of standard-size single and dual controls. Send today for full details. *Electronic Components Division, STACKPOLE CARBON COMPANY, St. Marys, Pa.*

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VARIABLE composition RESISTORS

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FIXED COMPOSITION RESISTORS • ELECTRICAL CONTACTS • CERAMAGNET® CERAMIC MAGNETS • BRUSHES FOR
ALL ROTATING ELECTRICAL EQUIPMENT • HUNDREDS OF RELATED CARBON GRAPHITE AND METAL POWER PRODUCTS



NEW FROM PHILCO

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SWITCHES**

| Type Number | h_{fe} | Typical Power Gain | Typical Switching Times (Saturated Test Circuits) |
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| 2N1199 | 12-60 (DC) | | t_r 35 μ sec t_s 10 μ sec t_f 25 μ sec |
| 2N1267 | 6-18 | } 25 db at 4.3 mc | |
| 2N1268 | 11-36 | | |
| 2N1269 | 28-90 | | |
| 2N1270 | 6-18 | } 25 db at 12.5 mc | |
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AMPLIFIERS**

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This high speed switch has exceptionally low saturation voltage (typically 0.125 V), permitting *practical* design of 5 mc pulse circuits, using conventional saturated switching configurations. 30 mc pulse rates are obtainable in *practical* circuits using non-saturating techniques.

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The excellent high frequency response of these transistors makes practical the design of high performance communications systems at frequencies up to 60 mc. They have the same low collector capacitance and are available with restricted beta ranges.

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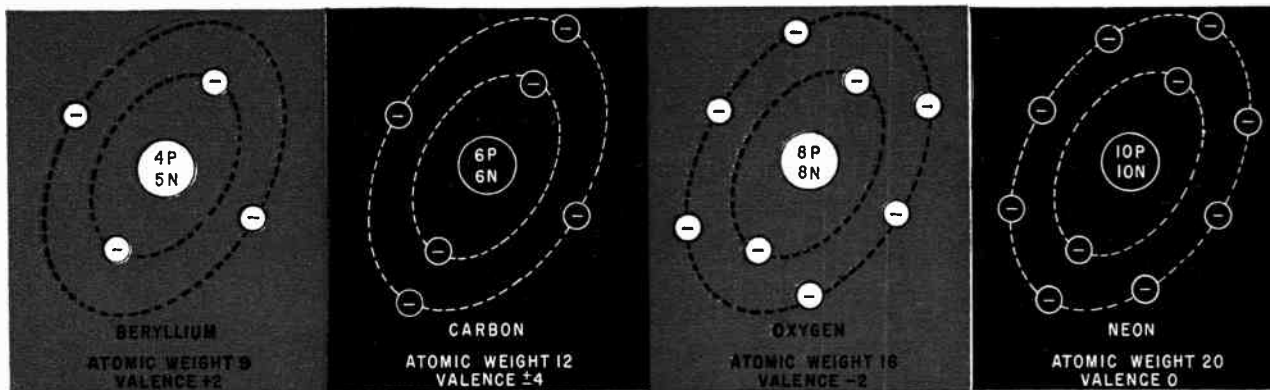


FIG. 1—Oxygen and beryllium can share each other's valence electrons to form stable compound BeO

New Frontiers for Semiconductors

To aid in understanding the relationship between the various elements and their performance in semiconductor devices, a detailed study is made of the periodic table of elements. Examination shows other semiconductor elements besides the relatively well-known ones are possible

By **CHARLES A. ESCOFFERY**, International Rectifier Corp., El Segundo, Calif.

FUTURE DEVELOPMENTS in the field of semiconductors are dependent upon a better understanding of the periodic table of the elements. Though first discovered during the early 1800's, electrical semiconductors were not put to practical use until almost 100 years later. Vacuum tubes soon replaced them and except for photocells and low-power rectifiers, little use was made of semiconductors until the high-frequency requirements of radar made it imperative that some device having a faster response than was available with tubes be developed.

The problem was then attacked jointly by solid state physicists and by chemists, and a theory of semiconduction evolved which has permitted the development of a group of semiconductors and semiconductor devices. These new devices have revolutionized the field of electronics. An understanding of this theory will help electronic engineers to apply

these new devices more effectively and will certainly aid in increasing their contributions to the development of new semiconductors.

PERIODIC TABLE—The internal action of semiconductors can be explained by the periodic table of the elements (front cover). The periodic table is an arrangement of the known chemical elements in order of increasing atomic number, the latter being defined as the number of units of free positive electricity in the nuclei of the atoms.

The elements are placed in horizontal rows called periods, each period beginning with an inert gas. The vertical columns are the period groups or families and, in general, the elements that fall in a given column have similar chemical and physical properties. The group of inert gases, shown in the column headed O, are termed inert because their outer or valence

shells are complete giving them a valence of 0. Having zero valence, these gases do not react chemically with any other substances and, therefore, form no compounds. The other groups of elements are fairly similar within each column, because they have the same number of valence electrons in their outermost shells.

ATOMIC STRUCTURE—A representation of atomic structure of various elements is illustrated in Fig. 1. Atoms tend to either gain or lose their valence electrons until the outermost shell contains eight electrons. Thus, if oxygen and beryllium share each other's valence electrons then the outer shells of both atoms will be filled and the two elements will form the stable compound, BeO.

Outer shell completeness is also of importance in the flow of electrical current which has been satisfactorily represented as the flow of electrons. If all of the outer shells of the atoms are filled, then there

are no free electrons and thus no electrical particles to cause current flow unless some electrons are knocked loose from their positions. If an electron is subjected to a sufficiently strong force, it may be pushed out of its position and become available to contribute to the flow of current. The required force is related to the so-called energy gap, an important parameter in semiconductor theory.

If a large electrical force is required to knock an electron loose, the material is termed an insulator; if no energy is required to knock it loose, it is termed a conductor; and if only a little energy is required, it is termed a semiconductor. Insulators have energy gaps of several electron volts and semiconductors energy gaps in the general range of one eV. Unfortunately, no reliable method has yet been discovered to forecast the energy gap of a proposed compound; therefore, this property is determined empirically.

SILICON—If an element such as silicon is obtained in its pure state, neighboring atoms will share the eight valence electrons and there will be no free electrons left over. The energy gap for pure silicon, however, is small. Although a perfect silicon crystal would be an insulator at zero degrees K, the thermal agitation at room temperature is sufficient to knock a few electrons out of their orbits. Thus, pure silicon acts as a semiconductor at room temperatures though it would conduct only a small amount of current. The current-carrying capacity can be increased by supplying a greater number of free electrons which can be done in a number of ways.

One way is by replacing some of the atoms of silicon (column IV in the periodic table) with atoms of an element from column V (such as arsenic). The arsenic atom fits into the crystal lattice, displacing one atom of silicon. For each atom of arsenic there is one surplus electron available for current flow, as there is no adjacent matching electron for the fifth electron in the valence ring of the arsenic atom as shown in Fig. 2. The proportion of the arsenic atoms to the silicon atoms must be carefully controlled for, if there are too many of them, the resulting material will not have the desired properties and will not act as a semiconductor. It has been found experimentally that impurity atoms in the ratio of about 1:10,000,000 seem to give the best results for this particular combination.

The foregoing illustrates the immense job which confronted the chemist in producing satisfactory materials for the production of semiconductors. It also shows the extent of the job still confronting chemists in producing new combinations that may be tested for their semiconductive properties.

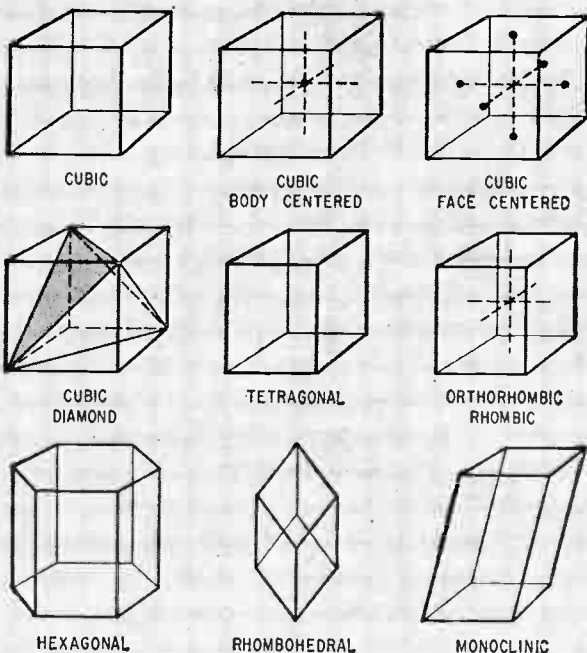
Pure silicon, shown in Fig. 3, (impurities less than 1:100,000,000) with the correct amount of arsenic added, produces a substance with an energy gap of 1.1 eV which qualifies it as a semiconductor. If a conductor is attached to each side of the semiconductor and a potential is applied, an increase in the concentration of electrons at one of the junctions will cause the surplus electrons to jump to the next group pushing those excess electrons to the next, where the process is repeated. Thus, a flow of current exists and can be in only one direction.

THE FRONT COVER—NOTES TO THE PERIODIC TABLE

CRYSTAL LATTICE—Conventional diagrams are used to represent the space lattice of typical crystal forms. The crystal lattices have been determined by X-ray diffraction analysis. Important among the factors which determine the crystal lattice type an element will possess are numbers of valence electrons and atomic radius.

CONVENTIONAL DIAGRAMS OF CRYSTAL FORMS—

The following diagram illustrates the various crystal forms:



PROMETHIUM—Element 61, promethium, was produced artificially in 1946 by fission of uranium. The names Illinium and florentium were proposed for the naturally occurring isotope. Its discovery in 1926 is questionable.

TEMPERATURE—The thermometer is used to indicate the melting and boiling point, in degrees C, of the various elements as far as known.

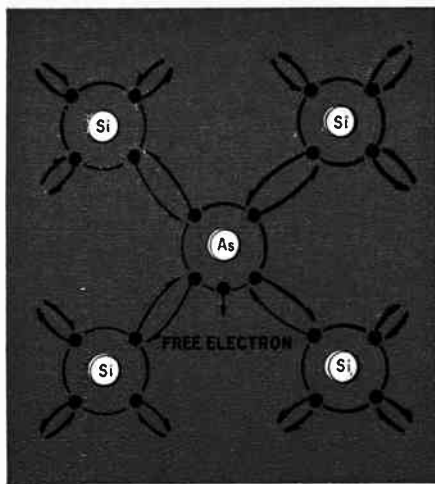


FIG. 2—Arsenic atom fits into silicon crystal lattice to increase number of free electrons

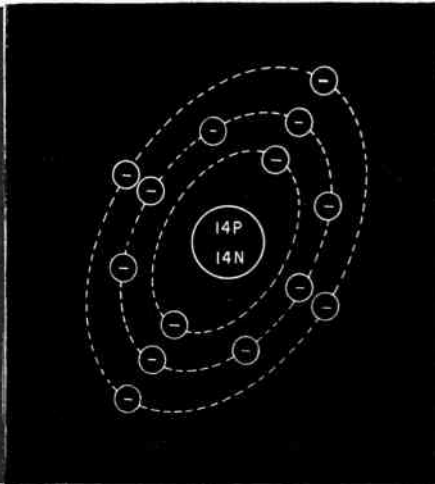


FIG. 3—Pure silicon atom having an atomic weight of 28 and a valence of 4

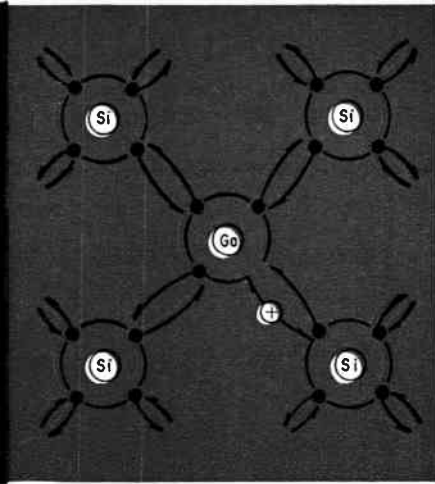


FIG. 4—Gallium added to silicon showing how hole is generated

CURRENT FLOW—Electric current is the flow of electrons and one ampere is, by definition, a flow of 6.24×10^{18} electrons per second. If a group of free electrons in a material has a conductor with a negative potential attached to one side, forces will be exerted on the electrons. The negative potential, caused by a concentration of electrons in the conductor, will cause the free electrons near the point of attachment of the negative conductor to move away. This action will leave vacancies where the electrons were. These vacancies will be quickly filled by other electrons repelled from the end of the attached negative conductor. The moving free electrons will then cause other free electrons ahead of them to move on because of the repelling force exerted by their nearness. Thus a flow of electrons (current) occurs.

SEMICONDUCTORS — Recalling the elementary theory of semiconduction, if instead of arsenic, gallium (or some other element from column III) were added to the silicon, instead of an excess electron a vacancy in the particular outer ring shared by the atom of gallium would occur. This gives rise to the term *hole* represented by the symbol + in Fig. 4.

Materials which donate electrons are called *donors* and the semiconductors are known as *n* type. Materials which attract and accept the electrons in their travel through the semiconducting material because of the *holes* are called *acceptors*. This type of semiconductor, characterized by a lack of electrons or an excess of holes, is termed *p* type.

In the case of *p* semiconductors the electrons in the end of the negative attached conductor will be both pushed by the negative charges behind them and attracted by the positive holes in front. In this way there will again be a flow of electrons across the semiconductor.

Applying this general philosophy it would appear that every member of column IV would be a potential semiconductor. There is another point, however, which must be considered, and that is the differing properties of subgroups A and B of the different columns shown in Fig. 5. The elements in the subgroups A are largely metallic and conducting. The elements which form nonmetallic crystals are principally the lower atomic number elements in subgroups B of columns IV, V and VI. It is from these groups that the elemental semiconductors must be drawn.

The elements in column IVB are given in Table I and of these all are semiconductors. Germanium is perhaps one of the most important of the present semiconductor materials. The energy gap is in the correct range, it has good carrier mobility and the technique of growing high purity crystals of this element has been well developed.

HIGH TEMPERATURE COMPOUNDS—Silicon is also an important semiconductor. It has a much higher melting point than germanium, a high band gap and a low intrinsic conductivity. These properties indicate the possibility of rectifiers and transistors which will operate well at high temperatures. Work which has been done with silicon substantiates this prognostication.

The other two elements of this group have also shown semiconductor properties; tin in the form of gray tin and carbon in the form of diamond. Diamond has a high energy gap and in the pure state is actually an insulator, but natural diamonds contain relatively large amounts of impurities. These impurities serve as carriers and practically all of the conductivity in diamond is due to their presence. As might be expected from the high energy gap value, diamond conducts only at higher temperatures since more thermal energy is required to provide free electrons for current flow.

Table I—Semiconducting Properties of Group IV-B Elements at Room Temperature

| Energy Gap (ev) | Element | Mobilities (cm ² /v-sec) | |
|-----------------|------------------|-------------------------------------|-------|
| | | Electrons | Holes |
| 6 | carbon (diamond) | 1,800 | 1,200 |
| 1.1 | silicon | 1,200 | 500 |
| 0.7 | germanium | 3,800 | 1,900 |
| 0.08 | tin (gray) | 2,000 | 1,000 |

rials problem and this places the bulk of the load on the chemist and the metallurgist. Pure compounds must be produced for testing, preferably in monocrystalline form and then carefully controlled infinitesimal amounts of specific elements must be added to the prepared compounds. Some of the more promising of the known semiconducting compounds are difficult to synthesize in the required range of purity (99.99999 percent pure) making the assemblage of the desired data a slow process. This factor also makes for expensive semiconductors.

Referring once again to the periodic table note that a number of elements seem to have excellent possibilities in the field of semiconductors. Boron, in Group IIIB, is an element which is being investigated because of certain favorable properties. As chemical techniques are developed this element will become quite important in the field of semiconductors.

Another material that is being looked into is silicon carbide, a compound of two elements of Group IVB. Although widely used for years in lightning arresters and also as an abrasive (Carborundum), it is only quite recently that scientists have been able to grow high-purity single crystals. Extensive and intensive research is being conducted and it is expected that silicon carbide will become a prominent member of the semiconductor family.

Selenium and tellurium are found in column VI. Selenium has been used in rectifiers and photocells for many years and is one of the most important and widely used of the semiconductor materials. Though it has been used and studied extensively it is still the least understood of the presently known important semiconductor materials because of its extreme complexity. As solid state theory develops and selenium becomes better understood it will undoubtedly be even more widely utilized.

Tellurium is also a semiconductor. In accordance with the theory that elements in a column become more metallic with increasing atomic weight, tellurium has a smaller energy gap than selenium, that is, 0.33 ev as compared with about 1.6 ev.

LANTHANIDE COMPOUNDS—The next group of potential importance is the lanthanide series (rare earth elements). These elements all have a principal valence of three while four of them have secondary valences of four. Some excellent semiconductor compounds may come out of this group at some future date. Research work is being conducted which indicates that certain compounds of the rare earth metals with elements from Group VIB have semiconducting properties with high melting points and good thermal stability.

RADIOACTIVE COMPOUNDS — The last group which would appear to have a particular potential is the actinide series. In this group occur elements with principal valences of both three and four which would indicate good semiconductor possibilities. Most elements in this group are radioactive. Present indications are that radioactivity is especially detrimental to semiconductivity; however, this might not be the case if the semiconductor itself is the producer of the radioactivity.

Table III—Characteristics of Selected Semiconductor Compounds

| Compound | Groups | Energy Gap (ev) | Mobilities (cm ² /v-sec) | |
|-----------------------------------|-------------|-----------------|-------------------------------------|-------|
| | | | Electrons | Holes |
| AgTlTe ₂ | I, IV, VI | 0.1 | | |
| Bi ₂ Se ₃ | V, VI | 0.35 | 600 | |
| Bi ₂ Te ₃ | V, VI | 0.15 | 800 | 400 |
| Cd ₃ As ₂ | II, V | 0.6 | | |
| CdSb | II, V | 0.5 | | 400 |
| Cs ₂ Sb | I, V | 1.0 | | |
| CuAlS ₂ | I, III, VI | 2.5 | | |
| CuFeS ₂ | I, VI, VIII | 0.5 | | |
| CuInSe ₂ | I, III, VI | 0.9 | 300 | |
| HgIn ₂ Se ₄ | II, III, IV | 0.6 | | |
| LiMgBi | I, II, V | 0.4 | | |
| Mg ₂ Ge | II, IV | 0.74 | 520 | 100 |
| Mg ₂ Sb ₃ | II, V | 0.8 | 80 | 20 |
| Mg ₂ Si | II, IV | 0.77 | 370 | 70 |
| Mg ₂ Sn | II, IV | 0.33 | 320 | 260 |
| PbS | IV, VI | 0.34 | 600 | 250 |
| PbSe | IV, VI | 0.22 | 1,200 | 475 |
| PbTe | IV, VI | 0.27 | 1,200 | 850 |
| Sb ₂ Te ₃ | V, VI | 0.3 | | 270 |
| SiC | IV, IV | 3.0 | 50 | 10 |
| ZnSb | II, V | 0.6 | 60 | 340 |

LOOKING AHEAD—The bulk of the work being done at present in the furtherance of the science of semiconductors is being done by both chemists and physicists and will no doubt continue to be done by them. Tremendous new developments can be expected when the solid state physicist, in conjunction with the chemist, ceramicist and physical metallurgist, has further perfected the theory of semiconductor operation and the techniques of producing the necessary crystals. The periodic table of the elements plays an important part in indicating which new compounds may demonstrate good semiconductive properties and will play an even more important role when semiconductor theory is further developed.

The future potential of semiconductors is tremendous. They have already made an impact which has reverberated through all phases of industrial endeavor and this is only the beginning. Every engineer, and particularly the electrical engineer, can think of many possible fields of application of devices incorporating semiconductor properties. One of the most intriguing of these is in conjunction with the forces of nuclear energy. The effective utilization of nuclear energy is hampered particularly by the difficulty of converting this energy into useable forms and the difficulties of guarding against harmful radiation. Both personnel and equipment must be protected from the radiation. It is possible that someday semiconductors may be developed to absorb this presently harmful radiation and convert it directly to electrical energy. Thus it may someday be possible to solve two troublesome problems at the same time and thus open a whole new era of electrical and industrial development.

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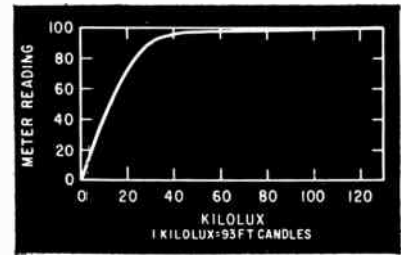
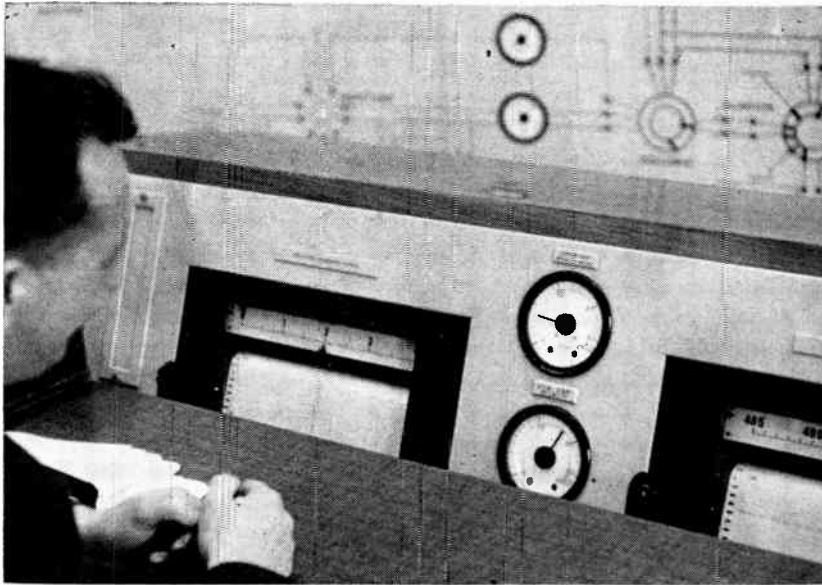


FIG. 2—Non-linear response shows limiting effect of photocell series resistor

Control desk daylight indicators compare London (25 miles away) light intensity with local light intensity

Intensity at a Distance

level on C_2 makes the low noise signal negligible. Residual variation will be averaged out in the meter stage.

When the plate supply is regulated, the circuit is largely self-compensating for tube aging. During oscillation, the drop across the tube is very small compared to that across the primary of T_1 , so that a large change in the emission characteristic of the tube, and therefore the plate-cathode voltage drop, will produce only a small change in the drop across T_1 and of the charge stored on C_2 .

Reduction of tube emission will be accompanied by a reduction in transconductance to produce a longer rise time for the cathode voltage with a correspondingly longer period during which grid current may be drawn through R_2 in series with the internal tube grid-cathode forward impedance. Resistor R_2 should have a high-stability pattern. The small error in the charge on C_2 is covered by the slight raising of the point in the characteristic at which tube gain is just sufficient for oscillation to occur. This requires that discharge of C_2 through the photocell must continue for a slightly longer period to reach that point.

Since a variation in heater voltage has the effect of changing the emission and transconductance of the tube, the circuit is also free from drift over normal power line variations. The value of plate voltage determines the pulse amplitude and therefore the peak voltage left on C_2 . Stabilization of the plate supply determines the accuracy of the instrument.

Some inaccuracy will occur due to drift of the photocell¹. This may be reduced by using an optical filter to operate the photocell at low light intensity level, and by using the whole surface area of the photocathode. Except at very low cathode currents, the voltage across the photocell is small. Application of reverse voltage across the photocell is avoided by use of filter network R_1 and C_3 .

Meter Circuit

Each blocking oscillator pulse has constant amplitude and duration but the interval between the pulses varies with illumination level. Diode D_1 supplies an averaging time-constant network consisting of C_3 , R_3 , C_1 , and R_1 . The smoothed direct voltage obtained increases linearly with pulse rate up to the saturation value. This voltage is ap-

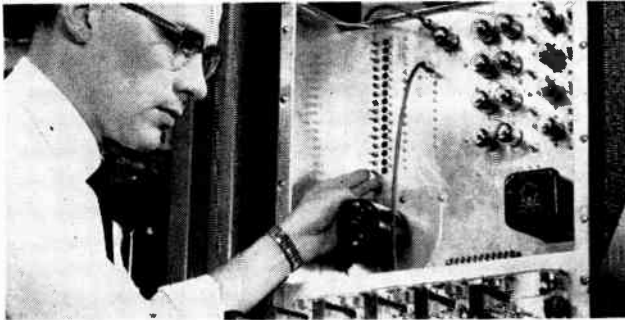
plied through cathode follower V_{2B} to operate the meter. The cathode follower uses approximately 95-percent negative feedback. Using this type circuit, drift involving 20-percent drop in tube emission and transconductance produces a change in zero setting of about 1-percent full scale and a meter indication which will be 1-percent low of indicated value. Better performance may be obtained by using a White cathode follower⁵ or other comparable cathode follower⁶. Potentiometer R_4 is used to compensate for line resistance.

If a linear relationship is required between light intensity and meter indication, removal of R_4 and reduction of R_1 coupled with a decrease in viewing aperture will produce this effect.

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- (1) E. F. Hasler and G. Spurr, Light Intensity Meters for Local and Remote Indication, *Electronic Engineering*, 30, p 690, Dec. 1958.
- (2) E. F. Hasler and G. Spurr, Improvements Relating to Apparatus for the Measurement of Radiation, British Patent Spec 786, 196.
- (3) Cathode Ray, The Blocking Oscillator, *Wireless World*, 63, p 285, June, 1957.
- (4) K. M. Greenland, Photoelectric Cells, *Control*, 2, Feb. 1959.
- (5) J. B. Earnshaw, Stacked Valve Circuits, *Electronic and Radio Engineer*, 34, p 404, Nov. 1957.
- (6) R. Benjamin, Electronic Switch Doubles as Cathode Follower, *ELECTRONICS*, 31, p 81, Jan. 17, 1958.

Testing High-Speed



Engineer uses switches to change word generator output

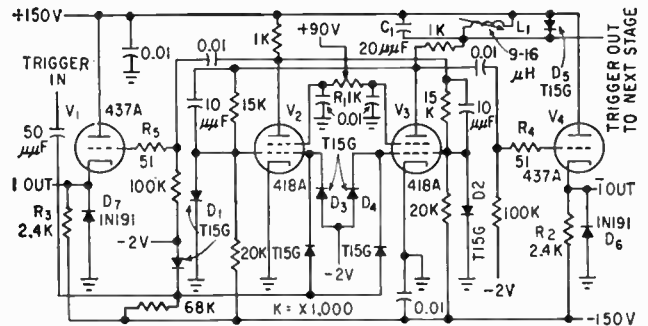


FIG. 2—One of four identical binaries used in word generator

DEVELOPMENT of high-speed computer circuits requires the use of pulse sources which simulate the expected input and are capable of driving the circuit under test. The word generator described here provides 16-bit serial binary words at a 10-mc rate. Any of the 65,536, (2^{16}), possible 16-bit words are available through manual selection and the word selected repeats every 1.6 microseconds.

Word Generator

A logic diagram of the system is shown in Fig. 1. The high-speed, four-bit binary stage triggered by the 10-mc clock is run at 50-percent duty cycle to provide the necessary inputs to the four to sixteen translator. The translator combines the eight binary outputs in such a manner as to provide 16 separate and consecutive time intervals which are then used to gate the 10-mc clock. Clock gating is done in the same 16 AND gates that select the 16 time intervals.

The 16 AND gate outputs are then combined in an OR gate, the output of which feeds the cathode follower output stage. Pulses reaching the OR gate are selected by manually switching the pull-up voltages to the 16 AND gates.

Figure 2 is a schematic diagram of one of four identical binary stages used in the word generator. These binary stages derive their speed from the use of high-transconductance 418A tubes. The 418A tube is an extremely rugged tetrode with a transconductance of 26,500

micromhos. The binary circuit is a conventional type designed around this tube. Pentodes are used to make the Miller effect in the grid circuits negligible and to allow use of smaller commutating capacitors. The high transconductance results in a large plate swing for a small grid voltage change and reduces the regeneration time.

Diodes D_1 and D_2 catch the control grids at ground to prevent operation of the 418A tubes with the control grid positive with respect to the cathode. The control grids are also caught at -2 v by D_3 and D_4 to insure that the grid circuit capacitance never has to recover from a large negative bias charge. In effect, these diodes catch the plates and limit the range through which the binary has to operate when chang-

ing from one state to the other.

Potentiometer R_1 in the screen circuit of the binary stage is used to adjust the binary for small variations in tubes and components.

Since the binaries always work on a 50 percent duty cycle, all of the coupling capacitors reach a quiescent condition and the problems encountered in binary circuits that must respond to random pulse inputs are not present here.

The trigger pulse for the next binary stage is developed across variable inductor L_1 and capacitor C_1 in the plate circuit of the normally off portion of the binary. Inductor L_1 and C_1 form a parallel resonant circuit which rings when the current through it is cut off. Diode D_5 damps out the ringing after the first positive pulse. This first positive pulse is used to trigger the next binary stage. The variable inductor L_1 allows the resonant frequency of the circuit to be changed and provides a convenient method of adjusting the delay between binary stages.

Plate signals from the binaries are a-c coupled to the cathode follower stages which are used to drive the translator.

Cathode Followers

The cathode followers use 437A tubes. The cathode circuits are clamped to ground through R_2 and R_3 and the -150 -v source, and by diodes D_6 and D_7 . Resistors R_2 and R_3 are also the pull-down resistors for the AND gate structure in the translator. The grids of the cathode

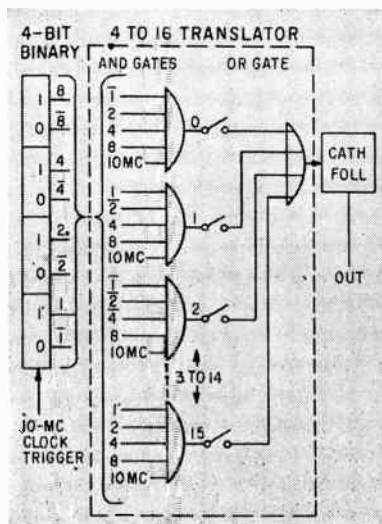


FIG. 1—Generator words are selected in translator by manual switching

Digital Computer Circuits

Here's a convenient way to check out an automatic computer or other fast digital equipment. Any one of more than 65,000 sixteen-bit words can be selected and fed in at the rate of 10 mc. Secret of high-speed operation lies in use of high transconductance tetrodes in the binary stages

By **ROBERT G. NORQUIST,**

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followers are returned to -2 v to protect the 437A tubes in the event of binary signal loss. Resistors R_1 and R_2 are parasitic suppressors.

In the usual four to sixteen translator a 0 pulse is made from the $\bar{1}$, $\bar{2}$, $\bar{4}$ and $\bar{8}$ pulse waveforms. Since this binary counter is going at a 10-mc rate and the minimum trigger delay between binary stages is in the order of 25 millimicroseconds, it is impossible to switch all of the binary stages fast enough to use a conventional four to sixteen translator. For this reason the delay between binary stages is purposely lengthened to one bit time by means of the triggering system previously described such that the wave forms into the translator are as shown in Fig. 3A.

There is a one bit time delay between the binary output waveforms. Outputs 2 and $\bar{2}$ are delayed one bit time from 1 and $\bar{1}$; 4 and $\bar{4}$ are delayed one bit time from 2 and $\bar{2}$ and hence two bit times from 1 and $\bar{1}$; 8 and $\bar{8}$ are delayed one bit time from 4 and $\bar{4}$. With these inputs to the translator a pulse in the zero position is made, as shown in Fig. 3B, from an AND gate with inputs $\bar{1}$, 2, 4, 8 and 10-mc clock pulse.

Translator

A partial schematic of the translator is shown in Fig. 4. Conventional diode switching is used to accomplish the AND and OR functions in the translator. Sixteen manually operated switches are provided to disable the AND gate func-

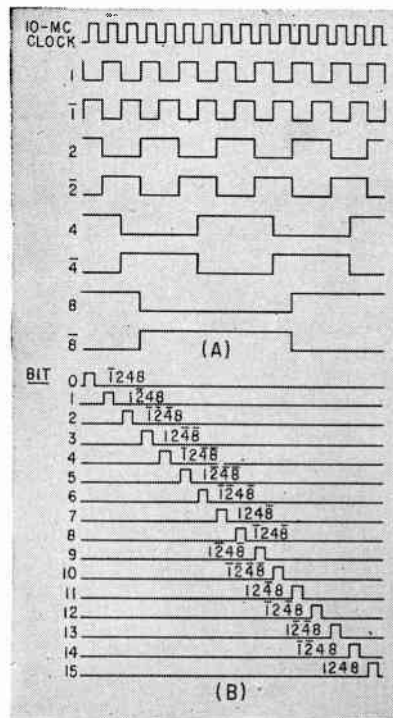


FIG. 3—Translator input (A) and output (B) waveforms

tion by removing the pull-up voltage from the unwanted AND gate output.

Since each AND gate pull-up resistor, R_1 , draws approximately 15 ma and since conceivably the $\bar{1}$ gate could be required to hold off the eight AND gates it drives, the cathode current required from the $\bar{1}$ cathode follower (Fig. 2) could be over 120 ma peak. Fortunately this is not the case because of the cyclic nature of the other inputs to these eight AND gates. With the worst combination, a 60-ma current

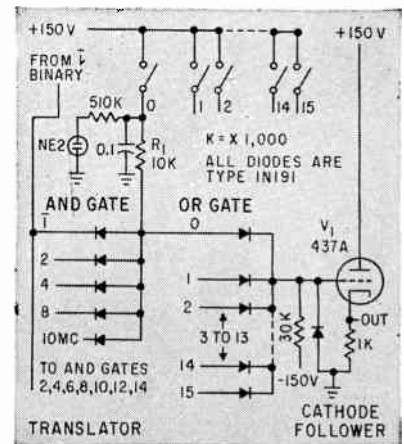


FIG. 4—Translator uses diode switching

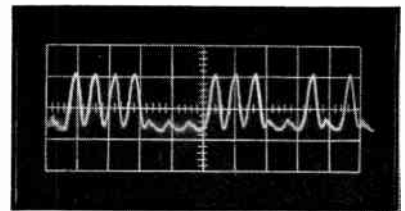


FIG. 5—Typical generator output word. Scales are 0.16 μ sec and 5 v per division

through the cathode resistor R_2 is sufficient to secure satisfactory gate operation. Accordingly, a value of 2.4 k was chosen for R_2 .

Figure 5 shows one typical output word from the high speed digital word generator. The particular word shown was selected by throwing the 0, 1, 2, 3, 7, 8, 9, 12 and 14 switches to connect the pull-up resistors to these AND gates.

This development work was supported by the Department of Defense under contract with the Denver Research Institute.

What the Military Expects From Future Components

New R&D environmental objectives issued by Department of Defense assist in current and future planning of electronic components

COMPONENT PARTS must operate not only under conditions required of prime electronic equipment but, more importantly, must be adapted to the environments existing within the prime equipments in which they are used.

A new government publication¹ establishes research and development objective environmental design requirements. Guide will assist in planning R&D programs involving components. The new guide supersedes a guide which was issued in 1957.

Environmental groups and the guide's definition

Table I—Definitions of Component Parts and Their Environmental Groups

Group I—Parts exposed to conditions no more severe than natural climates. Includes parts used in portable manpack communications equipment, r-f and other cables, meters, audio cords, waveguides and fittings

Group II—Parts of precision type used in oscillator tuning or frequency controlling circuits where electrical stability is of prime importance

Group III—Parts for general use in shipboard and ground electronic equipment

Group IV—Parts for use in electronic equipment of high-performance aircraft and surface-to-air and air-to-air missiles

Group V—Parts for use in electronic equipment of high-performance aircraft and specialized shipboard applications

Group VI—Parts for use in electronic equipment of nuclear-powered aircraft and ballistic missiles

Group VII—Parts with specialized applications in electronic equipment of high-performance aircraft and missiles

Group VIII—Parts for use in electronic equipment of nuclear-powered weapons

Component part—Term includes basic circuit elements such as capacitors, resistors, switches, relays, transformers, crystals, waveguides, electron tubes and semiconductor devices. It excludes complete equipments or parts thereof that are sometimes referred as electronic components

Table II—Radiation Environments

| Type of Nuclear Radiation | Group Number | | |
|------------------------------|------------------|------------------|------------------|
| | IV | VI | VIII |
| Reactor Radiation | | | |
| Neutron flux level (fast) | | | |
| neutron/cm ² -sec | NA | 10 ¹⁰ | 10 ¹⁰ |
| time (hr) | NA | 1,000 | 1,000 |
| Gamma photon flux level | | | |
| photon/cm ² -sec | NA | 10 ¹¹ | 10 ¹¹ |
| time (hr) | NA | 1,000 | 1,000 |
| Thermal neutrons | | <i>a</i> | <i>a</i> |
| Pulse Radiation | | | |
| Neutron flux level (fast) | | | |
| neutron/cm ² -sec | 10 ¹⁷ | 10 ¹⁷ | NA |
| time (μsec) | 80 | 80 | NA |
| Gamma flux level | | | |
| Roentgens/sec | 10 ⁶ | 10 ⁶ | NA |
| time (μsec) | 80 | 80 | NA |

NA—not applicable (*a*) not a requirement; but since all neutron fluxes have some thermal component, this component should be measured and reported with all tests

of component parts are listed in Table I. This is a composite of all three military services' requirements; however, all environmental groups are not necessarily emphasized by any one service.

The radiation environments relating to Groups IV, VI and VIII are given in Table II. Environments for all groups are given in Table III. Table III also lists some test methods. Additional test methods are summarized in Table IV. The original document should be consulted for detailed test descriptions, particularly radiation measurement.

The tests represent a compromise between simulated field service conditions and actual service conditions, so should not be interpreted as exactly representing field conditions.—GS

REFERENCE

(1) "Environmental Requirements Guide for Electronic Parts", Office of Technical Services, Washington, D. C., March 1959.

Table III—General Environmental Requirements for All Component Parts Groups

| Environmental Characteristics ^a | Group Number (See Table I for Definitions of Groups) | | | | | | | |
|--|---|---|------------|------------|------------|------------|------------|------------|
| | I | II | III | IV | V | VI | VII | VIII |
| Temperature (deg C) | | | | | | | | |
| Operating | -55 to 55 | -65 to 85 | -65 to 125 | -65 to 125 | -65 to 200 | -65 to 200 | -65 to 350 | -65 to 500 |
| Storage | -65 to 71 | -65 to 85 | -65 to 85 | -65 to 85 | -65 to 85 | -65 to 85 | -65 to 85 | -65 to 85 |
| Thermal shock | NA | -65 to 85 | -65 to 125 | -65 to 125 | -65 to 200 | -65 to 200 | -65 to 350 | -65 to 500 |
| Pressure | | | | | | | | |
| Operating (in. Hg) | 20.58 | 1.32 | 20.58 | 0.326 | 0.326 | 0.043 | 0.043 | 0.043 |
| Altitude (ft) | 10,000 | 70,000 | 10,000 | 100,000 | 100,000 | 150,000 | 150,000 | 150,000 |
| Nonoperating (in. Hg) | 3.4 | NA | 3.4 | NA | NA | NA | NA | NA |
| Altitude (ft) | 50,000 | | 50,000 | | | | | |
| Vibration (cps) | 10-55 | 10-2,000 | 10-55 | 10-2,000 | 10-2,000 | 10-2,000 | 10-2,000 | 10-3,000 |
| Acceleration (g) | NA | 10 | NA | 10 | 15 | 15 | 20 | 40 |
| Shock ^b | | | | | | | | |
| Time (millisec) | 6 | 11±1 | 11±1 | 11±1 | 11±1 | 11±1 | 11±1 | 11±1 |
| Air-induced | | | | | | | | |
| Vibration (cps) | NA | NA | NA | 150-9,600 | 150-9,600 | 150-9,600 | 150-9,600 | 150-9,600 |
| db above 2×10 ⁻⁴ dynes/cm ² | NA | NA | NA | 165 | 165 | 165 | 165 | 165 |
| Moisture | | | | | | | | |
| Salt Atmosphere | All groups | 100% relative humidity with condensation; Method 106 of MIL-STD-202A for 10 complete cycles 96 hours in accordance with Method 101A of MIL-STD-202A test in accordance with Procedure I of MIL-E-5272 non-nutrient; no damage or deterioration using Procedure I of MIL-E-5272 applies only to moving parts; test by Procedure I of MIL-E-5272 place in draft-free flame for 30 seconds (parts) or 10 seconds/in. ² (seals). Parts must not ignite; seals must be undamaged, container must not burst | | | | | | |
| Explosive Atmosphere | | | | | | | | |
| Fungus Resistance | | | | | | | | |
| Sand and Dust | | | | | | | | |
| Flammability | | | | | | | | |
| Life | | | | | | | | |
| Operating (hr) | 30,000 | 30,000 | 30,000 | 2,000 | 20,000 | 2,000 | 2,000 | 10,000 |
| Storage | All groups: 5 years. No test methods proposed for these life requirements | | | | | | | |

NA—not applicable (a) tests are to be given in order shown, except nuclear radiation tests which precede flammability tests in Groups IV, VI and VIII (b) acceleration of 50 g

Table IV—Summary of Additional Methods for Environmental Testing

Ambients—Temp: 25C (+10C, -5C); barometric pressure: 28-32 in. hg; relative humidity: 55% max

Operating temp—Rated life or minimum of 1,000 hr at high temp, 500 hr at low temp

Thermal shock—5 cycles; each cycle consisting of low temp, 10- to 15-minute room temp, high temp, and 10- to 15-minute room temp exposures. Exposure times for different weight specimens at temp extremes are:

| | | | | | |
|--------------|-------|-------|------|--------|------|
| part wt (lb) | ≤ 0.3 | 0.3-3 | 3-30 | 30-300 | >300 |
| time (hr) | 1/2 | 1 | 2 | 4 | 8 |

Pressure—30 minute exposure, Method 105A, MIL-STD-202A

Vibration—Groups I and III; Method 201A, MIL-STD-202A. For tubes and transistors refer to 4.9.20.3 of MIL-E-1 and/or 4.6.31 of MIL-S-19500B

Groups II and IV: Condition C, Method 204-MIL-STD-202A

Groups V and VI: Condition B, same method as with Groups II and IV

Group VII: same as with groups V and VI, except at 20-g level

Group VIII: same as with groups V and VI, except: at 40-g level; frequency increased to 3,000 cps with 22-min sweep cycling; test time of 4 hr. 20 minutes in each direction; and total test time of 13 hrs

Shock—Transient deceleration of 50-g for time listed. Also, 30 impact shocks (10 each plane, 5 each direction in a plane). Follow MIL-S-4456 (USAF) or Method 205, MIL-STD-202A (Method 202 for Group I), energize moving parts 2 drop in each direction. Tubes and semi-conductors: 4.9.20.5, MIL-E-1 or 4.6.53, MIL-S-19500.

Air-induced vibration—Monitor part operation through tests. Frequency sweep 1 octave/80 sec using log cycling rate; cycling time 8 hrs

Reactor radiation—Neutron energy spectrum is reactor spectrum modified by 1/4-inch of 35% boron carbide or 1/8-inch boron where shield is permitted. Gamma flux spectrum has average energy of 1 mev. Measure all fluxes by approved methods

Pulse radiation—Neutron or gamma pulse flux is essentially that of transient (fast) bare critical assembly

Reducing Errors Caused By

Differential amplifiers in cascade cancel the output error caused by power-supply fluctuations. Cancellation of this error greatly simplifies problem of low-level signal amplification

By JACK HOLTZMAN, Member of Technical Staff, Airborne Systems Labs, Hughes Aircraft Co., Culver City, Calif.

IN MOST VACUUM tube amplifiers, an appreciable portion of the variations present in the power supply appears at the plate of the output tube. If these variations are comparable to the smallest amplified signal, it is difficult to use the amplifier for low-level signals. This condition can be particularly serious in low-frequency and d-c amplifiers. The amplifier to be described cancels power-supply variations at its output.

Cancellation Principle

This amplifier consists of two differential amplifiers in cascade.

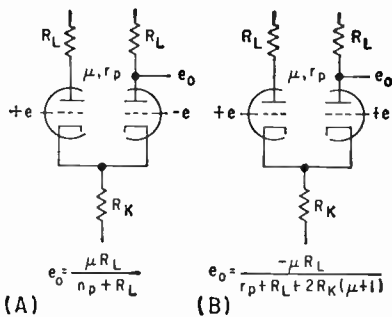


FIG. 1—Amplifier with push-pull input (A) and with common-mode input (B)

The second of these amplifiers has a lower common-mode rejection ratio than usual. For each differential amplifier, the common-mode rejection ratio is the ratio of the gain for push-pull input signals (Fig. 1A) to the gain for identical input common-mode signals (Fig. 1B). Push-pull input signal gain equals the output voltage divided by the difference of the push-pull

input voltages. Common-mode signal gain is measured from the signal on one grid to the signal at one plate, with both voltages referenced to ground.

Figure 2 shows a simplified schematic of two differential amplifiers. At each of the plates of tubes V_1 and V_2 there appears a fraction (nearly unity) of the supply-voltage variation, $f(\Delta E_{bb})$. This fractional variation also appears at the grids of tubes V_2 since they are connected to the plates of tube V_1 . Thus $f(\Delta E_{bb})$ appears as a common-mode (identical) signal input to tube V_2 . A signal appears at each of the plates of tube V_2 due to the common-mode inputs on its grids. This plate signal equals $Kf(\Delta E_{bb})$, where K is the common-mode gain. If K is made equal to -1 , signal $Kf(\Delta E_{bb})$ cancels signal $f(\Delta E_{bb})$; that is, $f(\Delta E_{bb}) + Kf(\Delta E_{bb})$ equals zero.

The common-mode gain of tube V_2 can be made equal to minus one by making the common-mode rejection ratio equal to the differential gain. If the two plate load resistors of tube V_2 are equal and the tubes are balanced, the common mode gain $= -\mu R_L / [r_p + R_L + 2R_K(\mu + 1)]$ and the common-mode rejection ratio $= 1 + [2R_K(\mu + 1) / r_p + R_L]$ where R_L is the plate-load resistor, r_p is the plate resistance, μ is the amplification factor, and R_K is the common cathode resistor. If the load resistors are not equal or the tubes are not balanced, the common-mode gain and rejection-ratio equations will be somewhat altered. Ad-

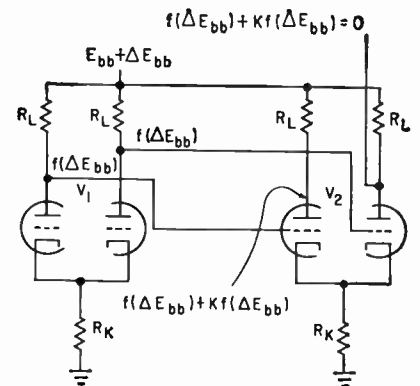


FIG. 2—Differential amplifier circuit illustrates cancellation principle

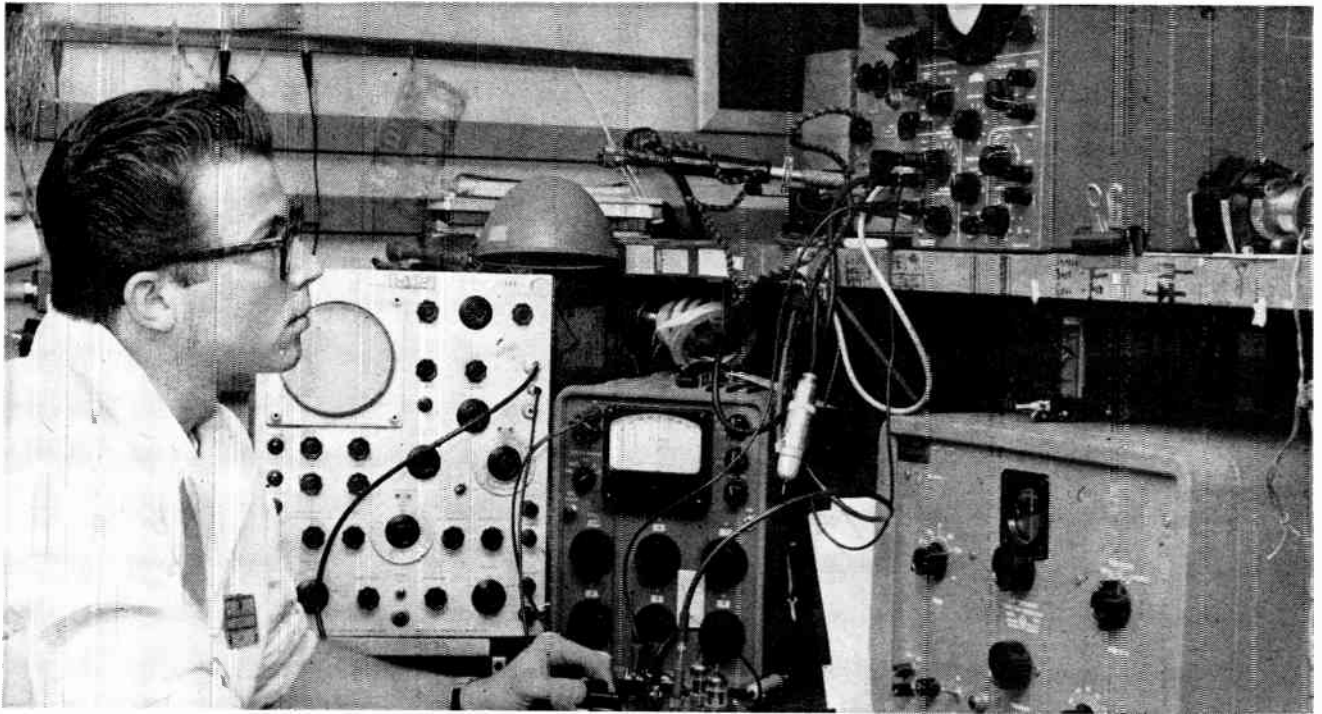
justment of the common-mode gain is made with resistor R_K .

Cancellation Circuit

Figure 3 shows a differential-amplifier cancellation circuit. Potentiometer R_1 adjusts the gain to 50. Rheostat R_2 adjusts the common-mode gain to minus one. To test the amplifier, a large a-c signal was put in series with the power-supply voltage and rheostat R_2 varied for a null at the output plate. Test signals of up to 20 v peak-to-peak, were reduced at the output plate by more than a factor of 30. Reductions decreased with larger signals because of tube nonlinearities. Reductions also fell off as test variations approached d-c due to the impedance of the coupling capacitors.

With a short-circuited input, amplifier output is less than 500 μ v. This output corresponds to an equivalent-input noise signal of 10 μ v rms.

Power-Supply Variations



Operator adjusts control of differential amplifier as he observes the cancellation of a power-supply variation

Impedance from each grid of V_1 to ground is kept approximately equal to eliminate the possibility of power-supply variations appearing as differential signals to tube V_1 . For example, a power supply variation appears as an attenuated signal in the cathode circuit. This signal goes to both grids due to the voltage division between the grid-return resistors and the coupling

capacitors. Therefore, to keep these signals equal on both grids of tube V_1 (which has a high common-mode rejection ratio), the capacitor on the grid of tube V_{1B} is made the same as the input coupling capacitor of V_{1A} — if the driving impedance is negligible.

This amplifier has a midband gain of 50, a bandwidth extending between 0.4 cps to 900 kc. Peak-to-peak input signals are in the order of tens of microvolts.

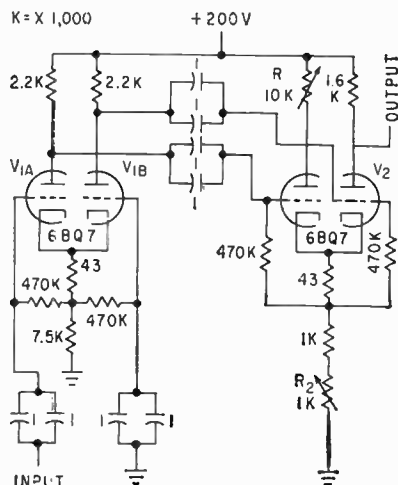


FIG. 3—Practical differential amplifier circuit reduces output fluctuations due to power-supply variation at its output

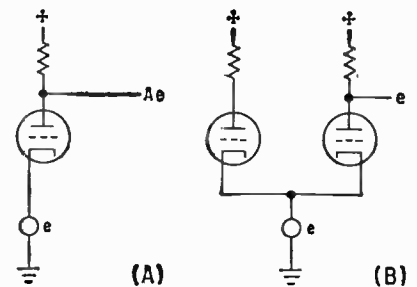


FIG. 4—Equivalent circuits of standard amplifier (A) and differential amplifier (B) show effect of heater-voltage variation

Effects

Despite the lower common-mode rejection ratio, the gain of tubes V_1 and V_2 as a differential amplifier is hardly affected.

Although the low ratio adversely affects heater-voltage-variation effects, there still is adequate heater-voltage-variation compensation. One reason is that the common-mode rejection ratio of tube V_1 can be made as high as desired. Another reason is that tube V_2 has not lost all of its common-mode rejection-ratio capabilities despite its common-mode gain of minus one.

For example, consider a standard

grounded-cathode amplifier which has an equivalent voltage e in series with its cathode due to a heater-voltage variation (Fig. 4A). This variation appears amplified at the plate. In a differential amplifier with a common-mode gain of one, the cathode signal appears at the plate but without being amplified (Fig. 4B). Strictly speaking, this action only diminishes, rather than eliminating the effect.

Power-supply-variation compensation can also be used in direct-coupled differential amplifiers. These amplifiers can compensate against low-frequency variations that approach d-c.

Checking Jitter in

Coherent oscillator's jitter in moving target radar system limits the effective range. This circuit automatically monitors the oscillator frequency and provides visible indication of amount of jitter and therefore a measurement of system capability

By CHARLES CLARK, Air Arm Division, Westinghouse Electric Corp., Baltimore, Md.

COHHERENT OSCILLATOR JITTER is one of the major limiting factors of the effectiveness of MTI (moving target indicator) type radar. An MTI radar system compares the phase of the received target pulse with an internal reference from a coherent oscillator. A changing phase relationship indicates a moving target that will be displayed on the radar while a non-changing phase relationship indicates a stationary target that will not be displayed. In this way, all confusing background clutter will be removed and a clearer display will be seen on the radar.

The coherent oscillator must be very stable in frequency for the overall MTI system to function properly. The circuit to be described continuously monitors the amount of oscillator jitter and allows the operator to observe the relative amount and cause of any oscillator jitter.

Coherent Oscillator

The source of the phase-locking pulse in a normal MTI radar system is the pulse that results from mixing a portion of the transmitted r-f pulse with a stable local oscillator, STALO. Assuming that the magnetron and the STALO are frequency stable, the phase locking pulse is a pure i-f pulse that is applied to the coherent oscillator (COHO) to provide proper MTI system performance. Phase coherence makes the pulsed oscillator provide a stable phase reference throughout each repetition period.

A coherent oscillator (COHO) has two main short comings; im-

proper or inadequate phase locking and frequency instability. The factors involved in improper or inadequate phase locking are transient phase error, video hash, and ringing. The factors involved in frequency instability are hum modulation, tube microphonics, vibration, and electronic loading of the driver. Transient phase errors are dependent upon the phase locking pulse width and the Q of the

lator circuits when a free-running oscillator is used as the COHO.

Gated oscillators are usually used with MTI systems that employ a short radar pulse width to make certain that the oscillator is phased correctly. Gating can cause video hash but is usually required for phase-locking pulse widths less than 2 μ sec. When gating an oscillator in synchronism with a phase-locking pulse, the oscillator is slow

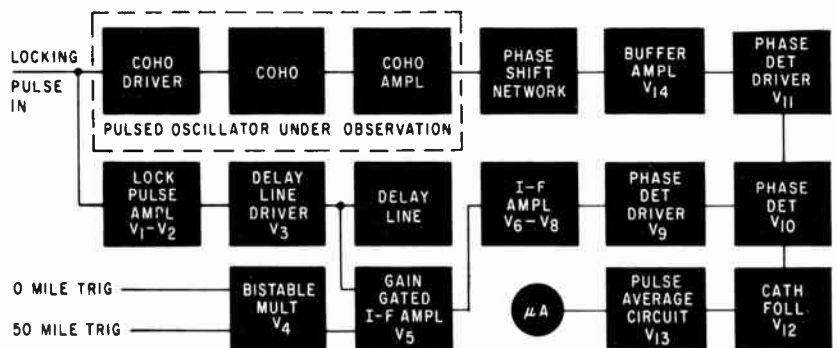


FIG. 1—Locking pulse synchronizes COHO and excites delay line. Phase detector output depends on COHO and delay line signals phase relationship. Difference is averaged and displayed on meter

oscillator circuit, with low values of Q imposing a limitation on the capability of the pulsed oscillator with respect to subclutter visibility.¹

Video hash may be caused by two sources, the gate pulse (when used) and the i-f locking-pulse circuit. The video hash resulting from the i-f locking pulse circuit can be traced to the COHO mixer or driver. The video hash of the COHO driver circuit usually results from nonlinearities of the driver tube operation. Ringing is present in the oscil-

gated. Slow gating is a method of gating in which the rise time of the leading edge of the gate is slowed down. The amount of slow down required for phase locking is a function of radar system pulse width. Slowing down the leading edge of the gate causes oscillations to build up slowly therefore the amplitude is controlled and is specifically kept much smaller than the injected phase-locking pulse. Relatively larger phase-locking pulses force the oscillator to get in phase with the locking pulse.

all unwanted variations of the video target pulses. Amplitude variations are of no concern because of the limiting action that takes place in the phase detector circuits. The amount of jitter that can be tolerated within the system depends on the capability desired of the system. The limiting factor of a coherent oscillator is usually hum modulation. MTI systems are designed to be a 50-mile system, a 100-mile system, etc., with inference that the hum modulation is the limiting factor. The oscillator failing in the attempt to phase lock to the locking pulse, will choose its own random phase to oscillate to. Hence, a 100-mile system will be no better than a 50-mile system because the jitter caused by phase-locking instabilities is not a function of range, whereas the jitter caused by frequency instabilities is. Phase locking of the oscillator is usually a condition of either locked or not locked. Although the jitter caused by COHO locking instabilities may vary from repetition period to period, the jitter will be constant throughout each repetition period. These two distinct types of jitter can be readily measured.

Jitter Checking

Major components of the automatic jitter-checking circuit are shown in Fig. 1. The electrical schematic diagram is shown in Fig. 2. The phase-locking pulse used to lock the oscillator is also used to generate the train of pulses in the ringing type of quartz delay line. Pulses of the delay line are later used at the phase detector for comparing phases with the oscillations of the COHO.

The ringing delay line output is coupled to an amplifier that is gain-gated by a multivibrator to produce a train of pulses of equal amplitude over the MTI range or the time when jitter measurements are required. To make a comparison of the coherent oscillator output with the train of pulses from the delay line, the phase of the COHO output is shifted 180 deg by the phase-shifting network prior to being coupled to the phase detector². By shifting the phase of the COHO 180 deg the only time that the phase detector will produce an out-

put is when there is a phase difference present in the system. Any phase difference detected by the phase detector represents COHO instability or jitter³.

Hum Modulation

When the normal amount of jitter is great enough to warrant a closer check on the COHO, or when the operator cares to check on specific jitter causes, operation of a test switch causes the prf of the radar system to be identical to the power source supply frequency making the hum modulation zero. Indicated jitter is caused by locking instabilities and the meter indication will be the limitation of sub-clutter visibility imposed on the MTI system by improper COHO locking. Any reduction of the jitter indication will be the amount of jitter caused by hum modulation.

Delay Line

The fused-quartz ringing type of delay line that is used to generate the train of 2 μ sec pulses is a single-ended delay line that has less than 1 db pulse-to-pulse attenuation, excluding the main pulse. The main pulse is attenuated to the level of the rest of the pulses by means of the gain-gated amplifier that follows the delay line.

Phase Shift Network

The COHO signal is transformer-coupled to the phase-shifting network which consists of a special variable inductor with associated components necessary to achieve the 180-deg phase shift. The inductor is adjustable over about 10-deg range and is locked at the proper position in the initial system calibration.

Phase Detector

A buffer amplifier is used between the phase-shifting network and the phase-detector driver. The phase detector uses a gated beam tube⁴. The phase detector driver is designed to aid in maximum phase detection capability, particularly for small angles of phase differences. With careful design, the phase detection of a few degrees can be made using a 30-mc i-f frequency. Jitter of the millimicrosec range can be detected and indi-

cated on a meter. The phase-detector output is coupled to a cathode follower and the pulse amplifier which in turn feeds a conventional pulse averaging circuit and indicating meter⁴.

Calibration

Calibration of the indicating meter depends on system parameters. Regardless of what system is under test, the indicating meter must be properly calibrated to enable any operator to interpret the meter readings. The simplest calibration would be a go or no-go calibration. The system under discussion used a sub-clutter visibility calibration.

The amount of jitter existing in the system was measured. The meter indication was a measure of the performance of the COHO in db of sub-clutter visibility. In calibration of the meter scale, several measurements are required before the meter indication can be reasonably accurate. First, the stability of the phase-locking pulse must be known. In the case of a MTI system, the stable local oscillator (STALO) stability must be known and this stability must be as good as the COHO or better. Secondly, the COHO stability must be known, and must be good enough to allow the MTI system to function at the desired sub-clutter visibility level.

Once the stabilities of the two oscillators are satisfactory (the assumption is made that the STALO stability will remain constant), and after the appropriate calculations and some actual measurements for correlation are made, the meter scale can be calibrated (based on the COHO instabilities only). Properly designed and constructed, the STALO exhibits less tendencies to stray from a set stability than the rest of the MTI system which outside of the magnetron has many more inherent reasons to stray from any set stability because of the circuit complexity.

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Microwave Power Detectors

Charts help select device for detection or measurement of microwave power.

Thermistors, crystal rectifiers and barretters are compared

By **RAY STATA**, Field Engineer, Yewell Associates, Burlington, Mass.

MICROWAVE MEASUREMENTS differ considerably from conventional measurements in low-frequency circuits. At microwave frequencies, power is the significant variable in that it is invariant to the position of the measurement. At these frequencies, most detection devices operate on the principle of converting electrical energy to heat energy and power is measured directly rather than by the voltage, current or impedance concept.

Confusion often arises because the distinction between power detection and power measurement is not clear. Detection indicates the presence and relative magnitude of power while measurement determines the absolute magnitude. Some devices are used for both detection and measurement but the requirements in the two applications often vary. For instance, a long time constant (averaging) is desirable for power measurements but undesirable for detection (demodulation).

BOLOMETER—The bolometer is a device used for

both detection and measurement whose resistance varies with temperature. In use, the bolometer is biased to an operating resistance of 100 to 200 ohms by a d-c current. Resistance change due to temperature change generated by the dissipation of microwave power is measured. Bolometers are of two general types: metallic wires or films called barretters and semiconductors called thermistors.

Barretters and crystal rectifiers are the commonly used detectors. Table I compares their characteristics.

Average power is measured and peak power in pulsed signals is computed from the duty cycle and the average power. Thermistors and barretters are the elements used for bolometric power measurements. Table II compares their characteristics.

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Table I—Characteristics of Power Detection Devices

| | Crystal Rectifiers | Barretters | Application Notes |
|---|---------------------------|--------------------|---|
| Min Detectable Power (100-cps bandwidth) | 2.5 x 10 ⁻¹² w | 10 ⁻⁸ w | Crystals used for low-level signals and slotted-line measurements |
| Sensitivity | 5,000 μv/μw | 50 μv/μw | Crystals used for low-level signals and slotted-line measurements |
| Rise Time | 0.5 μsec | 1 millisecc | Crystal good for detecting pulse and h-f modulation |
| Square-Law Response (power for 2-percent deviation) | 1/4 μw | 200 μw | Barretter good for accurate slotted line, attenuation measurements and power monitoring |
| Drift | 1.5-percent/deg C | 0.15-percent/deg C | Barretter accurate and reproducible |

Table II—Characteristics of Power Measuring Devices

| | Thermistors | Barretters | Application Notes |
|-------------------------|-------------------|--------------------|---|
| Time Constant | 1 second | 350 μsec | Long time constant to measure pulsed power |
| Max Average Power | >25 mw | <10 mw | Thermistor good for pulsed power and sudden overloads |
| Peak Overload Power | 400 mw | <25 mw | Same as above |
| Power Sensitivity | 35 ohms/mw | 5 ohms/mw | Thermistor good for low duty cycle pulsed power and low-level signals |
| Drift (200 ohms) | 1.8-percent/deg C | 0.15-percent/deg C | Barretter has accuracy and low drift |
| Temperature Coefficient | negative | positive | Negative coefficient less sensitive to burnout |

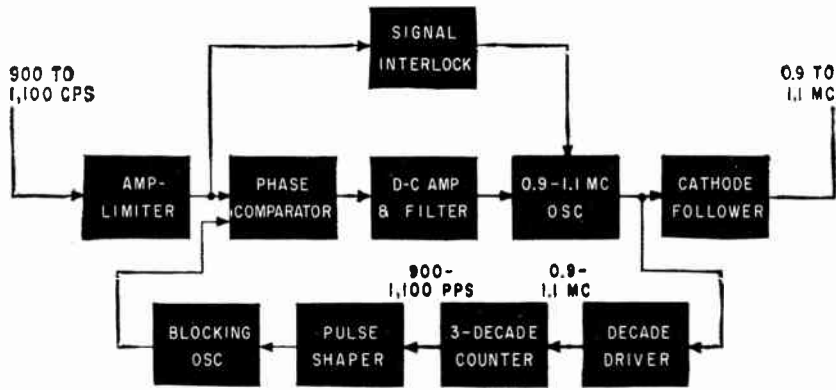


FIG. 1—Digital feedback method of frequency multiplication

Stepping Up Frequency

FREQUENCY STEP-UP or multiplying circuits for broadband applications are not as yet commercially available. Frequency division by divide-by-two circuits or decade counters is well known and, by using feedback method, practically any frequency division can be made.

In this unit, a phase comparator circuit is combined with a divider circuit and a feedback loop to give highly accurate frequency multiplication over a wide band of inputs. The multiplying factor used is 1,000 but the technique is adaptable to different requirements.

It is possible to synchronize two widely spaced oscillators with the technique. The controlling oscillator feeds a signal to a counter which converts the signal to a low frequency. The low frequency can then be transmitted over low band-pass telephone lines. At the receiving point it is multiplied up to the desired local frequency. The two oscillators need not run at the same frequency. Alternatively, a low frequency signal may be used to control one or more remote oscillators.

The usual method of multiplication using harmonic generators and high-Q tuned circuits works well with a narrow bandwidth signal. But bandwidth can be increased only by lowering the Q of the tuned circuits. This causes a loss of filtering and unwanted harmonics cannot be removed. Sidebands of an early stage may thus fall within the pass band of the final stage.

The system uses a voltage-con-

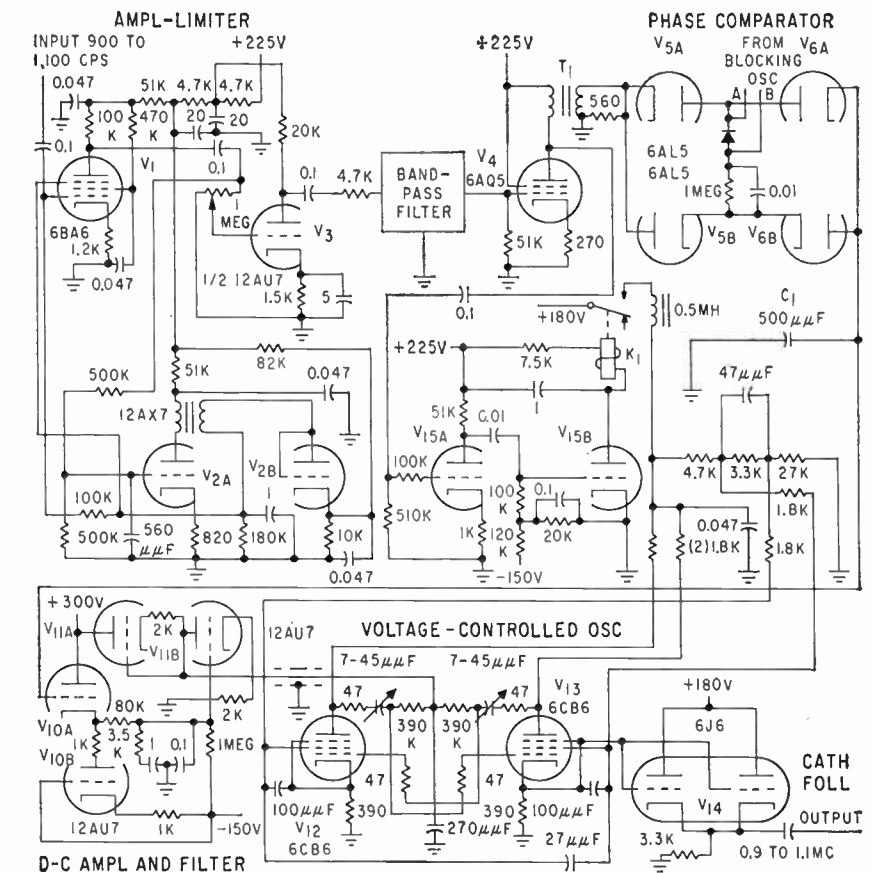


FIG. 2—Control signal is developed in phase comparator. Amplified signal is used to regulate voltage-controlled oscillator

trolled local oscillator for the output. Input bandwidth is from 900 to 1,100 cps and output is from 0.9 to 1.1 mc. This is a bandwidth of ± 10 percent of the center frequency. Output is input multiplied by 1,000 and accuracy is one part in 1,000 or 0.1 percent.

Figure 1 shows the circuit operation. The output of the 1-mc oscil-

lator is fed to a counter through a decade driver amplifier. Output of the counter is one pulse out per 1,000 pulses in. This pulse is shaped and then fed to a blocking oscillator which produces a pulse 1- μ sec wide. A phase comparator is gated by this 1- μ sec signal. The phase comparator also receives the input signal, which has first been amplified and

Digital feedback using counter circuits gives precise frequency multiplication. Unit can step up frequency in any desired ratio, requiring only simple changes in the feedback arrangement of the counters

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With Counter Circuits

limited, and a sampling action takes place. The resulting signal is amplified and filtered, and then used to control the frequency of the 1-mc oscillator. This is a phase correction system and average frequency is therefore precisely correct.

A signal interlock circuit is used to monitor the low-frequency input. It shuts down the 1-mc oscillator if no input is being received.

Output of the multiplier is taken from a cathode follower. The isolation thus obtained prevents the load from affecting the frequency of the oscillator and gives a low output impedance.

The low-frequency input signal is fed into the amplifier-limiter, shown in Fig. 2. In this circuit, V_1 is a remote-cutoff pentode with grid return through the circuit of V_2 . Connected as a diode, V_{2B} is biased at the cathode to conduct only above a minimum signal level. Stage V_{2A} furnishes drive for V_{2B} . The amplifier-limiter furnishes a signal to V_3 which is held to a two-to-one amplitude range as the input to V_1 varies over a ten-to-one range. The circuit is for a signal of approximately 0.1 to 1 volt rms.

Output from V_3 is fed to a band-pass filter. The filter is a commercially available unit and is used to

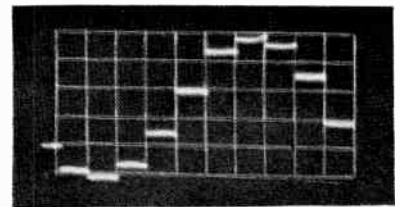


FIG. 4—Stair-case output of phase comparator

remove signals outside the 900 to 1,100-cps multiplier range. Resistors are added at filter input and output for impedance matching. Gain loss is made up by V_4 which also serves as the driver for the phase comparator circuit. The resistor at the output of transformer T_1 acts as a constant load and presents a low impedance to the phase comparator.

The voltage-controlled oscillator is a free-running multivibrator consisting of tubes V_{12} and V_{13} . It is adjusted with trimmers to operate at the center frequency of 1 mc with +140 v d-c on the grid return. Output is approximately 10 volts peak-to-peak and linearity is good from 0.5 to 1.5 mc. Frequency control over the desired operating range of 0.9 to 1.1 mc is obtained with ± 8 -v d-c change at the grid return. Output is taken from cathode follower V_{14} .

Feedback Circuit

Digital feedback is developed as shown by the circuit of Fig. 3A. The signal from the oscillator, varying in frequency from 0.9 to 1.1 mc in response to the input, is fed to

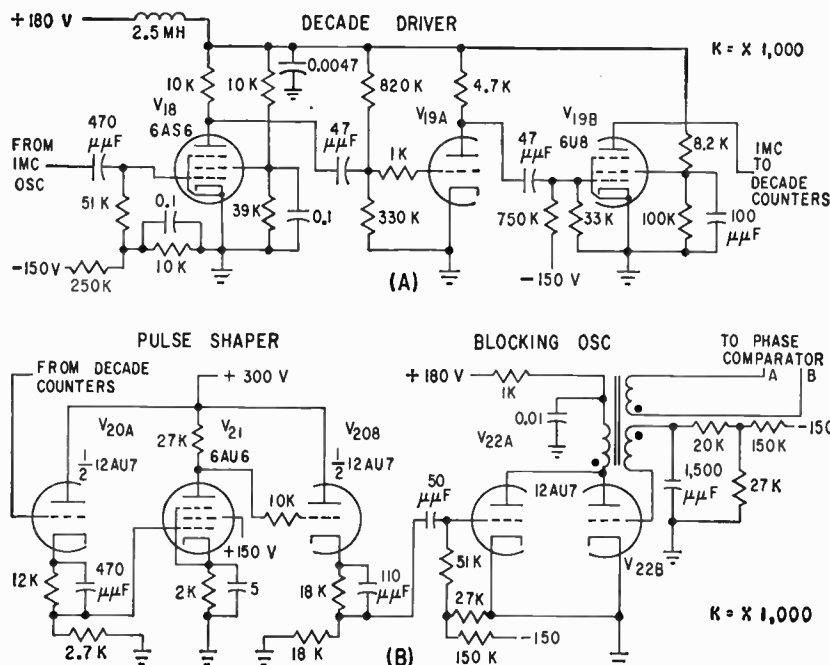


FIG. 3—Feedback circuit divides by 1,000 and triggers blocking oscillator

the decade driver circuit. For accurate triggering, the first decade counter requires a signal of approximately 80 v p-p and 1- μ sec rise time. This is accomplished with tubes V_{1a} , V_{1b} and V_{1c} . The first counter divides the oscillator output by ten. Pulses from the last decade counter have a 900 to 1,100 repetition rate, a rise time of about 10 μ sec and are 80 v p-p.

For precise timing, the pulse to the blocking oscillator must have a rise time of the order of 1- μ sec and the amplitude must be 150 volts peak-to-peak. The pulse-shaping circuit (tubes V_{2a} , V_{2b} and V_{2c} of Fig. 3B) accomplishes this. Clipping is used in V_{2b} while cathode followers V_{2a} and V_{2c} use cathode peaking to increase the rise time. There is no loading on the counter circuits and the desired low-impedance output source is available to drive the blocking oscillator. Rise time of the blocking oscillator trigger is approximately 0.5 μ sec.

Blocking oscillator V_{3a} is a conventional circuit, triggered through a differentiating network. Output of the blocking oscillator is a pulse 1 μ sec wide, with 0.05- μ sec rise time and 75 volts peak.

Phase Comparator

The signal to control the multi-vibrator is developed by the phase comparator. In Fig. 2, this is the balanced bridge circuit of V_{4a} and V_{4b} . Similar to a balanced modulator, it is called a boxcar circuit.

Pulses from the blocking oscillator build up a voltage across the RC combination in the phase comparator. A voltage of approximately 75 volts d-c is developed and cuts off

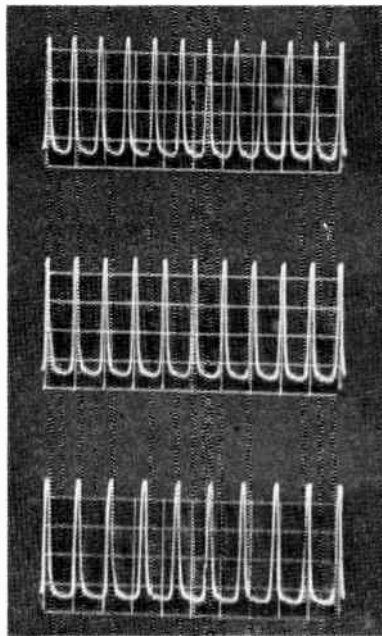


FIG. 6—Oscillator output for varying input frequencies. Top to bottom: 1,100 cps, 1,000 cps, 900 cps

the diodes. The other signal into the phase comparator is the original low frequency sine wave, which has an amplitude at this point of approximately 50 v p-p. Because of the bias on the diodes, the low frequency cannot pass through. But signals from the blocking oscillator act to cancel the bias. Cancellation occurs during the 1- μ sec span of the pulse, occurring once for each cycle of original signal. Slices or segments of the low frequency are thus fed through the phase comparator to the output capacitor C_1 . Since there is no load on C_1 except the grid circuit of the following stage which does not draw current, the charge is stored until the next

cycle is sampled. Output from the phase comparator is thus a staircase waveshape. This is shown in Fig. 4.

D-C Amplifier

Following the phase comparator is d-c amplifier and filter. Since it is a d-c amplifier and the problem of drift is of prime importance, the tubes are connected in-series or cascode. The circuit has a cathode follower input followed by an amplifier with a gain of 10. Grids and cathodes are returned as necessary to reduce the voltage at the grid of V_{11a} to near zero. The plate of V_{11a} is thus brought to the +140 volts needed for the voltage-controlled oscillator at its center frequency.

An RC filter is included in the d-c amplifier. Its purpose is to remove as much 1-kc ripple as possible without causing enough phase shift to create loop instability. At the same time, there must be enough gain in the pass band to cause pull-in when the system is first turned on.

Proportional-plus-integral control is desirable for the application. Accuracy, loop stability, filter bandwidth, and amplifier gain are all interrelated by formulas given in the referenced article. The filter shown meets the necessary conditions and its response is shown in Fig. 5.

Performance

Output waveforms of the multiplier are shown in Fig. 6. Residual f-m at the 1-mc center frequency indicated an accuracy of 1 part in 2,000 or 0.05 percent. A bandpass filter may be added at the output to remove harmonics.

When the bandpass filter between V_7 and V_8 in Fig. 2 is removed, the system tracks the input from 800 to 1,200 cps. Hold-in range is actually from 600 to 1,300 cps. Since the first decade counter has a maximum counting rate of 1.3 mc, an input greater than 1,300 cps cannot be tracked. The bandpass filter is not suitable for use with a fast varying input. To maintain accuracy with this type of signal, a special filter is needed.

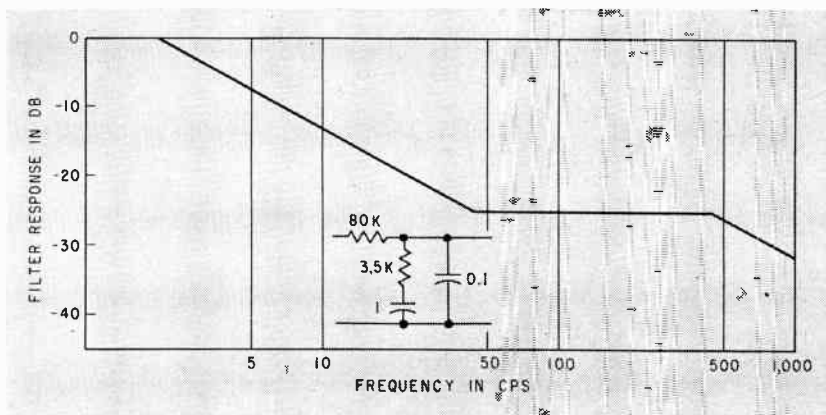
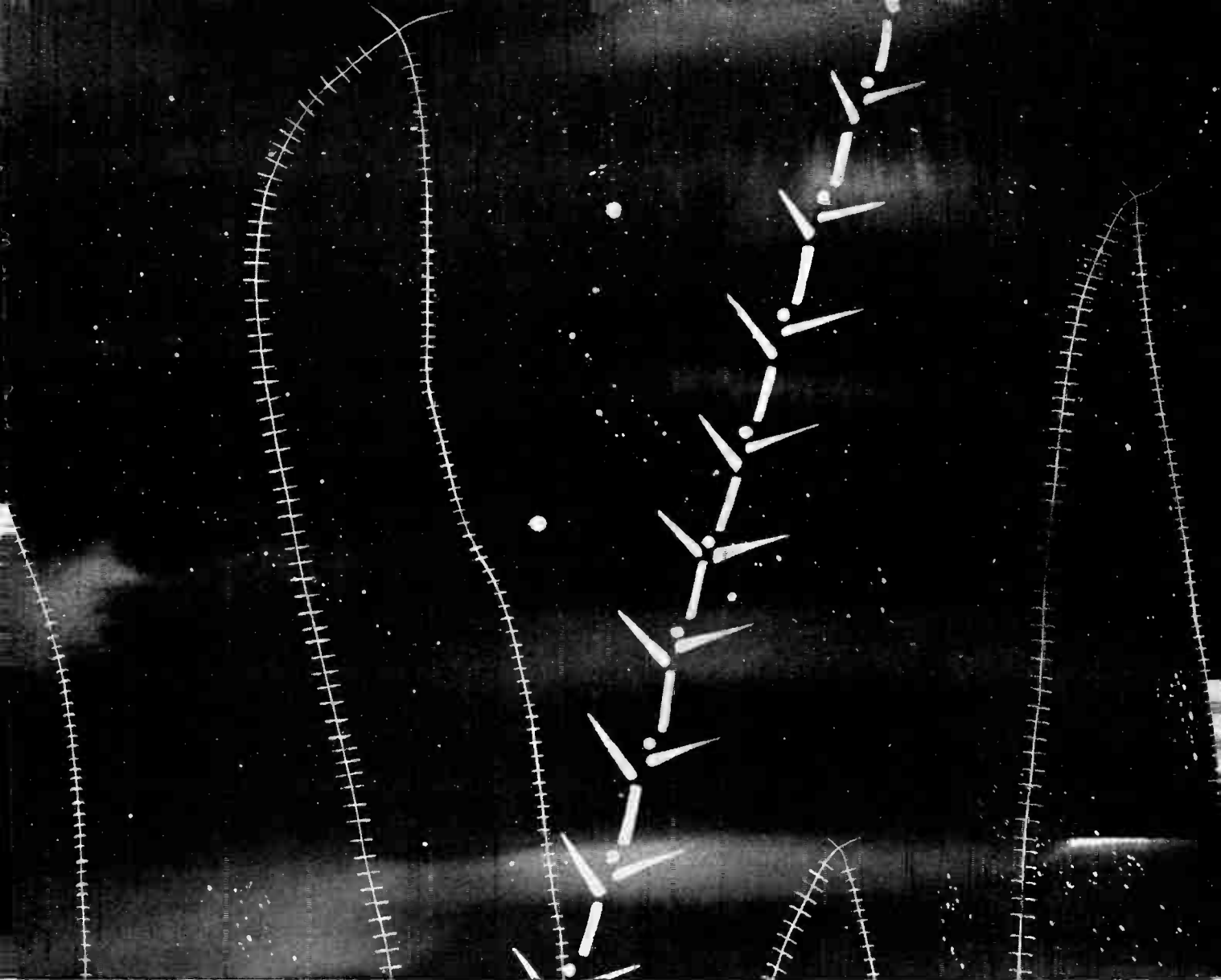


FIG. 5—Filter characteristics for 1 kc meet stability requirements

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Report from IBM



Yorktown Research Center, New York

WALLS THAT WALK THROUGH MAGNETIC MATERIALS

The track-like patterns above represent iron oxide tracings of boundaries between magnetic domains in thin films. The behavior of these boundaries is now under study by a group of scientists at the IBM Research Laboratories in Zurich, Switzerland. This is one of the laboratories serving IBM Research with headquarters at the Yorktown Research Center.

To map the boundaries between domains of opposing magnetic polarities, the Zurich group employs the "Bitter" method in which iron oxide particles in liquid suspension are deposited on a magnetized film. On either side of a given domain wall, electron spins are oriented in opposite directions. As a wall moves in a changing magnetic field, spins reverse polarity as

they pass from one domain into another. It has been found that spins reverse their polarity by gradually turning in a direction out of the plane of the film and perpendicular to it. Spins turning out of the film plane generate a large magnetic stray field. It is the tendency to minimize the energy of this field that leads to the complicated arrangements of spins observed in the walls.

The motion of domain walls in thin films is one aspect of a broad area of study at IBM seeking new insight into the physics of magnetism. A deeper understanding of magnetic phenomena may be expected to yield fruitful applications in improved or even unique magnetic devices.

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Regulating High Voltage With Magnetic Amplifiers

Auxiliary winding on the power transformer of a high-voltage, 400-cps rectifier performs sensing function for regulating magnetic amplifier

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Bell Telephone Laboratories,
Whippany, N. J.

THIS ARTICLE describes a high-voltage regulated power supply in which a magnetic amplifier is used as the control element. By placing this control element on the low-voltage input side of the regulated supply, and by adding an auxiliary winding for output sensing, both the control and sensing functions are electrically isolated from the high-voltage circuit.

Regulator Circuit

A 2,300-v magnetic-amplifier regulated d-c supply is shown in Fig. 1. The high-voltage power supply and the regulator sensing and control elements may be physically separated in the manner indicated in the figure by the dotted outlines.

The rectified voltage from a third winding (1-2-3) on transformer T_1 provides a voltage proportional to the peak value of the induced high voltage. Consequently, the current flowing in the control winding (4-5) of the magnetic amplifier is a function of the difference between this voltage and the reference voltage. Potentiometer R_6 sets the output level

Resistor R_1 limits inrush current at turn-on to a value lower than that assured by winding resistances alone. Resistor R_3 shunts the magnetic amplifier and lowers its effective input impedance during that part of the cycle in which the magnetic amplifier impedance is much lower than that of the primary of T_1 .

The voltage reference utilized is

a series of six temperature-compensated Zener diodes, each rated at 6.2 v. The use of a bridge arrangement in the sensing circuit as shown in Fig. 1 permits more turns to be employed in the control winding (4-5) than some other sensing circuit configurations,¹ resulting in higher magnetic amplifier sensitivity. At the same time, the voltage reference diodes are op-

tageous for high-voltage circuits of moderate-wattage capacity.²

The secondary voltage of the step-up transformer T_1 and the required filter capacitance C_1 are estimated by Schade's generalized curves.² For the particular application shown in Fig. 1, a maximum rms ripple of 0.5 percent is required at a 50-ma load. This is attained by using a 4- μ f capacitor of 2,000-v rating in each doubler section.

Magnetic Amplifier

The magnetic amplifier configuration is a doubler-circuit³ which provides a full-wave a-c output. In this arrangement, the magnetic amplifier has two gate windings, I and II, which are electrically similar. The circuit of Fig. 1 has the characteristic of working into a rectified capacitive load when the high-voltage rectifiers are conducting, and into an inductive load essentially consisting of the no-load inductance of the transformer when the rectifiers are not conducting.

Using a value of C_2 at which the sensing circuit discharge time constant is only one tenth of that of the high-voltage circuit, it is possible to obtain ± 0.25 -percent regulation with values of 9.2 ohms for R_2 and 400 ohms for R_3 .

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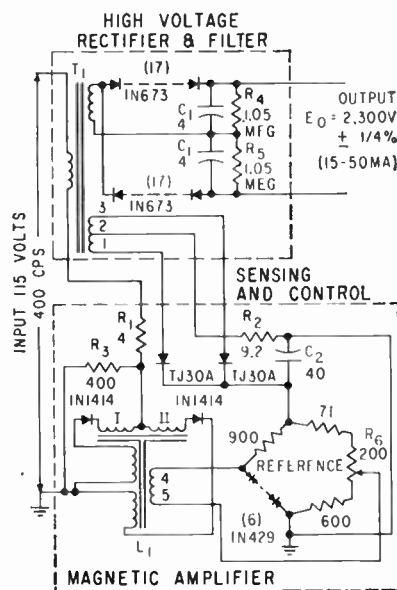


FIG. 1—Control of output is accomplished with self-saturating magnetic amplifier in series with primary of transformer T_1

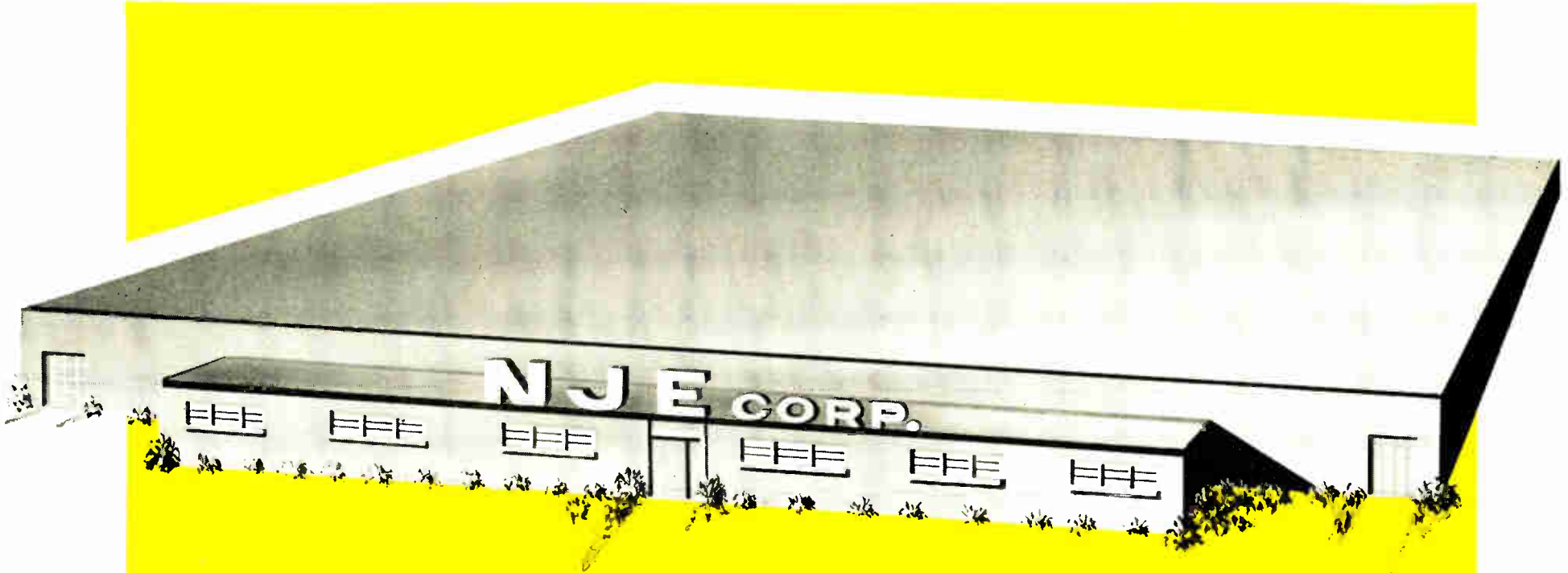
erated in the current range for which optimum temperature compensation may be realized.

Rectifier Circuit

The high-voltage rectifier and filter shown in Fig. 1 is the conventional full-wave voltage-doubler circuit, which is generally advan-

* On assignment with Bell Labs, Whippany, N. J.

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Designing a Power Density Meter

By ALAN BORCK, Chief Engineer, Empire Devices, Inc., Amsterdam, N. Y.

RADIATION hazards to personnel working with higher powered military radars and communications equipment have increased several fold in recent years. Narrowed antenna beam widths are also increasing the danger in the near field.

Determining power density in the near field can be accomplished with a portable power density measuring set made under Air Force contract. Response of the set is accurate and extremely broad band. It can measure power density from 200 to 10,000 mc over the input power range of 1 mw/sq cm to 1 w/sq cm.

Unlike the usual antenna design, which maximizes power transfer from free space to the input, this system uses antennas that minimize power transfer to the load and that have an effective area essentially constant as a function of frequency.

The power density meter is divided into two sections—r-f probes and a power measuring bridge.

One approach to design of r-f probes (antennas) uses as few probes as possible to cover the desired frequency range. Another

uses a discrete probe for each different frequency measurement. To develop the most useful instrument for field personnel and to limit number of components, a minimum number of probes are used for maximum frequency coverage.

Low-Frequency Probe

The primary design problem of the low-frequency probe is developing an ineffectual antenna covering the 4:1 frequency range. In the plot of effective area in Fig. 1, G is antenna gain (equal to that of an isotropic radiator) and λ is free space wavelength in centimeters of an isotropic radiator as a function of frequency over this range. If the isotropic radiator is immersed in a field of 1 w/sq cm at 200 mc, power output will be about 1,800 w.

This much power cannot be handled in a portable device. Assuming the instrument could handle about 1-10 watts of r-f power, a probe was required with a gain much less than one.

To design an antenna with gain inherently less than one, a dipole is used capable of adjustment for self-resonant operation. Its balanced output excites a section of circular waveguide below cutoff.

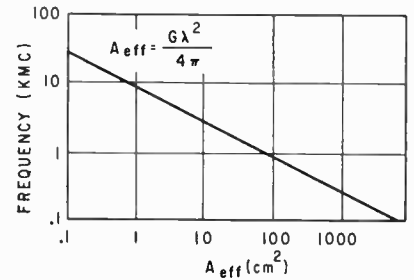


FIG. 1—Effective area is plotted as a function of frequency for an isotropic radiator

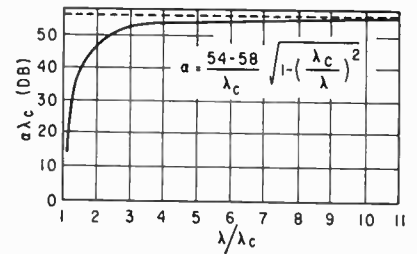


FIG. 2—Plot shows attenuation for a waveguide below cutoff

In Fig. 2, attenuation has been plotted as a function of wavelength for a waveguide below cutoff. At longer wavelengths, attenuation is independent of length. Hence, the operating range of the waveguide is a function of the flatness desired and the cutoff wavelength of the guide.

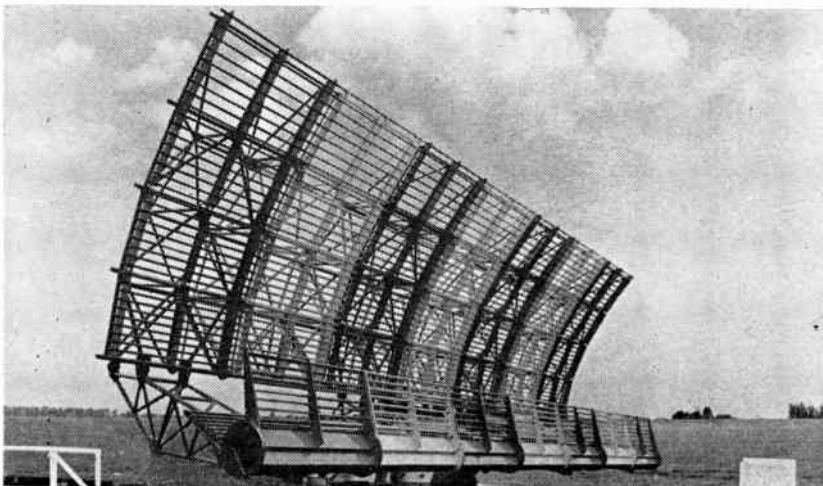
Using a waveguide beyond cutoff requires very adequate shielding and shaping of the attenuation curve as a function of frequency, to get constant power level into the power bridge.

High-Frequency Probes

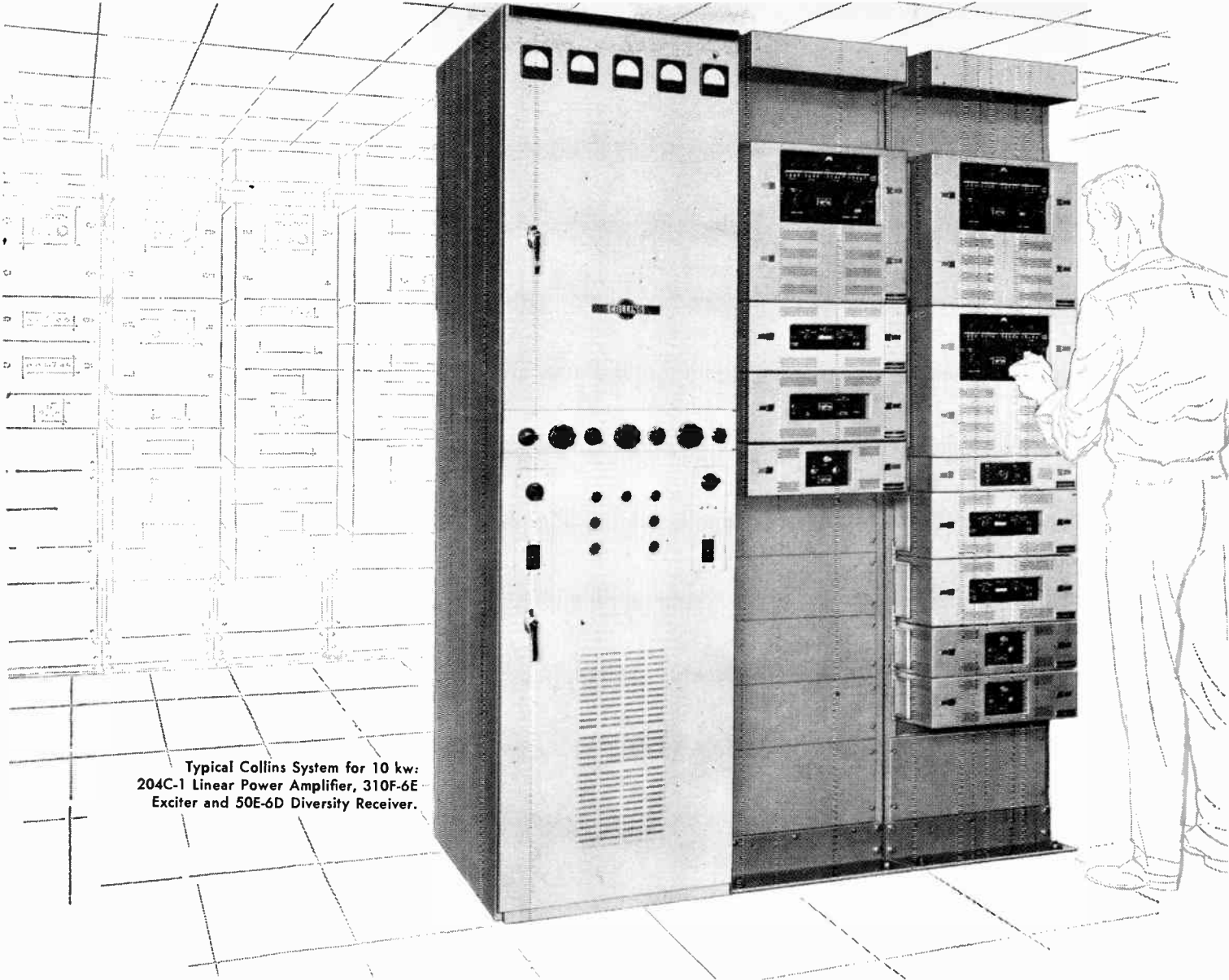
Design problems of the high-frequency probes are entirely different with regard to power-handling capabilities. An isotropic radiator at 800 mc has an effective area of about 115 sq cm and at 10,000 mc has an effective area of about 0.8 sq cm.

For 750 to 4,000 mc and for 3,750 to 10,000 mc, conical horns with variable concentric probes are used. By proper choice of cone angle and cone length, and by proper positioning of the conical probe, the characteristics of these antennas can be modified to correlate with the requirements of the power density

Antenna Has 2.25-Deg Beamwidth



Antenna for airfield control radar by Marconi Wireless Telegraph Co. Ltd. has horizontal beamwidth of 2.25 degrees. System provides coverage to 100 nautical miles up to 40,000 ft on medium-size aircraft



Typical Collins System for 10 kw:
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simplified manual
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COLLINS SSB

Integrated design of the full Collins single sideband line of power amplifiers, exciters and receivers provides a multiplicity of system combinations covering a wide range of output powers and frequency requirements. Here is one type of system that might be assembled for 10 kw peak envelope power output.

The linear power amplifier is the 10 kw 204C-1, offering RF feedback for low distortion, grounded screen for grid-plate isolation, and broadband neutralization. A unique feature of the 204C-1 is the ease of tuning provided by phase detectors which compare grid

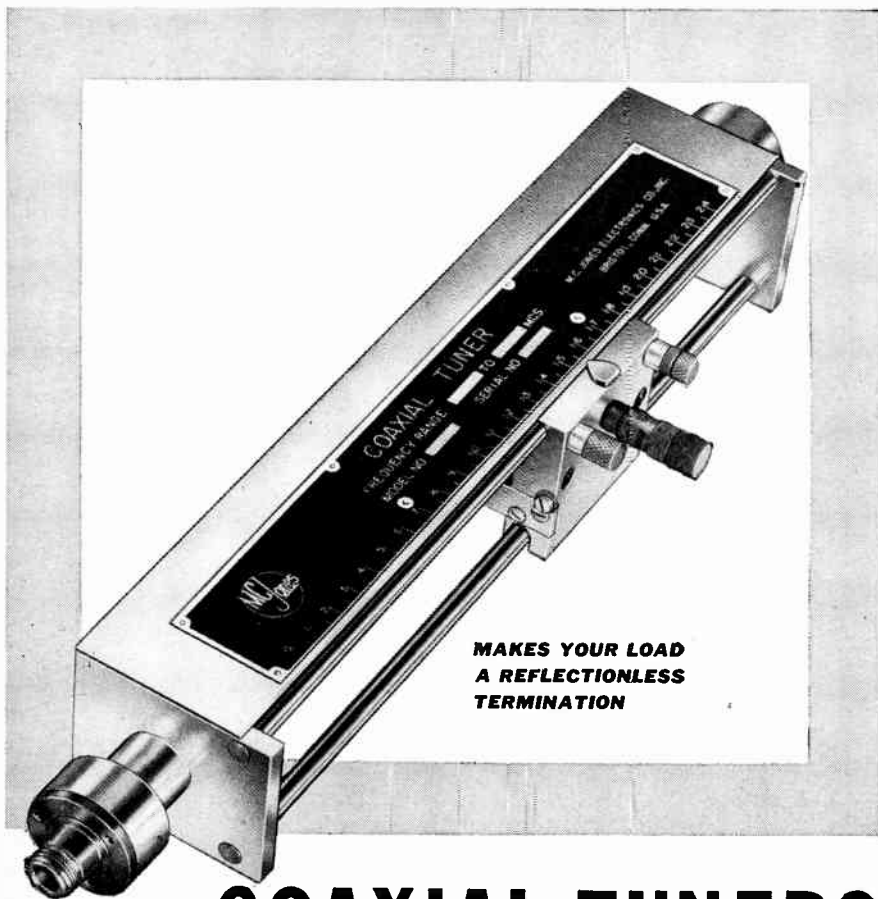
and plate circuits and indicate resonance on a zero-center meter. Loading is also accomplished by centering a meter pointer. Tuned circuits are continuously variable by front panel controls over the 4 to 25 mc range.

Excitation of the 204C-1 is accomplished in this example by a 310F-6E Exciter. Offering full manual coverage of the 2 to 30 mc range in 1 kc increments, the exciter is easily tuned to the desired frequency. Frequency stability of 1 part in 10⁶ per month is achieved by a stabilized master oscillator phase-locked to an internal standard. Frequen-

cy standards with a stability of 1 part in 10⁶ per day are available. A related diversity receiver with Mechanical Filter selectivity and minimized cross-modulation and blocking is the 50E-6D. A combined exciter-receiver, designated the 310F-6, is also available.

The equipment described is part of the complete Collins line of SSB equipment and accessories. Other equipment can provide from 100 watts to 45 kilowatts output with manual or automatic servo tuning. Write for literature or contact your nearest Collins representative for particulars.





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PRECISE COAXIAL TUNERS TUNE TO VSWR 1.000

200-4000 MCS.

DESIGNED FOR USE whenever extremely accurate RF power terminations are required. This laboratory type Coaxial Tuner will tune out discontinuities of 2 to 1 in coaxial transmission line systems or adjust residual VSWR to 1.000 of loads, antennas, etc. May also be used to introduce a mismatch into an otherwise matched system.

M. C. Jones Coaxial Tuner is designed for extreme ease of operation, with no difficult laboratory techniques involved. Reduces tuning time to a matter of seconds. Graduations on carriage and probe permit resetting whenever reusing the same termination.

SPECIFICATIONS

| | |
|---------------------|--|
| Impedance | 50.0 ohms |
| Frequency Range | Model 151N 200-1000 Mcs. Model 152N 500-4000 Mcs. |
| RF Connectors | E1A 7/8" 50.0 ohm Flange plus adapters to N female connector |
| Power Rating | 100 watts |
| Range of Correction | VSWR as high as 2 may be reduced to a value of 1.000 |

For more information on Tuners, Directional Couplers, R. F. Loads, etc., please write for 68-page Catalog No. 12 or see Electronics Buyers Guide or Electronic Engineers Master.

M. C. JONES ELECTRONICS CO., INC.

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meter.

Setting the conical probe within the conical antenna is calibrated as a function of frequency, so that antenna output is one watt when immersed in a 1 w/sq cm field.

Power Measuring Circuit

Output of the r-f probes is coupled via a Teflon coaxial cable to a variable-step coaxial attenuator followed by a thermistor mount in a power indicating circuit. The attenuator has one subassembly for d-c to 4,000 mc and a second covering 4,000 to 10,000 mc.

The low-frequency coaxial attenuator consists of the standard T pad; the high-frequency coaxial attenuator is of the lossy-line type.

The attenuator decreases input power to about 1 mw to operate the thermistor bridge. A thermistor was chosen instead of other non-linear resistive elements because its negative coefficient creates an r-f mismatch as power is increased, decreasing possibility of burn-out.

Requirements of the thermistor mount are unlike those of the standard laboratory mount where significant changes in temperature do not occur. This thermistor must operate in widely varying ambient temperatures with minimum warm-up time when going from one extreme temperature to another, as would be encountered going from a closed, heated shop to the field.

The power bridge compensates variations in thermistor operating conditions similarly to those used in laboratory bridges. Physical

Radio Telescope Gets Checked



Ninety-foot diameter steel-mesh antenna is checked by technician using Colson Corp. telescopic lift. California Institute of Technology operates radio telescope on Owens Valley desert in California

location of these compensating elements is somewhat critical to ensure proper tracking with each other and the thermistor mount to gain optimum bridge compensation.

Space Radar Will Have 1,000-Ft Reflector

PLANS are nearly completed for construction of a radar with a 1,000-ft spherical antenna. It will be used to explore the earth's upper atmosphere and space.

Designed by William E. Gordon of Cornell University, the system will be built in Puerto Rico and will be ready for operation in 1961. Construction was prompted by Professor Gordon's discovery of radio-wave scattering by free electrons in an ionized medium.

The radar will be capable of studying nearby heavenly bodies and atmospheric phenomena. Its large antenna will be stationary, precluding use in satellite or missile tracking, but will be highly sensitive to radioactive particles that might result from a nuclear explosion in the atmosphere.

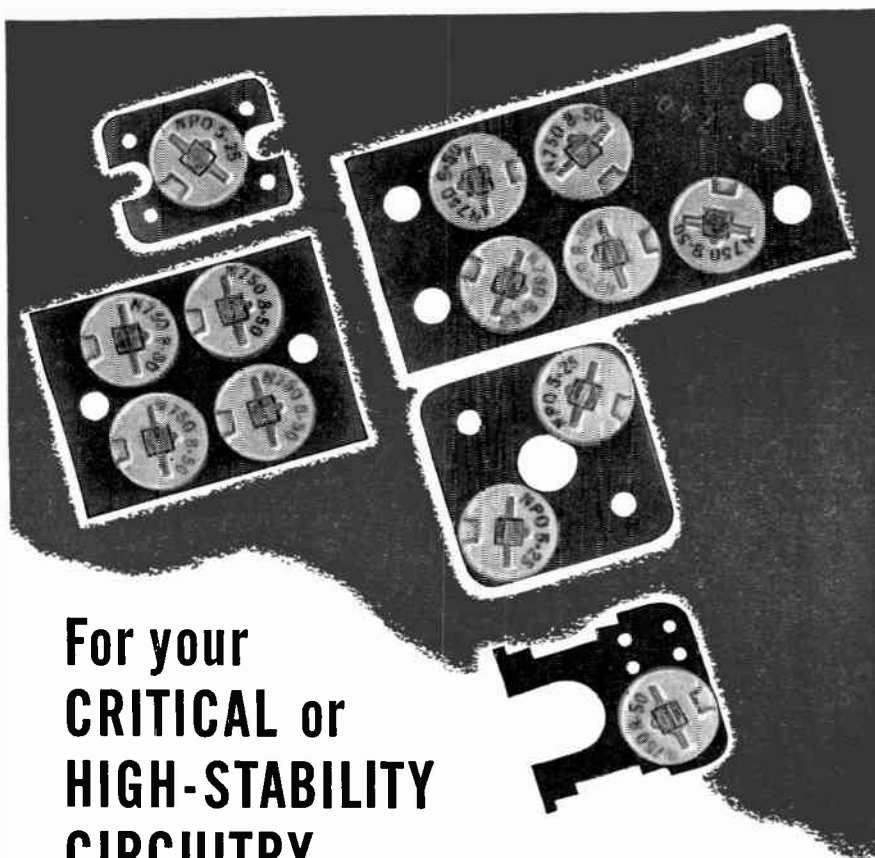
The planets to be studied pass directly over this semitropical location, permitting the antenna to remain stationary. Also, natural limestone formations at the site will ease excavation problems.

System

Average power capability of the standard transmitter will be 100 to 175 kw with possible peak power of 2 megawatts. Maximum pulse width will be 10 milliseconds. The spherical reflector will permit the beam to scan 20 degrees without an intolerable power loss.

The standard receiver must have sufficient sensitivity to pick up faint echoes. By using semiconductor diodes or the Zenith parametric amplifier, receiver noise temperature can be kept at 100 to 125 K. Additional noise temperature from the sky, ground and transmission line need not exceed 80 K.

One of the first projects after the radar is completed will be the study of Venus. In April 1961, the planet will be close to the earth, and it is hoped that its position can be precisely determined. Investigators also plan to explore Mars, the moon, the sun and possibly Jupiter.



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By D. WALSH, Engineering Laboratory, Oxford University, Oxford, England

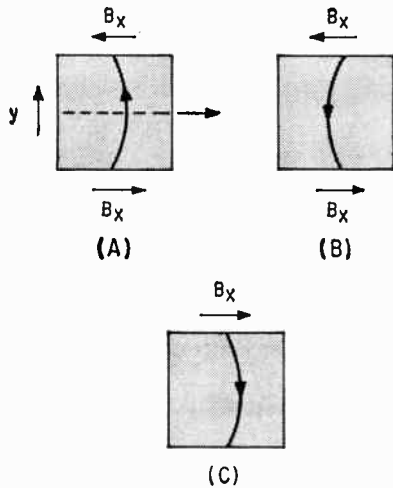


FIG. 1—Converging and diverging effects of magnetic lens, arranged to produce fields shown in A and B are cancelled when magnetic field lines at the two gaps are curved as in A and C

ALTERNATE GRADIENT focussing¹, discovered several years ago, has often been applied in synchrotrons. In this system, a single lens produces a line image: there is focussing in one plane, and defocussing in the perpendicular direction. A quadrupole magnetic lens is often used.

In a magnetic undulator² with curved magnetic fields, a similar focus can be produced, due to the curvature of the magnetic lines. The focal length is a readily calculated function of the curvature.

Application

A possible application of this lens would be in producing an approximately strip section beam for tubes in which electrons are required to interact with plane structures.

The simplest lens of this type is two pairs of magnets arranged to produce fields shown in Figs 1A and 1B. Electrons travel into the paper and pass first the field in 1A, then through that in 1B. If the fields are equal and opposite in magnitude as well as in curvature, then undulation in the x—direction will consist of an excursion to the left in the first gap and a restoration to the

axis in the second, providing the deflecting angle is small. An electron that is off the $y = 0$ axis will experience a B_y component of field towards the left for $y < 0$ and towards the right for $y > 0$.

This component will not reverse directions in the second gap. Hence electrons in both gaps will experience forces towards the axis. Now consider what happens in the other plane. The above condition for field curvature can be written as $B_x/y < 0$: that is, B_x is in the negative x—direction for $y < 0$ and in the positive x—direction for $y > 0$.

Therefore, since $B_x/y = B_y/x$, B_y is greater at $x = 0$ than for $x \neq 0$. Thus an electron at $x = 0$ will experience a greater force to the left than electrons that are farther to the right. Similarly, in Fig. 1B, the greatest value of B_y , the restoring field, is on the right. Hence electrons that have experienced the greatest excursion to the left in the first gap will have the weakest restoring force in the second gap.

Hence along the x axis there will be defocussing.

It can be shown similarly that it is possible to have a line focus in the vertical plane, when the curvature is reversed. The linear approximation to the focal lengths, which are equal in magnitude, is:

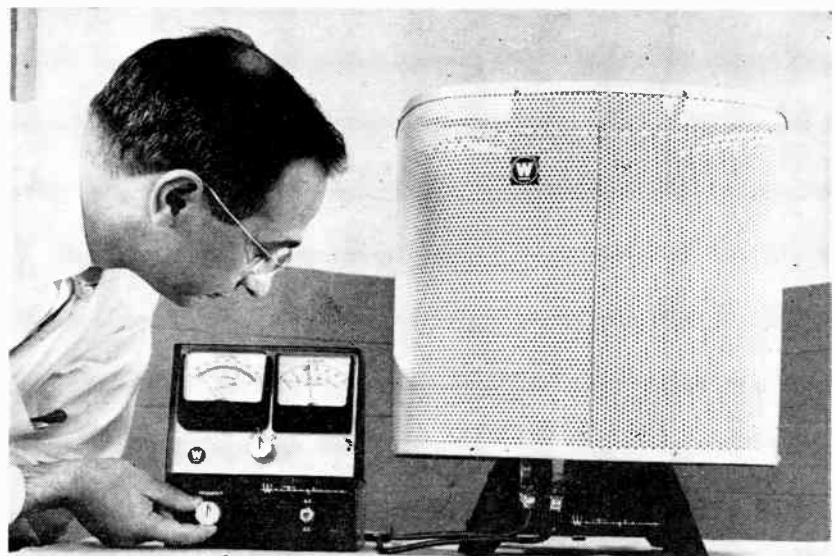
$$f_1 = -f_2 = \frac{mv}{e t_0 \frac{B_y}{x}}$$

where v is the electron velocity, t_0 is effective length of the lens, and B_y/x is the variation of the magnetic field which is most conveniently measured.

Emergent Beam

This simple lens, Fig's 1A and 1B, can be considered as a quadrupole magnetic lens split into two sections separated by a short axial distance. Its disadvantage for most electron optical systems is due to the fact that on emerging, the electrons are not traveling parallel to the

Gas Flame Generates 100 Watts



Thermoelectric generator produces 100 watts by converting the heat of a gas flame directly into electricity. Developed for Air Research and Development Command by Westinghouse, under the direction of S. J. Angello, R. E. Davis and E. J. Duckett, the TAP-100 now burns propane or gasoline or kerosene. An advanced version of this terrestrial auxiliary power generator will be fired by nuclear fuel in the form of an efficient, long-lived radioactive isotope. Use: powering electronic installations in isolated areas of the world



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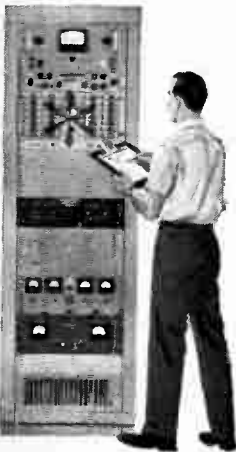
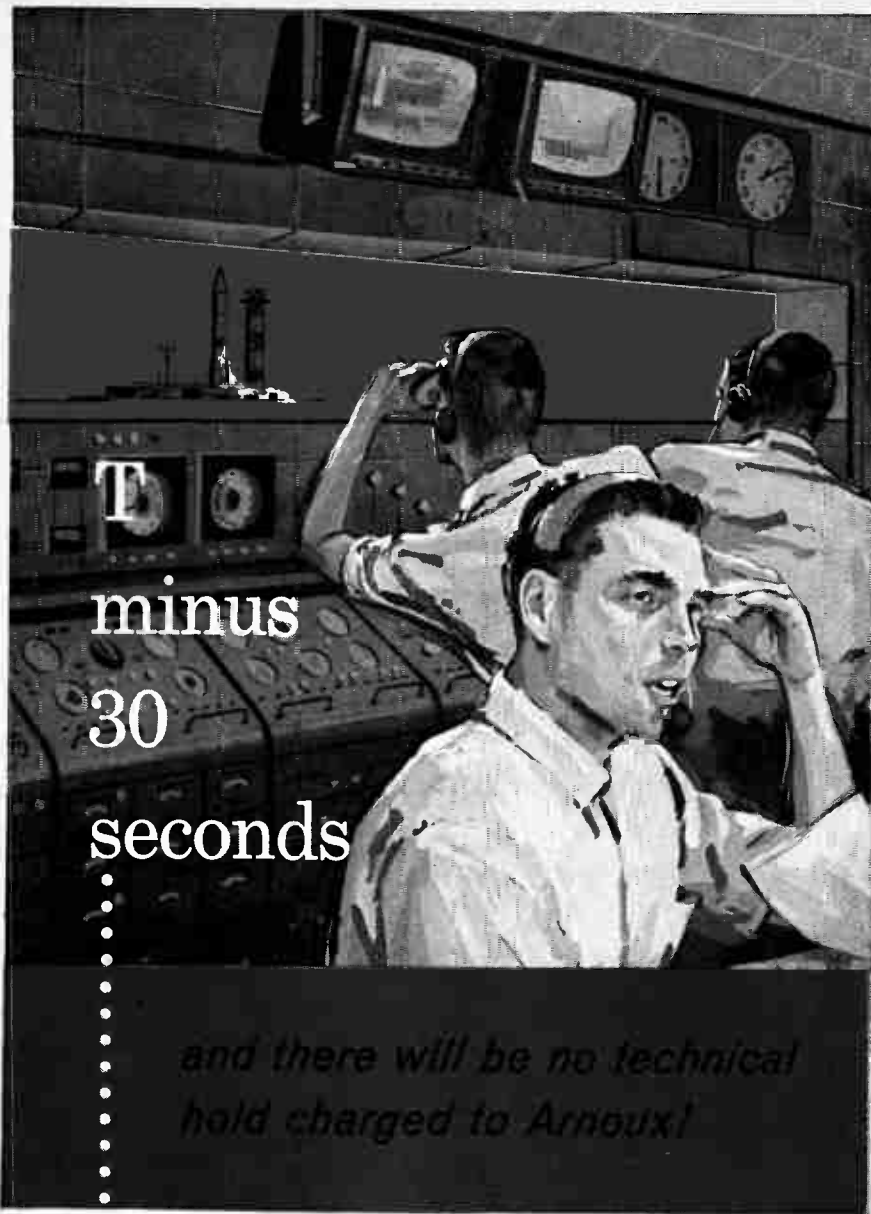
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Shown here:
portion of Arnoux-built
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axis.

Now suppose that the magnetic field lines at the two gaps are still in the opposite directions but are curved in the same manner as in Fig's 1A and 1C. Then the main deviation of the electrons, the undulation in the x -direction, will be equal and opposite in the two gaps as before. But now converging and diverging effects will also be cancelled so that the emergent beam is paraxial. But in the interval between the pairs of magnets, the beam will have diverged in the x -direction and converged in the y -direction. It is simple to show that this transformation of dimensions means that a circular cylindrical incident beam becomes an elliptic cylindrical emergent beam. By varying the axial separation of the gaps, the minor axis of the ellipse can be reduced, in principle, to zero, and the major axis then will be twice the diameter of the original circular cylinder beam.

In practice, the minor axis will be limited by lens aberrations and space-charge repulsion of the electrons but by suitable design a very flat beam should be achieved.

Strip Beam

An electron beam of elongated cross-section is desirable in several types of microwave tubes. For example, in Karp tubes³, where the beam interacts with a flat structure, a circular beam is very wasteful as much of it is too far away to experience the microwave field. Many attempts have been made to design focussing electrodes for strip beams but none have been entirely successful. On the other hand, the procedure for designing a circular section beam is well known⁴ and the results are extremely good. Hence this method of focussing has two distinct advantages.

First, by starting with an easily attained circular section beam, this simple lens produces a controlled amount of ellipticity that increases the efficiency of interaction with microwave structures.

Second, the area of the ellipse is smaller than the original circle. Hence the current density is increased, which again improves the efficiency of a microwave tube. The increase in current density is by a

factor $1 - (d/f)^2$ where d is the axial separation of the two lenses.

Example

In a backward-wave oscillator a strip beam of 2,500-v energy might be required. Suppose magnets are arranged in a skew manner so that the field changes by a factor 2 in 5mm. Then for a focal length of 2.5cm, this field change should be from 140 to 70 oersteds. The maximum value of the undulator deflection angle is 2.10^{-3} radians, which means that the beam is accurately returned to the original direction by the second pair of magnets at the focal plane of the first pair.

REFERENCES

- (1) M. S. Livingston, High Energy Accelerators, Interscience Publishers, New York, 1954.
- (2) H. Motz, *J. App. Phys.*, 22, 257, 1951.
- (3) A. Karp, *Proc of IRE*, 43, 41, 1955.
- (4) J. R. Pierce, Theory and Design of Electron Beams, Van Nostrand, New York, 1949.

Insulation Coatings For Printed Circuits

EPOXY FILMS with improved handling characteristics, lower initial viscosity, longer pot life and a slower rate-of-drop of insulation resistance during humidity have been developed by Houghton Laboratories of Olean, N. Y.

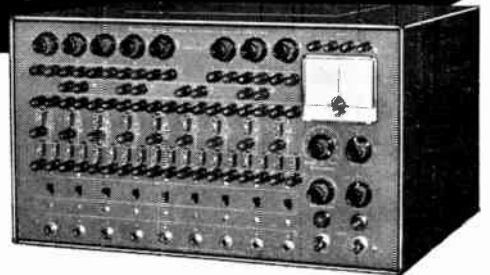
Tests were run on their developmental coatings in accordance with MIL-STD-202 method 106. Surface resistance was measured at the conclusion of a 10-day humidity cycling. The coatings were evaluated on etched $\frac{1}{16}$ -in. XXXP laminate, lined 0.030-in. wide and spaced 0.030-in. apart. Test results of their new HYSOL 6233 are presented in the following table:

Table I—Printed-Circuit Coat 6233

| | |
|--|---------------------------|
| Surface resistance | 125×10^9 megohms |
| Dielectric strength | 2,000 v/mil |
| Dielectric const. (1 mc) | 3.35 |
| Power factor (1 mc) | 0.0278 |
| Temp. cycling, -55 to 85 C: $\frac{1}{8}$ -in. casting with metal inserts; 10-mil coat on XXXP | No Cracks |
| Flexibility | Good |

Houghton Labs have conducted a series of research studies for the improvement of insulating coatings for printed circuits. Published U. S. Government Research Report numbers are PB 135 756; PB 135 755; PB 136 059 and PB 139 052.

NEW! An Electronic ANALOG COMPUTER KIT for just \$199⁹⁵



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Industry will find the EC-1 invaluable in trial solutions to mechanical and mathematical problems . . . shortens engineering time, speeds up preliminary work, frees the advanced-computer time for more complex problems and final solutions. And the EC-1 aids in training computer operators and acquainting engineers with computer versatility and operation.

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Set up scores of complex problems with the assortment of precision components and patch cords supplied. Read problem results directly on the 3-range computer meter, or use an external read-out device such as the Heathkit OR-1 DC Oscilloscope, or a recording galvanometer. Meter can be switched to read output of any amplifier for problem results or balancing purposes. Informative manuals provided show how to set up and solve typical problems, illustrate operating procedures, and supply basic computer information, references, and construction procedure. Shpg. Wt. 43 lbs.

SPECIFICATIONS: Amplifiers: 9 D.C. Operational Amplifiers using one 6U8 per amplifier; each solves mathematical problems; each balanced by individual panel control without removing problem set-up. Computing components mount on connectors and plug into panel sockets. Open loop gain approximately 1000. Output -50 to +60 volts at 3 ma. Power Supplies: +300 volts at 25 ma electronically regulated; variable from +250 to +350 by control with meter reference for setting +300 volts. Negative 150 volts at 40 ma regulated by V R tube. Coefficient Potentiometers: Five on panel. Initial Condition Potentiometers: Three on panel; used to introduce initial velocity, acceleration, etc. on the three "given" quantities. Repetitive Operation: Multivibrator cycles a relay at adjustable rates (.1 to 15 CPS), to repeat the solution any number of times; permits observation of effect on solution of changing parameters. Meter: 50-0-50 ua movement. Power Requirements: 105-125 volts, 50-60 cycles, 100 watts. Dimensions: 19 1/4" W. x 11 1/2" H. x 15" D.

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Transistor Tester Prints Results



Control unit of sequential analyzer. Lights in horizontal rows indicate transistor under test, lights left of meter indicate test being made

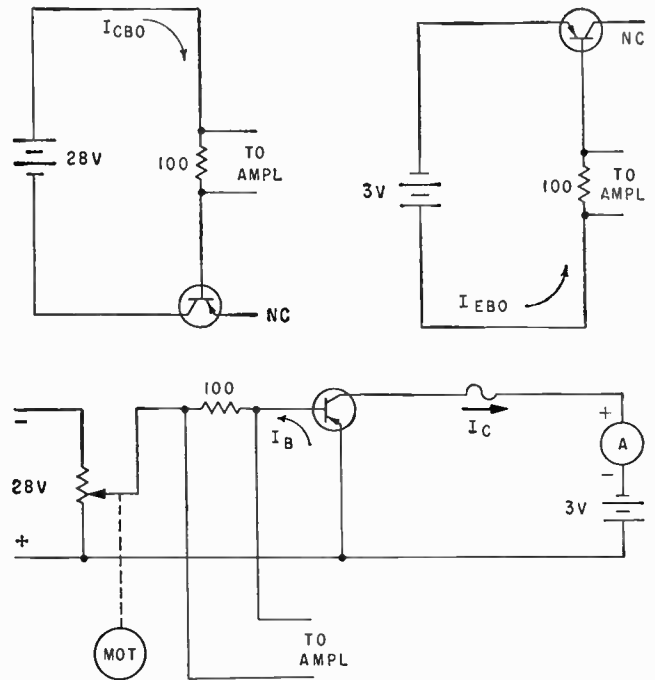


FIG. 2—Test circuits used in analyzer. I_{CBO} and I_{EBO} are determined directly; beta is found as ratio of I_C to I_B

PRINTED RECORD of transistor test results are obtained by Ford Instrument Co., Division of Sperry Rand Corp., Long Island City, N. Y., with an automatic tester made up of commercially available instruments and control circuitry designed by the firm.

The tester sequentially analyzes groups of 28 *npn* or *pnp* power transistors for parameters indicating suitability for servo amplifier use. Testing time is approximately $\frac{1}{2}$ that required by manual methods.

Parameters measured are collector-base diode reverse current with emitter open (I_{CBO}), emitter-base diode reverse current with col-

lector open (I_{EBO}) and d-c current gain in the common emitter configuration, beta (h_{FE}). Beta is determined as the ratio of d-c collector current to the d-c biasing current required to produce the value of collector current.

Fig. 1 is a block diagram of the system and Fig. 2, the test circuits. The control unit is seen as the bottom deck in the photo. The control unit panel contains 30 lights indicating the number of the transistor under test or the control signal (lights 29 and 30), 3 lights indicating which parameter is being measured, 5 toggle switches to select polarities for *nnp* or *pnnp* types of transistors, a counter and reset button and a relay type ammeter to set the beta measuring level.

The transistors are mounted on test boards with sockets designed to accept diamond or square heat sinks. Spring-loaded toggle clamps insulated with a rubber patch keep each transistor firmly in contact. Emitter and collector terminals of the sockets are each wired in multiple and terminate in receptacles at



Test record is transcribed into log

one end of the test board. The receptacles connect the 28 collectors and 28 emitters to the selector switch via cables. The base terminals of the sockets are commoned at the test board. A single base lead is run into the control unit.

The rotary selector switch has 30 contacts on each of 6 decks. Contacts on deck A connect to the 30 monitor lights. Collector and emitter leads terminate in decks B and C. Deck D is active only in position 29, providing control voltage to switch into d-c beta operation. The remaining 2 decks can permit expansion to a 56-transistor setup.

During the switch's first cycle, I_{CBO} is measured. At position 30, a leaf switch is closed, setting up

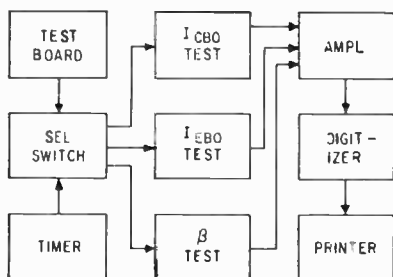
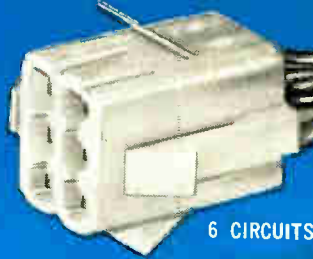


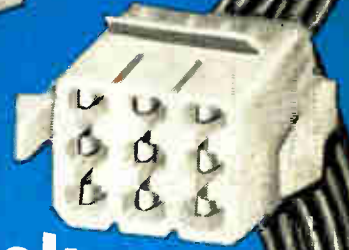
FIG. 1—Block diagram of system

**AMP**

3 CIRCUITS



9 CIRCUITS



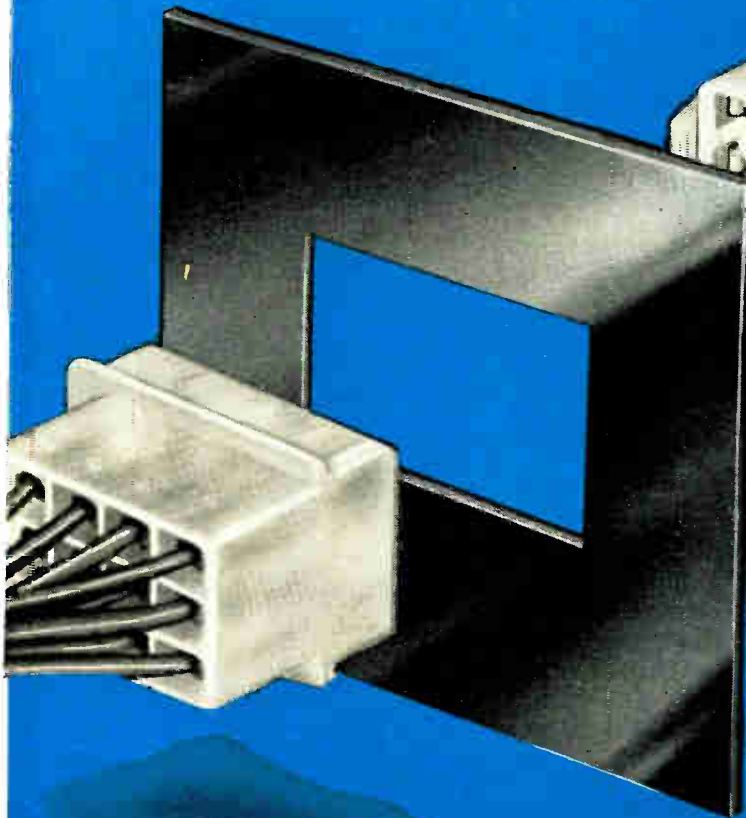
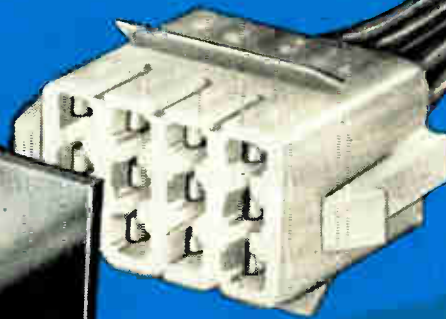
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12 CIRCUITS



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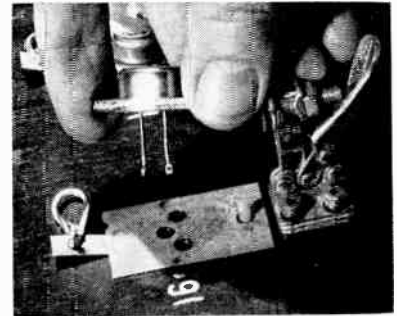
SEMINOLE DIVISION

FORT LAUDERDALE, FLA.

SM15'



Test board holds 28 transistors. Rubber patches insulate toggles



Closeup of test board socket

the I_{EBO} test circuit. Another leaf switch makes or breaks connections at each step of the selector switch, which is stepped by an electromagnet energized by the timer. Various relays bring in measurement circuits and panel lamps as required.

The timer is a multivibrator with *on* and *off* conditions set at 15 seconds. The time lag guards against errors due to initial test circuit instability or wiper contact noise.

I_{CBO} and I_{EBO} are measured during *off*. At the start of *on*, a print command signal is relayed to the digitizer and progresses to the printer. After printout, the printer trips a snap-action switch, sending a feedback pulse to the electromagnet, readying it to step the selector.

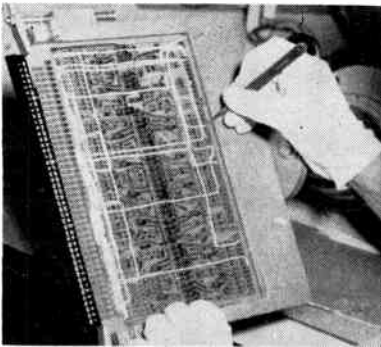
Beta measurement is generally during *off*. However, if no beta is obtained due to some fault, an artificial beta reading is introduced to at the *on* point insure that there is a line of data for each transistor. The relay ammeter senses the pre-selected beta current at which the d-c beta is measured, triggering printout. The potentiometer drive motor advances during *off* and reverses during *on*.

The d-c amplifier preamplifies

signal voltage across the 100-ohm resistor in each case. The digitizer (digital voltmeter) converts the d-c voltage to a corresponding digital code signal which is converted by the printer's type wheels into the actual values. Values are printed on paper tape.

The operator loads the test board, sets the toggle switches and resets the counter to 90. The operation is then automatic until the counter reaches zero and the analyzer shuts off.

Numbered Strip Guides Board Terminal Wirer



Guide does not interfere with use of holding fixture

HANDY GUIDE for wiring edge-mounted taper-pin terminals is used at Arma Division, American Bosch Arma Corp., Garden City, N. Y. When terminal identifications are not printed on the board, it avoids errors which might occur if assemblers counted terminals. The first terminal position on the board shown, for example, is vacant.

Because spacing between terminals is generally standard, the guide can be used for a variety of boards. Numbers, counting positions from top or bottom, are printed on a strip of $\frac{1}{8}$ inch Bakelite. Four U-shaped and tapered pins or bars are riveted to the strip, as shown in Fig. 1.

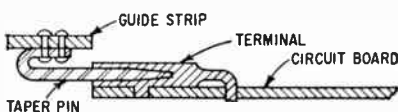
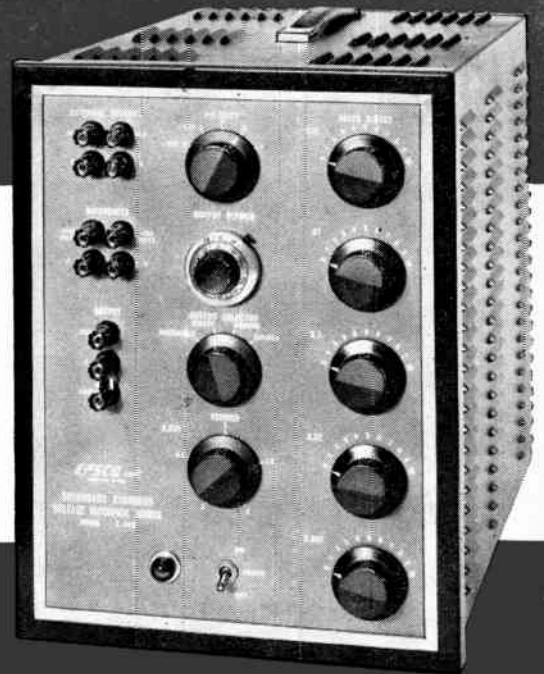


FIG. 1—Cross section through a guide mounting pin

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VR-607B — portable, 17 binary-coded toggles plus vernier and divider
VR-608 — rack-mounting, 5 decade switches plus vernier and divider, and front panel null meter

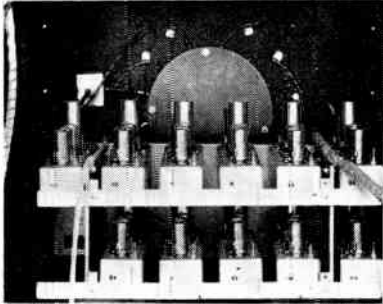
- Out-perform any other voltage reference source on the market • contain highest quality components: certified standard cells, oil-immersed ultra-stable resistors, high-gain chopper-stabilized amplifiers • being used in the most demanding and critical applications across the country, such as at Convair Astronautics, North American Aviation, Argonne National Laboratory, Massachusetts Institute of Technology, Bell Telephone Laboratories, Goodyear Rubber, Patrick Air Force Base.

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In the West: Epsco-West, 125 E. Orangethorpe Ave., Anaheim, California

On The Market



Tapped Delay Line jitter free

ANDERSEN LABORATORIES, INC., 501 New Park Ave., West Hartford 10, Conn. An ultrasonic, tapped delay line to provide various delays from one input signal, has been developed. This may be used for data processing and analysis of digital and analog information. Number

of taps and delay per tap are available to suit customer requirements. Typically, taps range from 5 μ sec per tap to 50 μ sec per tap with additional range also available. Counting rates can be achieved up to 2,000,000 pulses per sec. Drivers and post delay amplifiers may be supplied with pulse reshaping if desired.

CIRCLE NO. 200 READER SERVICE CARD

Voltmeter expanded scale

AMERICAN MACHINE & FOUNDRY Co., 1025 North Royal St., Alexandria, Va. Principal feature of the new expanded scale voltmeter is accurate indication of true rms voltage in the presence of harmonic content in the power supply. It maintains 0.1 percent accuracy over

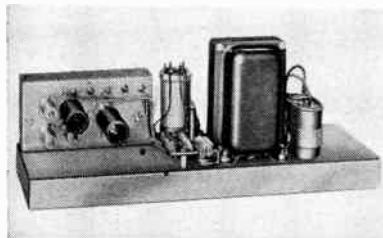
a wide temperature range and in the presence of as much as 5 percent harmonic content, thereby providing a more accurate indication of input power levels than is possible with conventional types of voltmeters. The new design uses a 250-deg scale to provide maximum readability on the 115 to 125 v dial. Unit includes a 3½ in. panel meter.

CIRCLE NO. 201 READER SERVICE CARD



VHF Amplifier low noise

ADLER ELECTRONICS, One LeFevre Lane, New Rochelle, N. Y. Type VCA-1 amplifier provides a minimum gain of 40 db on any vhf tv channel in the 54-88 mc frequency



range. At Channel 6, the noise figure is 3 db. The amplifier also features 10,000-hr tubes for reliability and remote crystal-control monitoring. The compact 12-lb unit may be either pole, rack or chassis mounted.

CIRCLE NO. 202 READER SERVICE CARD

Machinable Ferrite highly permeable

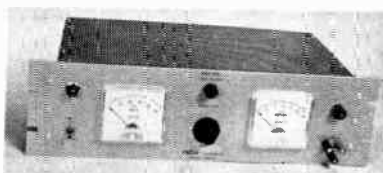
KEARFOTT Co., INC., Clifton, N. J. The MN-30 high permeability ferrite is ideal for use in magnetic cores. Its low losses and high saturation magnetization make this material suitable for applications



at frequencies up to 500 kc, and eddy current losses are minimized

by its high resistivity. Virtually any size and shape specified can be readily furnished, with dimensional tolerances within ± 0.001 in., and the grinding operation does not alter the ferrite's magnetic properties. Density ranges from 4.9 to 5.0.

CIRCLE NO. 203 READER SERVICE CARD



Power Supplies transistorized

VALOR INSTRUMENTS, INC., 13214 Crenshaw, Gardena, Calif., announces a new series of continu-

ously variable regulated d-c transistorized power supplies. Output is 1.5 to 50 v, 0 to 2 amperes and 1.5 to 32 v, 0 to 3 amperes; transient response, 40 mv typical for 15 μ sec; line regulation, less than

Meet Bill Bushor and Sam Weber

Associate Editors, electronics
FEATURE ARTICLE EXPERTS



Resumés:

Bushor, William E., Lawrence Institute of Technology, BSEE, I. R. E. member. 9 years experience: U.S. Army (communications chief), Bell Aircraft (air-to-air missile), G. M. Research Labs, Sperry Gyroscope, etc. Member Society Technical Writers.

Weber, Samuel, Virginia Polytechnic Institute, BSEE, I. R. E. member. 10 years diverse engineering experience: U. S. Navy, Barlow Electrical Mfg. Co., Curtiss-Wright, etc. Primarily in communications, uhf and microwave components and design, jet engine test instrumentation.

Present Occupations:

Bill Bushor is preparing a series to appear in 1959 on medical electronics comprising diagnostics, therapeutics, prosthetics, and clinical and operative aids.

Sam Weber is working on "Sophisticated Communications Methods" for the October 1959 issue. Report covers scatter systems, meteorburst transmission, satellite relays, carrier systems, etc.

References:

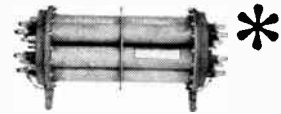
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electronics

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E PLURIBUS



Many bits of information to transmit...one optimum antenna... If this is the problem to be solved (as it was in the Titan), Rantec **multiplexers** can couple two, three, four or six telemetry signals of different frequencies to one antenna system. Insertion loss (only 1.5 db on model above) is minimum, weight is minimum, space is minimum, and isolation (20 db) is maximum.



corporation
calabasas, california

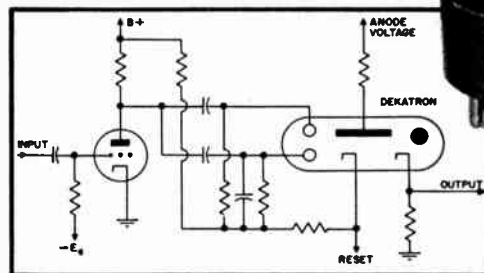
* UNUM

CIRCLE NO. 117 READER SERVICE CARD

Simplify Circuitry
using

dekatron

Electronic Counting Tubes
(up to 20,000 counts/sec.)



Typical Drive Circuit

As a user of DEKATRON cold cathode glow-transfer counting tubes, you are welcome to use this and many other drive circuits designed by us. Circuits are patented (or applied for) but are available to DEKATRON customers on a royalty-free basis.

Write to us for complete information.

Baird-Atomic, Inc.

33 UNIVERSITY RD., CAMBRIDGE 38, MASS



Instrumentation for Better Analysis



... now wind 19,000 times!

If you're dedicated to the cause of high resolution, you could wind your own pots and be sure. Allow yourself plenty of time, though — because the secret's in the number of turns per inch, and the spacing between 'em. Pack those turns right in there *closely and accurately*, and you *might* have a pot you'll be proud of!

But if you want to eliminate all bother, but not the high resolution, call on Ace! We've designed and built our own special winding equipment; we use premium, close tolerance resistance wire — and really leave no winding unturned to produce pots with the highest resolution in the industry. All AIA sizes, all mounting styles, specials and standards. So get your resolution the easy way — get Acepots! See your ACErep at once!



Here's highest resolution in a standard sub-miniature pot: The 500 Acepot® ½" size, ±0.3% independent linearity. Special prototype section insures prompt delivery on the Acepot® - ½" to 6" AIA sizes.

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOMerset 6-5130 TMX SMVL 181 West. Union WUX

Acepot® Acetrim® Acesel® Aceohm® *Reg. Appl. for

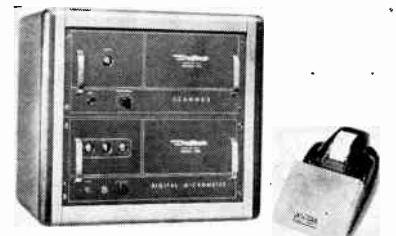
0.1 percent; load regulation, 25 mv typical; ripple, less than 0.02 percent; output impedance, 0.5 ohm maximum d-c to 5 kc; input 105-125 v, 60-400 cps. Weight of the unit is 15 lb.

CIRCLE NO. 204 READER SERVICE CARD

Transistor Machine for fast assembly

ELECTRO-MACHINERY DIVISION, Design Tool Corp., 772 Bergen St., Brooklyn 38, N. Y., has introduced a new radial lead straightener, model AL3NS, an all purpose machine for automatically straightening, cutting and preforming the leads of transistors. It is simple in operation: (1) Straightens and aligns transistor leads; or (2) straightens, aligns and cuts transistor leads to specific lengths; or (3) the wire transistor leads can be cut and notched to stand above the board for heat dissipation.

CIRCLE NO. 205 READER SERVICE CARD

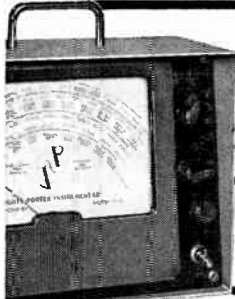


Digital Micrometer accurate to 0.0001 in.

DAYTRONIC CORP., 216 S. Main St., Dayton 2, Ohio. Automatic scanning and printing of dimensional data with accuracy to 0.0001 in. is achieved with the model 700 digital micrometer and accessory items. From one to 99 gaging points can be measured in rapid sequence with the identification number and dimension of each point printed automatically on paper tape or stringed cards (for attaching to part). Operation can be manual, semiautomatic or completely synchronized with manufacturing and inspection process.

CIRCLE NO. 206 READER SERVICE CARD
(Continued on p 84)

accuracy



±1%
(and better)

**zero drift
even from
a cold start**

new MODEL T-2 Frequency Meter

21 Direct Reading Scales—14 ranges from 25 cps to 80 kc; 7 from 1250 to 80,000 rpm.

Extreme Readability

Any Input 10 mv-300 v, with equal accuracy any repetitive function.

New Model T-3
Frequency Meter



● 0 to 300, 0 to 3000 cps ranges. Operates on any 60 to 400 cps line.

● Ideally suited to tone selector adjustment in two-way communication systems.

Write

JONES-PORTER
INSTRUMENT CO., INC.

Box 302, Millburn, N. J.



CIRCLE NO. 44 READER SERVICE CARD

MEET TOM EMMA

Associate Editor, electronics
FINANCE EXPERT



Thomas Emma, BA, Columbia, is a U.S. Naval Reserve officer who was formerly a technical writer with IT&T. Tom prepares "Financial Roundup"—a regular weekly business feature. In the coming months Tom will be concerned with radio communications, but he will be specifically involved with spectrum usage problems. To keep abreast of finance in electronics, turn to Tom's weekly coverage of latest developments. To subscribe or renew your subscription, fill in box on Reader Service Card. Easy to use. Postage free.



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Aerojet-General Corporation

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June 25, 1959.

CIRCLE NO. 119 READER SERVICE CARD

ENGINEERS

Newport Beach, Southern California...

Holds the Key to YOUR Future!

FORD MOTOR COMPANY'S young and rapidly expanding subsidiary, **Aeronutronic Systems, Inc.** is now offering outstanding opportunities for an exciting and highly rewarding career to Computer Engineers capable of making significant contributions to advanced computer technology.

AERONUTRONIC—a dynamic new name in science and research—is moving into the future fast. The first phases of a new Research Center are nearing completion at Newport Beach, where California living can be enjoyed at its finest. You'll work in an intellectual atmosphere—in a community away from congestion, yet close to most of Southern California's cultural and educational centers.

These positions are now open:

Systems Engineers
Magnetic Memory Engineers
Communications Engineers
Digital Computer Programmers

Logical Designers
Circuit Engineers
Mechanical Engineers
Optical Engineers
Transistorized Circuit Engineers

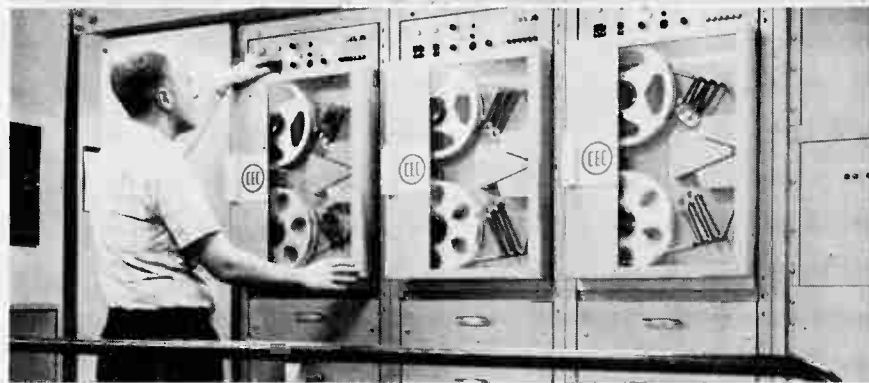
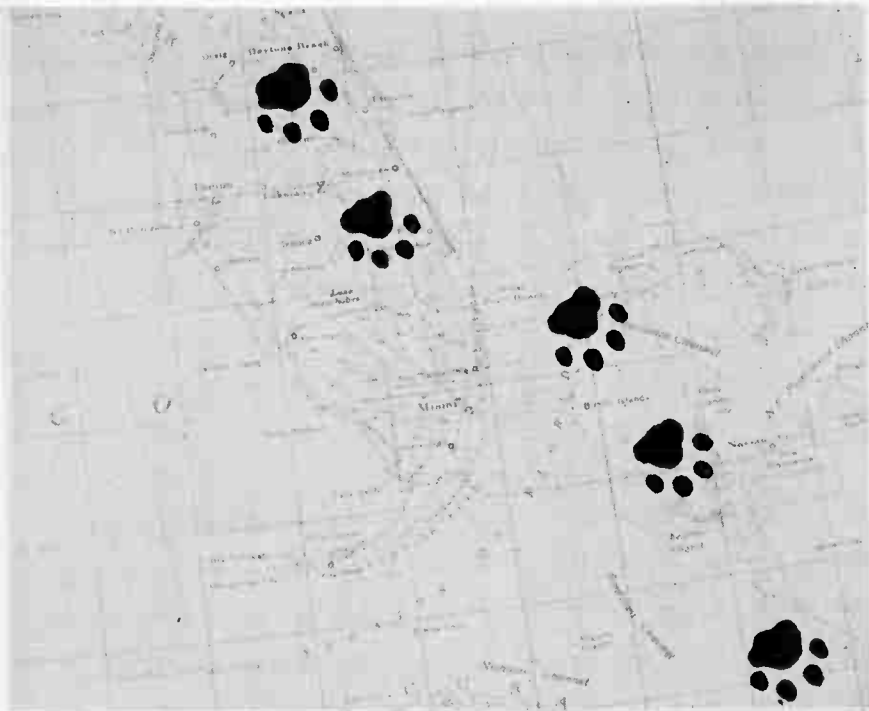
Qualified applicants are invited to send resumes or inquiries to Mr. L. R. Staple, Aeronutronic Systems, Inc., Box NK 486, Newport Beach, California.

COMPUTER DIVISION

AERONUTRONIC

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THE FINE ART OF TRACKING and recording data from the nation's newest missiles is the task of the newly outfitted USS American Mariner—operating in the waters of the Atlantic Missile Range. Advanced electronic equipment aboard includes CEC DataTape 5-681 Digital Recorder/Reproducers. Employing all solid-state electronics, the units feature 5-millisecond start and stop times, 0.05" tape positioning accuracy, 10½" NARTB reels, and complete front accessibility. Transport fits standard 19" relay rack. Two types provide tape speeds to 30 and 150 ips. For more information, call your nearest CEC sales and service office, or write for Bulletin CEC 1618-X5

DataTape Division **CEC**

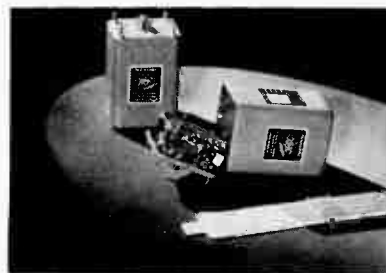
CONSOLIDATED ELECTRODYNAMICS / 360 sierra madre villa, pasadena, california

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

H-V Rectifier Tube mercury-vapor

WESTINGHOUSE ELECTRONIC TUBE DIVISION, P. O. Box 284, Elmira, N. Y., has available a high-voltage mercury-vapor rectifier tube (WL-575A) used in power supplies for r-f heaters, radio broadcasting transmitters, or sonar transmitters. It is rated at 15-kv inverse voltage and 1.5 amperes. The anode is specially processed for reliable performance as a h-v rectifier. A special silicone cement is used for the base and top cap for long trouble-free service.

CIRCLE NO. 207 READER SERVICE CARD



Power Packs transistorized

ELECTRONIC RESEARCH ASSOCIATES, INC., 67 Factory Place, Cedar Grove, N. J., announce the incorporation of new short-circuit and transient-proof circuitry in their line of solid miniaturized power packs. New power packs cover the voltage range 5-60 v d-c in fixed and adjustable types and are available in ratings up to 200 ma. All units operate from an input source of 105-125 v a-c, 60 or 400 cps. Typical volume is 25 cu in.

CIRCLE NO. 208 READER SERVICE CARD

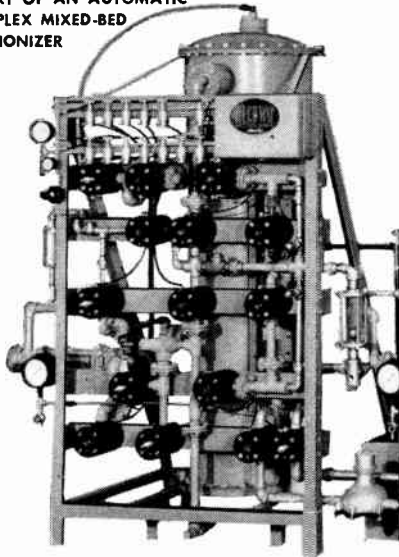
Decimal Scaler weighs only 16 lb

ELDORADO ELECTRONICS, 2821 10th St., Berkeley 10, Calif., announces a decimal scaler with better than 1 μsec resolution. Though the model SC-700 is designed for general radiation counting, size, weight and performance gear the unit especially to accelerator counting room service. The instrument features seven decades of decimal counting storage, stable feed-back input amplifier with 25 mv sensi-

Get Water "AS PURE
AS POSSIBLE" with



ILLUSTRATED:
PART OF AN AUTOMATIC
DUPLIX MIXED-BED
DE-IONIZER



PROVED IN SERVICE

FOR TUBES AND TRANSISTORS

Manufacturers of tubes and transistors using ILLCO-WAY ionXchange Equipment are now getting up to 20-megohm water consistently and at low cost — and you can't hardly do that any other way. We have supplied various types and sizes of Automatic Mixed-Bed and "Package" Units, as required by individual conditions. Several have proved so successful as to call for multiple and repeat installations.

TAKE ADVANTAGE OF OUR PIONEERING KNOWLEDGE

We originated the Mixed-Bed De-Ionizer in 1949 and have led the way in introducing it to the electronics industry. In each case, the particular units furnished have been determined from a careful analysis of raw water conditions. *Where you need the purest possible water*, let your ILLCO-WAY representative advise you.

Write for Bulletin MB



ILLINOIS WATER
TREATMENT CO.
840 Cedar St.
Rockford, Ill.

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Can.

CIRCLE NO. 120 READER SERVICE CARD
ELECTRONICS • JULY 17, 1959

Varflo

sleeving and tubing

**... Will do Class A and Class B jobs!
... For the Price of Class A Insulation!**



Varflo enlarged
for details



Wherever you use either—
or *both*—Class A and Class B sleeving
and tubing, Varflo will save you
money . . . by filling the require-
ments of *both* classes at the cost of
Class A insulation!

Varflo vinyl-coated, Fiberglas
Sleeving and Tubing with its superior
qualities of flexibility and greater
dielectric strength under all conditions
make it ideal for both Class A and
Class B installations.

- **FLEXIBLE** It can be bent or even tied in knots without cracking or crazing.
- **RESISTANT** to water, alkalis, mild acids, oils and greases.
- **TOUGH** and stands up under vibration. Ideal for "After Treatment" operations.
- **LONGER LASTING** at high temperatures. Withstands hundreds of hours at 300° F. Good shelf life, too.
- **MORE STABLE**, retains dielectric value when pulled back during soldering.
- **AVAILABLE IN 3 NEMA GRADES**, B-A-1, B-B-1, and B-C-2 in 10 colors, in coils, 36" lengths or short pieces.

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Electrical Insulating
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complete line of samples and
recommended uses.



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Please send me free folder containing description and test samples of Varflo Sleeving and Tubing.

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HIGHER POWER OUTPUT

Using VTP's new Xenon Thyatron VTP-7386

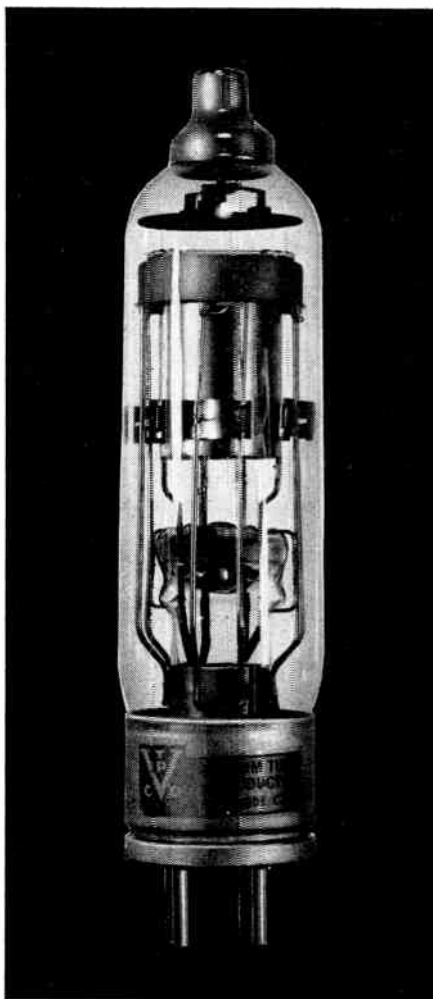
30% more peak plate current

With this new type of tube, employing new techniques in filament and grid construction, you can obtain sharply increased power output from AC-DC converters, spot-welding equipment and other instruments using xenon thyatrons of the C6J, C6JA, 5685 or 5C21 types.

VTP's new VTP-7386 equals or exceeds all of the electrical characteristics of the older tubes, and in addition provides up to 30% higher peak plate current. The effect is to increase immediately the power rating of devices using tubes of this type, and the life that you can expect from the equipment before tube replacement.

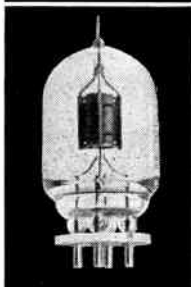
Peak plate current for the new VTP-7386 is 100 amperes, compared to 77 amperes for the earlier tubes. Triggering voltage is -3.0 to -7.5 volts D.C., with a maximum forward voltage on the plate of 1000 volts. Maximum recommended frequency is 440 cps.

The VTP-7386 is one member of VTP's complete line of gas-filled thyatrons and rectifiers available to you. Other tube types from Vacuum Tube Products:



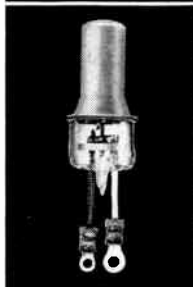
4B31

(as clipper diode)
Peak inverse voltage:
16,000 volts
Peak plate current:
12 amperes
Average plate current:
60 ma DC



705A

(half-wave, high vacuum rectifier)
Peak inverse voltage:
30,000 volts
Current at peak inverse voltage:
100 ma
Static test plate current at 300 VDC:
290 to 440 ma DC



554

(as clipper diode, liquid cooled)
Peak inverse voltage:
16,000 volts
Peak plate current:
12 amperes
RMS current:
450 ma AC



6339

(as clipper diode, liquid cooled)
Peak inverse voltage:
10,000 volts
Peak plate current:
8 amps
RMS current:
150 ma AC



For additional information on VTP-7386 and other tubes in the VTP line, write to Vacuum Tube Products, P.O. Box 810, Oceanside, California. For export write: Hughes International, Culver City, California.

VACUUM TUBE PRODUCTS

a division of HUGHES AIRCRAFT COMPANY

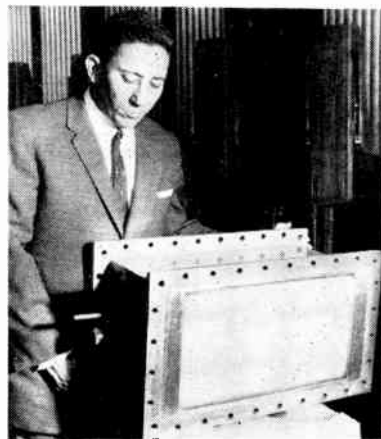
tivity, precision integral discriminator, and built in line frequency test circuit. Price is \$595.

CIRCLE NO. 209 READER SERVICE CARD

Ladder Filters miniature line

CLEVITE CORP., 3311 Perkins Ave., Cleveland 14, Ohio. Line of miniature ceramic i-f bandpass filters provide low impedance, increased selectivity, high stability with respect to time and temperature, high Q and low cost.

CIRCLE NO. 210 READER SERVICE CARD



Waveguide Window for large radars

I-T-E CIRCUIT BREAKER CO., 1900 Hamilton St., Philadelphia 30, Pa., has developed a new waveguide window for use in multi-megawatt applications with WR-2100 waveguide. The new window provides excellent radio-frequency continuity and a low swr of 1.03 over a 10 percent band. It achieves its high power-handling capabilities through use of a special cross-linked polystyrene as the mechanical barrier.

CIRCLE NO. 211 READER SERVICE CARD

Voltage Response Tester automatic unit

BRIGGS ASSOCIATES, INC., 10 DeKalb St., Norristown, Pa. A new automatically swept power supply is useful in testing voltage response characteristics over narrow or broad scanning limits. It can be coupled with an X-Y recorder to draw response curves. Sweeping limits may be preset or manually controlled at continuously variable scanning speeds. Typical dual-voltage ranges are 2,000 and

**lacing tapes
ENGINEERED for
TEMPERATURE
by GUDEBROD**

375°C GUDE-GLASS

Flat braided of glass fibers, Gude-glass is recommended for use where high temperature is a factor. Available with special finishes for non-slip characteristics, it is non-toxic, resists fungus and is flexible within its complete range: -40°C to 375°C.

220°C TEMP-LACE

Manufactured of pure TEFLON*, Temp-Lace is the latest addition to the Gudebrod line. Chemically inert, it is available in natural finish, with a fungistatic rubber coating or with a silicon dispersion finish. In five sizes, it is flexible from -40°C to 220°C.

160°C STUR-D-LACE H

Flat braided of DACRON** with non-corrosive rubber finish or wax finish, Stur-D-Lace H meets the most severe requirements for fungus-resistance. It is non-toxic, knots tightly, is unaffected by most chemical solvents. In five sizes, all with high dielectric strength.

90°C GUDELACE

The original Gudebrod lacing tape, flat braided of nylon with special wax finish, Gudelace has become the standard where excessive high temperatures are not encountered. In seven sizes, Gudelace also comes in six colors for circuit coding.

Write for new Data Book with complete specifications of All Gudebrod Lacing Tapes.

*Du Pont's trade mark for its TFP fluorocarbon fiber
**Du Pont's trade mark for its polyester fiber

**GUDEBROD
BROS. SILK CO., INC.**

ELECTRONICS DIVISION
225 West 34th Street, New York 1, N.Y.
EXECUTIVE OFFICES
12 South 12th Street, Philadelphia 7, Pa.

CIRCLE NO. 121 READER SERVICE CARD
ELECTRONICS • JULY 17, 1959

**ALL NEW! BRUNING
COPYFLEX
435**



**IT HAS EVERYTHING
EXCEPT A HIGH PRICE!**

Here, without question, is the greatest value in reproduction today!

Bruning's Copyflex 435 is a completely new medium-volume machine that offers you all the conveniences of most big-production machines but at an amazing low price!

It has a spacious 42" printing width, powerful 3,000* watt lamp, and a mechanical speed of 40 feet per minute . . . plus a host of such conveniences as automatic separation, a foot lever for releasing incorrectly fed stock, adjustable front print tray, automatic tracing stacker, new air filtering system that assures cleaner prints, and a pressure-roller developer system that provides positive print development at all speeds. The 435 is fully equipped for roll stock. It provides selective front or rear print delivery.

Like all Copyflex machines, the 435 is odor-free, requires no venting, plumbing, or auxiliary equipment. Built by Bruning, it offers the durability and dependability that Bruning machines are famous for. You have *everything* to gain by investigating now the whiteprinter that gives you *everything* at the lowest price ever!

*4,000 watt lamp optional.

BRUNING

Copyflex®

Low Cost Diazo Reproduction at It's Best!

The Bruning Man is your expert on diazo reproduction. He's backed by a company with over 60 years' experience.



Charles Bruning Company, Inc. Dept. 7-UU
1800 Central Rd., Mt. Prospect, Illinois
Offices in Principal U. S. Cities
In Canada: 103 Church St., Toronto 1, Ont.

Please send me more information on the new Copyflex Model 435.

Name _____ Title _____

Company _____

Address _____

City _____ County _____ State _____

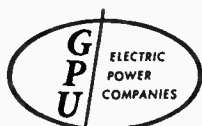
CIRCLE NO. 87 READER SERVICE CARD 87

If "Site-
Seeking" has
you going
'round in
circles



You need GPU Site-Service surest way to find the right plant location

The *one* complete, central source of plant site information for nearly half of Pennsylvania and New Jersey is ready to help solve your problem. It will furnish all the local and area economic data you need and help you secure an exactly suitable location in one of the nation's most desirable industrial areas. For further details, wire, write or phone today. You can be assured that your inquiry will receive prompt, *confidential* attention.



Metropolitan Edison Co.
Pennsylvania Electric Co.
New Jersey Power & Light Co.
Jersey Central Power & Light Co.

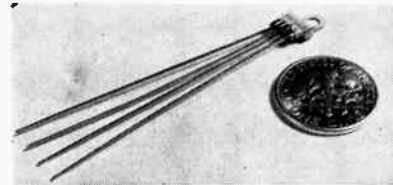


GENERAL PUBLIC UTILITIES CORPORATION

Att: Wm. J. Jamieson, Area Development Director, Dept. E-4
67 Broad St., New York 4, N. Y. Whitehall 3-5600

15,000 v at 4 ma. Accuracy and linearity, better than 1 percent.

CIRCLE NO. 212 READER SERVICE CARD



Rectifiers five standard types

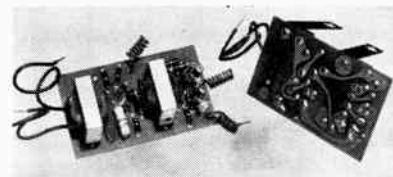
CONANT LABORATORIES, Box 3997, Bethany Station, Lincoln 5, Neb. New series 80 rectifiers are designed for use with d-c meters of 20 to 200 μ a full-scale current. Active cell area is only 0.0012 sq in. providing high efficiency at very small currents and better frequency response. Dimensions are 0.125 in. by 0.270 in. by 0.400 in. exclusive of leads. Nickel silver filiform leads are easily soldered or formed to fit printed circuits.

CIRCLE NO. 213 READER SERVICE CARD

A-C Solenoid small size

GUARDIAN ELECTRIC MFG. CO., 1621 W. Walnut St., Chicago 12, Ill. The No. 24 a-c midget solenoid is available for intermittent or continuous duty operation. Plunger stroke is adjustable from $\frac{1}{8}$ in. up to $\frac{3}{8}$ in. with maximum lift of 12 oz, continuous duty; 19 oz, intermittent. Coil voltages range from 6 to 230 v, a-c. Small size, $\frac{3}{8}$ in. high by $1\frac{1}{4}$ in. long by 1 in. wide, provides optimum power for miniaturized systems or wherever space is limited. Shipping weight is approximately 3 oz.

CIRCLE NO. 214 READER SERVICE CARD



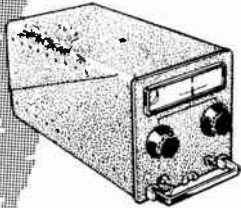
D-C Amplifiers compact units

TRI-PHI, INC., 141 Albertson Ave., Albertson, L. I., N. Y., announces the first in a series of d-c amplifiers incorporating printed circuitry and

AWA

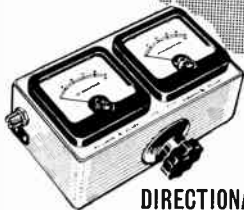
ELECTRONICS

New concepts in electronics have been developed at AWA, as a result of experience with missile systems. Now they have a wider application. Here are some of the new AWA devices now available to industry.



U.H.F.
WIDEBAND
RECEIVER

Basic arrangement consists of R.F. amplifier, mixer, local oscillator, I.F. amplifier (A.G.C. controlled), cathode follower output stage. Tuning indicator (EM 34) is also fitted to receiver. The standard forms: one for airborne racking with special separate power supply unit, the other on larger chassis including power supply unit (conventional 19" front panel). *Standard specification: 420-470 M/cs frequency range; 4 M/cs overall bandwidth, approximately 10 db noise factor; approximately 70 ohms input impedance, 200-250 V and 50-60 c/s input supply. Input is unbalanced, output is via low impedance (cathode follower) stage.*



DIRECTIONAL COUPLER

Of the 'Loop' type, suitable for measurements of RF power and Standing Wave Ratio in coaxial cables. Directional properties are largely unaffected by frequency changes, so coupler may be used to help obtain optimum termination of a 52 ohm coaxial system up to 600 M/cs. *Standard specification: Size 7" x 4" x 2½"; weighs 4 lbs. 3 ozs.; Power Measurement Range is Low range 1w.cw.max. High range 5w.cw.max.; less than 1% attenuation; better than 2% accuracy at frequency of calibration.*

All devices are adaptable to suit customers' own requirements. For further information consult:

COMMERCIAL ELECTRONICS DEPT.

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.

Baginton, Coventry, England

MEMBER OF THE HAWKER SIDDELEY GROUP

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ELECTRONICS • JULY 17, 1959

Pulse Notes

Introducing a New Sub-Miniature
Pulse Transformer

This is the Micro-Stat*



in epoxy...

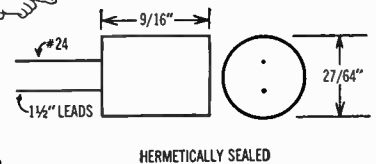
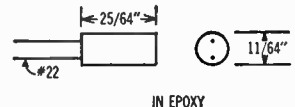


...hermetically sealed

These little guys meet all applicable
MIL SPECS and feature core-gapped
construction for

Faster reset and less B, Higher power capabilities, Lower losses, Improved insulation resistance, Increased total flux swing capability, Improved TC

They are
this big



You can choose Micro-Stats from over 50 designs, each with Pulse Engineering's singular clamped core construction. Pulse constructs these units on an armite form for precise winding geometry to control leakage inductance and distributed capacity. Voltage breakdown and insulation resistance are improved over conventional toroid and cup core construction. Available for immediate delivery — many types in stock. If you have critical space or performance requirements, call your nearby Pulse Engineering representative or write directly to us. Ask for our new 16 page catalog which gives complete information on 250 Pulse Engineering transformer designs.

Pulse Engineering Inc.

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*REGISTERED TRADEMARK, PATENTED CONSTRUCTION

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the tough jobs go to Frenchtown

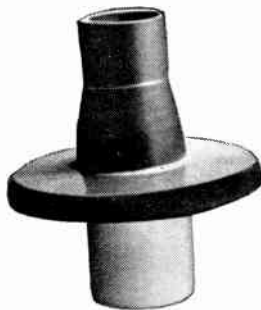
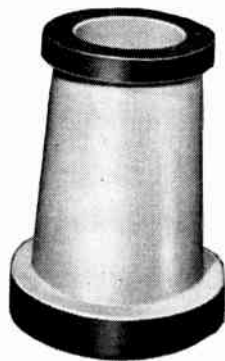
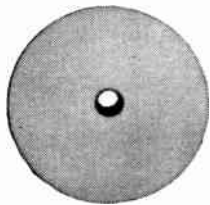
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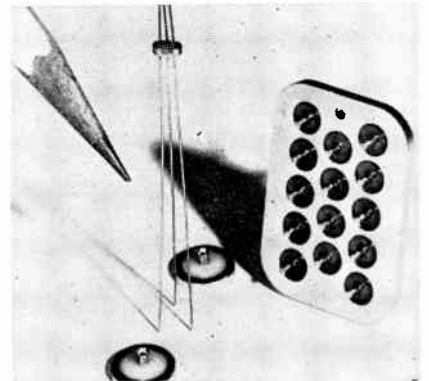
Literature is available on Frenchtown materials and products. We'll be happy to send you copies without obligation. Write *today*.

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FRENCHTOWN, NEW JERSEY



transistors. The TPC-324, a high impedance input unit which operates on 3 to 24 v d-c power, can drive a 3.2 ohm speaker directly without the use of output transformer. At 6 v, the unit has an acoustic audio output of 750 mw. Current drain ranges from a minimum of 10 to a maximum of 300 ma. Frequency response ranges from 50 cps to 20 kc, ± 2 db.

CIRCLE NO. 215 READER SERVICE CARD



Multiform Glass for steel sealing

CORNING GLASS WORKS, Corning, N. Y. A pressed and sintered glass which can be sealed directly to 430 Ti and 446 stainless steel has been developed. Typical applications for the Code 9019 Multiform glass include the two terminal coaxial hermetic connectors, the multi-lead connector and the semiconductor hermetic terminal block.

CIRCLE NO. 216 READER SERVICE CARD

Power Transistors in sealed package

MOTOROLA INC., 5005 E. McDowell Road, Phoenix, Ariz. Types 2N375 and 2N618 germanium *pnp* h-v power transistors meet or exceed MIL-T-A500A. Both are specified to include close parameter control for switching and amplifier applications throughout the a-f range. Maximum beta spread is 2.5 to 1.

CIRCLE NO. 217 READER SERVICE CARD

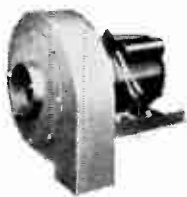
Servo Amplifier plug-in type

WESTAMP, INC., 11277 Massachusetts Av., Los Angeles 25, Calif., announces a high performance silicon transistor servo amplifier. Model A411 plug-in unit is de-



Peerless Electric Blowers perform an important and dependable cooling function in radio and radar equipment at hundreds of airports all over the world. Isolated transmitter equipment guiding aircraft in to safe landings *must* remain properly and continually ventilated to operate at peak efficiency. We are designing and building to customer and government specifications all the time. Whatever your air flow requirements or application, it will pay you to consult Peerless Electric.

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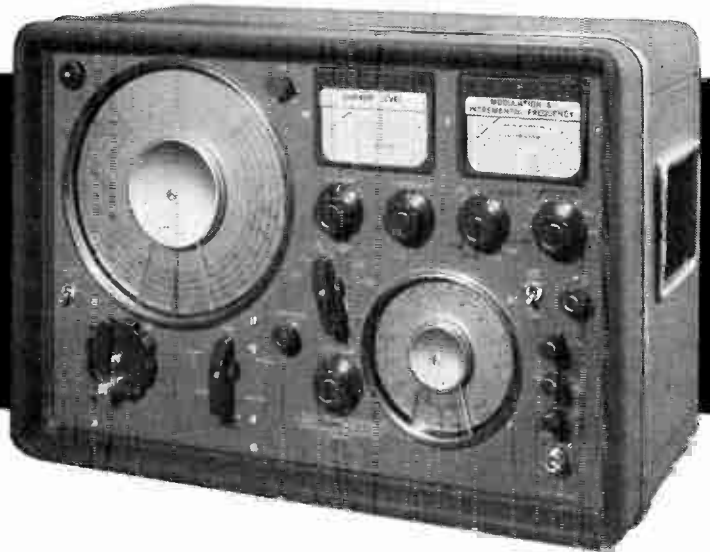
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ELECTRONICS · JULY 17, 1959

MARCONI FM SIGNAL GENERATOR

Covers 10 to 470 mc on fundamentals



Model 1066A offers a unique combination of features essential to the exacting tasks required of a precision fm generator.

Its wide range is covered with the complete absence of spurious sub-harmonics. Directly calibrated stepped and continuous incremental tuning, supported by exceptional frequency stability, bring new ease and accuracy to bandwidth measurement. Deviation up to ± 100 kc is produced at either of two modulation frequencies by a ferrite modulator. Other major features are the Marconi-patented contactless range turret, and a piston attenuator giving a high-quality 50-ohm output.

MARCONI FM SIGNAL GENERATOR MODEL 1066A

Abridged Specifications

FREQUENCY RANGE: 10 to 470 mc in five bands—all on fundamentals. FREQUENCY STABILITY: Better than 0.0025% per 10-minute period after warm-up. INCREMENTAL FREQUENCY CONTROLS: Variable, 0 to ± 20 and 0 to ± 100 kc. Stepped, ± 5 , 10 and 15 kc. MODULATION: 0 to 20 and 0 to 100 kc deviation monitored and continuously variable; amplitude modulation at any depth up to 40% is also obtainable. MODULATION FREQUENCIES: 1 and 5 kc. OUTPUT: 0.1 μ v to 100 mv across a 50 Ω termination. OUTPUT ACCURACY: Incremental, 0.2 db; within 2 db overall. LEAKAGE: Negligible; allows full use of 0.1 μ v output. TUBES: 5Z4G, 6AK6, 6CD6G, 6AK5, 5861, 6C4, 6L6G, 12AT7, OB2, 5651.

Marconi FM Deviation Meters 791D and 934/2 are companion instruments.
Send for leaflet B159 for full details.

**MARCONI
INSTRUMENTS**

*Marconi
for fm
test gear*

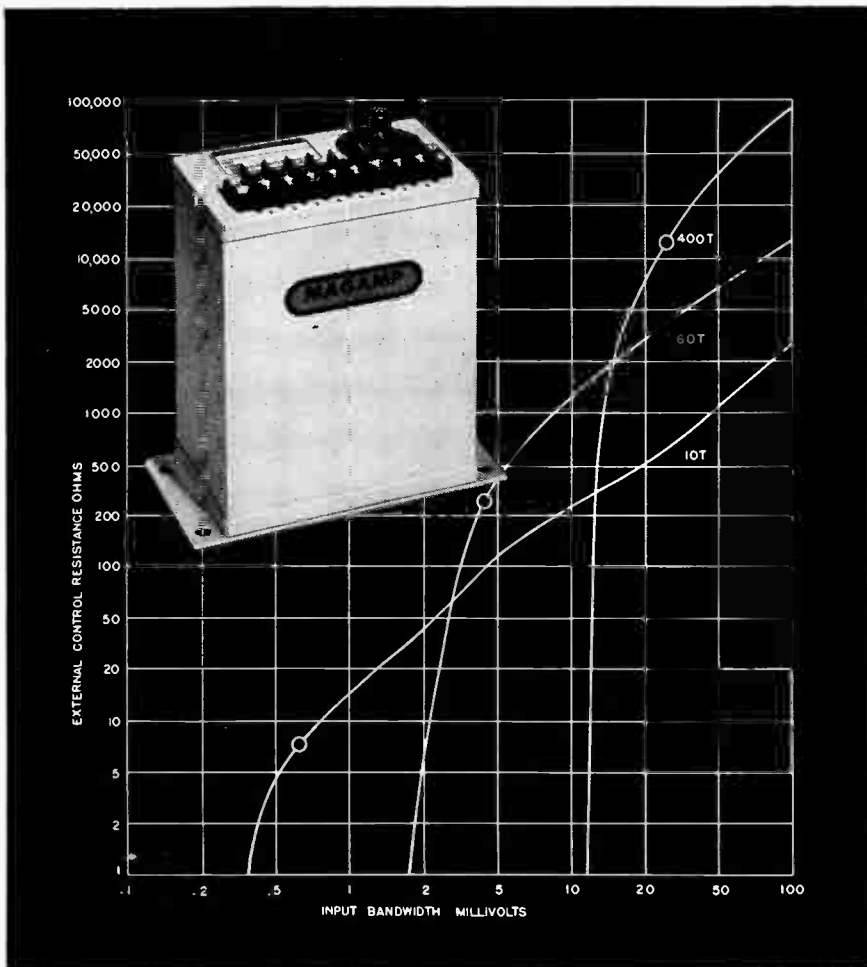
111 CEDAR LANE · ENGLEWOOD · NEW JERSEY Tel: LOwell 7-0607

Canada: Canadian Marconi Co. Marconi Building, 2442 Trenton Ave., Montreal 16

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TC159

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NEW WESTINGHOUSE BISTABLE AMPLIFIER

Ultra-Sensitive On-Off Static Amplifier

BISTABLE AMPLIFIER combines magnetic and transistor circuitry for an input sensitivity of 5×10^{-8} watts a-c or d-c. The output power is 6 watts at 24 volts d-c. This output is sufficient to drive auxiliary relays or static power amplifiers.

For current-control problems or voltage regulation, check these Bistable features:

- No tubes . . . no moving parts . . . no maintenance
- Exceptional sensitivity, 5×10^{-8} watts
- Multiple control windings
- A-C or d-c input signals
- Fast response . . . 20 milliseconds
- Economical . . . less expensive than relays
- Military versions available

GET ALL THE FACTS: Write Westinghouse Electric Corporation, Director Systems Department, 356 Collins Avenue, Pittsburgh 6, Pennsylvania. Complete information on the new Westinghouse Bistable will be sent to you by return mail.

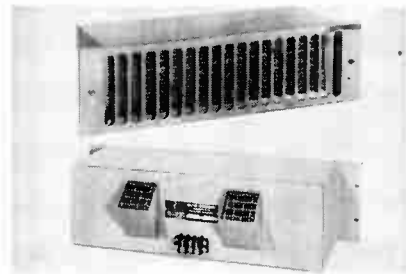
J-01009

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

signed to drive center-tapped motors from size 11 to size 15 with voltage gains up to 10,000. It is designed to operate from a single phase 115 v, 400 cps power supply over an ambient temperature range from -55 C to $+120$ C. Typical gain variation with temperature is less than ± 10 percent. Unit measures only $1\frac{1}{4}$ by $1\frac{1}{4}$ by 3 in. high yet is capable of a generous 6 w output.

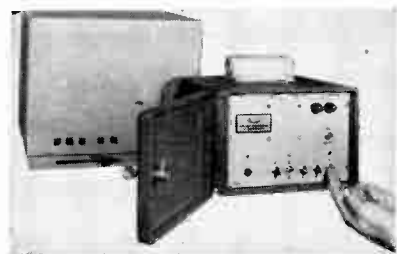
CIRCLE NO. 218 READER SERVICE CARD



Cooling Blower meets Mil Specs

MCLEAN ENGINEERING LABORATORIES, Princeton, N. J., has added an extremely quiet dual centrifugal blower to its line of packaged cooling equipment. It is designed specifically for cooling computers, control panels, telemetry cabinets, consoles and other equipment packed with tubes, power supplies and heat generating equipment. Air delivery is 150 to 500 cfm. Units fit 19-in. racks.

CIRCLE NO. 219 READER SERVICE CARD



Carton Sorter automatic unit

ATRONIC PRODUCTS, INC., One Bala-Ave., Bala-Cynwyd, Pa. Automatic case selection is possible with the model 410 carton selector. Selection of any type case, box, or carton regardless of size or shape is by means of a 5-bar code. Up to 30 different items may be separately coded with the 5 vertical bars. The selector switches may

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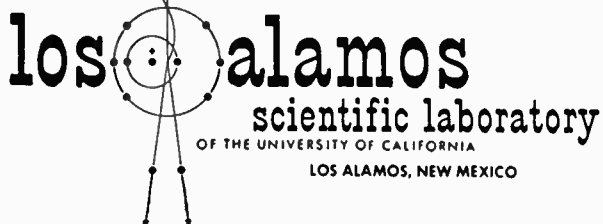


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At Los Alamos, one of the world's finest physics laboratories, the vast scope of modern physics research offers stimulating opportunity to versatile physicists who welcome change and the pursuit of the unusual. Theoretical, nuclear and weapons physics are the major fields of endeavor — and physics is only one of the many scientific activities in which trained men and women with imagination find challenge at Los Alamos.

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Manufactured by
SUPERIOR CABLE CORPORATION, Hickory, North Carolina

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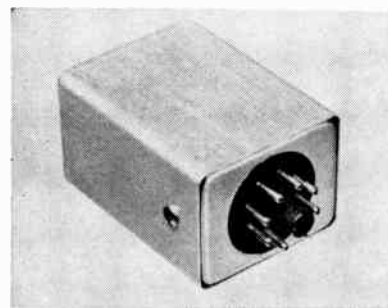
then be set to recognize any one of the markings as the cartons pass at speeds up to 180 ft per sec. The code may be printed on the cartons at the same time other printing is done; no special inks are required.

CIRCLE NO. 220 READER SERVICE CARD

Character Generator high speed

PHILCO CORP., Philadelphia, Pa., has an alphanumeric character generator for use in continuous display of tabular information and/or insertion of written data into pictorial-type displays by means of time-sharing techniques. It is especially suited for air traffic control operations and can be adapted for high speed computer readout functions. Basic module provides a selection of up to 64 characters of any shape or size, including geometric descriptive symbols.

CIRCLE NO. 221 READER SERVICE CARD



Miniature Oven octal based

MONITOR PRODUCTS Co., South Pasadena, Calif. The ET-M high-precision oven has been miniaturized to size 1 1/4 in. by 1 1/4 in. by 2 1/2 in., and houses an MC6. Heater voltage is 115 v, a-c, with low inductance windings and stability of ± 0.2 C. The octal based oven will meet severe shock and vibration requirements. Temperature range is -55 C to 5 C below specified operating temperature. Warm-up time is seven minutes.

CIRCLE NO. 222 READER SERVICE CARD

Chart Drive multispeed

INSCO Co., Div. of Barry Controls, Inc., Groton, Mass. A new chart drive can be easily field mounted on

JULY 17, 1959 • ELECTRONICS

*Expanding the Frontiers
of Space Technology in*

TELEMETRY

■ Telemetry at Lockheed has been brought to a high degree of successful application in the integration of circuits and components into high-performance systems. A completely sub-miniaturized FM-FM system has been developed, along with a complete PAM-FM system characterized by highly efficient band-width utilization, low power consumption and economy of size and weight. This represents a significant achievement in the field of high capacity telemetry.

Other Lockheed designed and developed equipment is successfully providing highly accurate telemetered information on temperature, pressure, acceleration, vibration, thrust, vehicle attitude and other conditions during actual hypersonic flights.

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Lockheed MISSILES AND SPACE DIVISION

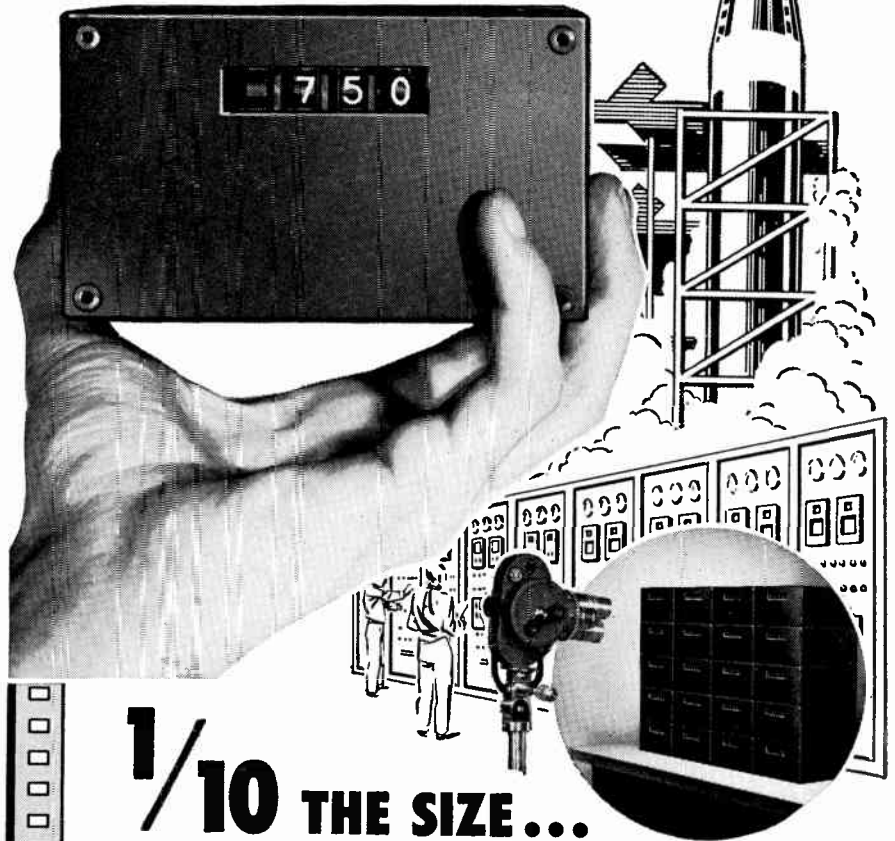
*Systems Manager for the
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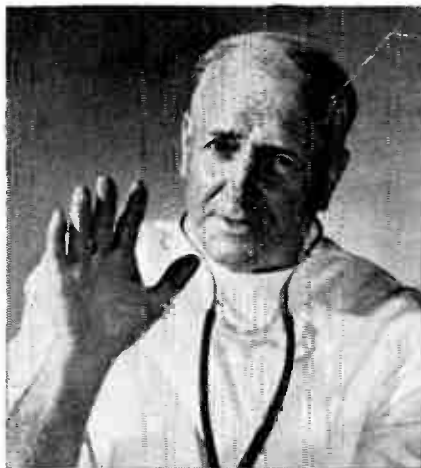
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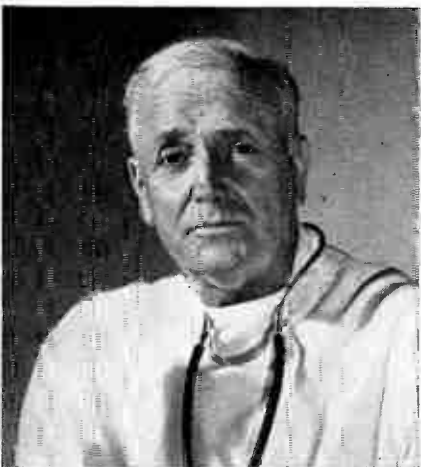
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"Congratulations, Doctor, that was a remarkable operation..."



"Thank you... but I'm not really a doctor... I'm a microwave engineer."



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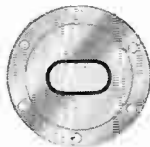
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MA-1474



MA-1452



MA-904



any standard Dynamaster strip chart recorder. Unit allows instant dialing on any of six different chart speeds without the need of stopping the chart. It can be field mounted directly on change gear hubs, requiring no previous experience, no recorder modification and no special tools. Substantial saving of chart paper costs can be achieved by dialing a slow speed for monitoring, then quickly changing to a fast speed during important tests or when the greater resolution of faster chart speed is required.

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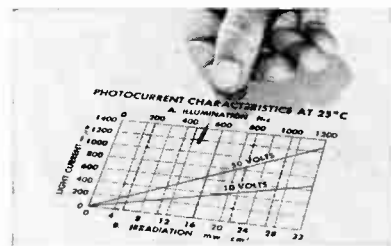


Photo-Duo-Diode highly sensitive

TEXAS INSTRUMENTS INC., P.O. Box 312, Dallas, Texas. The 1N2175 sub-miniature silicon photo-duo-diode passes up to 1,200 μ a when exposed to 1,200 ft-candles of light. In darkness it will pass less than 0.5 μ a. Dissipation is rated at 250 mw at 25 C and any biasing voltage up to 50 v will operate the device. As the 1N2175 is an *n-p-n* double-diode unit, it will operate equally well on either a-c or d-c. It is derated to 125 C with a minimum operating temperature of -55 C.

CIRCLE NO. 224 READER SERVICE CARD



Delay Lines potentiometer-type

DELTIME, INC., 608 Fayette Ave., Mamaroneck, N. Y. The standard potentiometer-type delay line comes in a conventional 3 in. diameter

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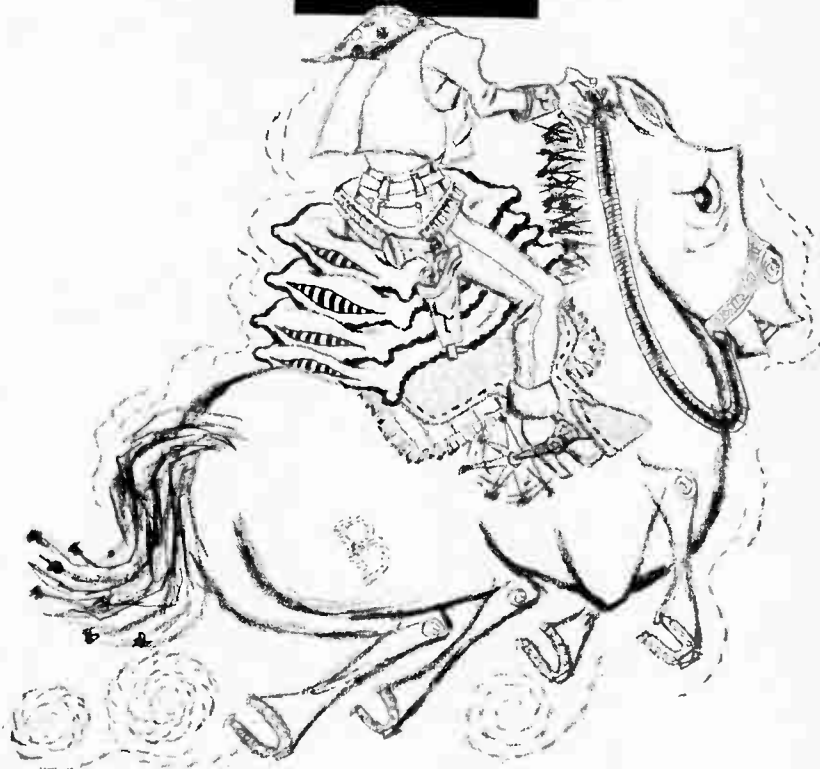
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MEANS
EFFICIENT
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Jumper-wired plugboard programming utilizes simple, straight-forward adapter cables. Circuit modification problems vanish because all changes are easily made by re-jumpering the readily accessible plugboards.

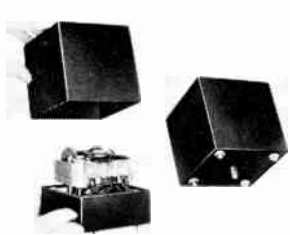
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case, with delay time variable from 3 to 30 μ sec. Shaft rotation is 210 deg. A locking device can be provided for high-vibration applications. This potentiometer packaging is available, on special order, for delay lines of greater length, ranging into the milliseconds. On the larger models a multiturn construction is used to limit the size of the line. Such long delay lines are continuously variable from about 3 μ sec upwards.

CIRCLE NO. 225 READER SERVICE CARD



**Magnetic Shields
structurally rugged**

MAGNETIC SHIELD DIVISION Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill., has developed a new Netic Co-Netic magnetic shield which permits lower cost shaded pole motors to be used in many servo and their instrumentation applications which formerly required more expensive components. With proper grounding, effective electrostatic shielding is also accomplished. The shield reduces the radiated field to under 5 gauss thereby aiding miniaturization by permitting sensitive magnetic components to be positioned in close proximity.

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**Decade Counter
plug-in module**

ELECTRONIC COMPUTER Co., 618 Maple St., Conshohocken, Pa. A digital decade counting plug-in module, model 10-A, is announced. The counter will resolve pairs of pulses 6 μ sec apart from 0 to 100,000 pps. Using computer type 5963 tubes, the binary stages provide an electrical four line 1224 code and staircase outputs. Plate supply may range from 135 to 200 v with 160 v nominal. Unit measures 5 1/4 by 1 1/2 by 5 1/2 in. overall.

CIRCLE NO. 227 READER SERVICE CARD

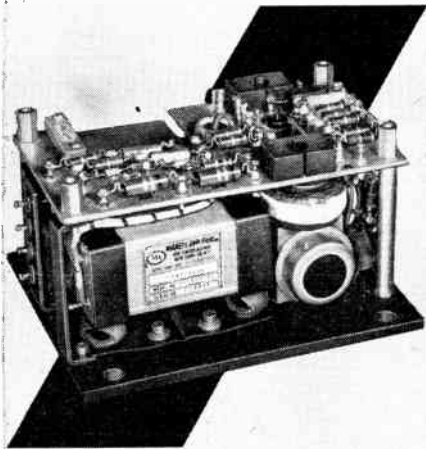
New PRECISION
FREQUENCY

**STATIC
INVERTER
SUPPLY**

INPUT **28V D.C. ± 10%**
 OUTPUT Nom. **115V ± 2%**
 400 CPS ± 0.01%
 1 ∅ (2- or 3-phase output available)
 RATINGS: **30VA 50VA 100VA**
 Higher ratings available.

APPLICATION:

For gyro wheel supplies and where precise 400 cycle voltages are required in aircraft, radar and missile computers.



FEATURES:

- PRECISION OUTPUT FREQUENCY
 - RUGGED
 - EXCELLENT WAVEFORM
 - SIMPLICITY OF CIRCUITRY
 - FAST STARTING TIME
 - GOOD VOLTAGE REGULATION
 - throughout an adjustable range
 - ISOLATED CASE DESIGN
 - HIGH RELIABILITY
 - VIBRATION ISOLATED
 - COMPACT
 - LIGHTWEIGHT
 - MILITARY SPECIFICATIONS
- (Send for Bulletin S-864)



**MAGNETIC
AMPLIFIERS, INC.**

632 TINTON AVENUE • NEW YORK 55, N. Y. • CYPRESS 2-6610

West Coast Division

136 WASHINGTON ST. • EL SEGUNDO, CAL. • OREGON 8-2665

CIRCLE NO. 127 READER SERVICE CARD
ELECTRONICS • JULY 17, 1959

CURTISS  WRIGHT

TIME DELAY RELAYS

Instant reset—Voltage compensated



Curtiss-Wright "IR" thermal time delay relays reset the instant they are de-energized. The second cycle will always provide the same delay as the first cycle. Variations from 22 to 32 volts will not affect the time delay of the "IR" Series.

SPECIFICATIONS

Time delay Preset 20 to 180 seconds
 Contact arrangement . SPST, DPDT or SPDT
 Temperature compensation. -65°C to +125°C
 Weight 4½ ounces
 Terminals Hooked solder type
 Mounting Bracket or stud

Variations of the above relay characteristics available upon request.

The Components Department also manufactures digital (stepping) motors, ultrasonic delay lines, and other units for electronic systems.

WRITE FOR
COMPLETE
COMPONENTS
CATALOG
159

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • WEST CALDWELL, N. J.

CIRCLE NO. 128 READER SERVICE CARD

DIMCO-GRAY

SNAPSLIDE FASTENERS

**PROVIDE VIBRATION-PROOF HOLDING
AND QUICK, FOOL-PROOF RELEASE!**

APPROVED UNDER ARMY-NAVY STANDARDS

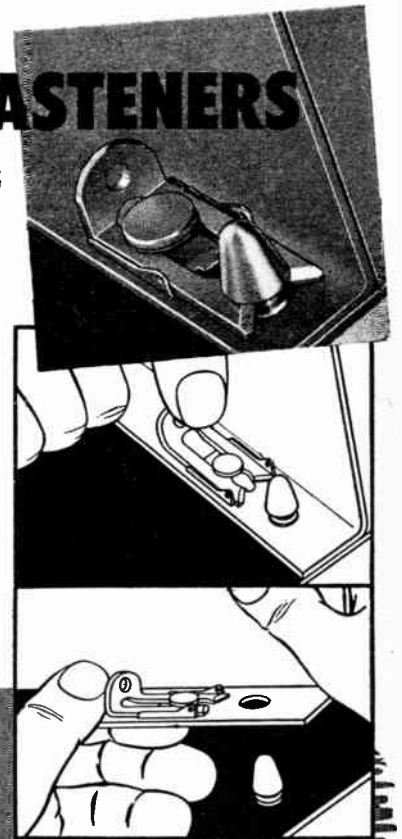
Here's a simple, easy means of securely fastening assemblies to withstand shock or vibration, and yet allow quick removal for inspection or repair. Instant snap action engages or releases fastener . . . no tools are required! After installation, fasteners never need adjustment . . . even with repeated use.

Three sizes available for different load requirements. Large and medium sizes are made of corrosion-resistant stainless steel. Small size is made of nickel-plated brass. Stock parts fit various thicknesses of flanges and mounting plates . . . special parts can also be supplied.

WRITE FOR FULL DETAILS TODAY!

DIMCO-GRAY COMPANY

204 E. SIXTH STREET DAYTON, OHIO



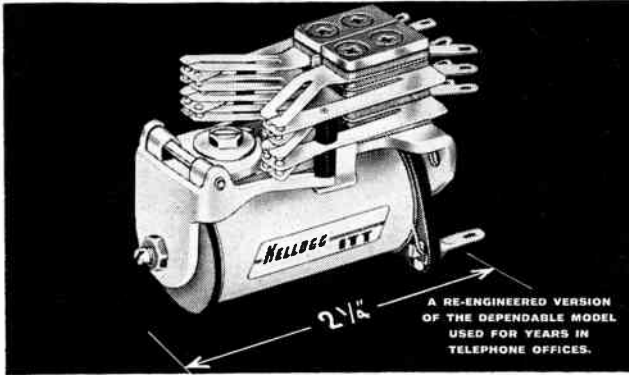
CIRCLE NO. 101 READER SERVICE CARD

101

KELLOGG

TYPE "L" RELAY

miniaturized • versatile • reliable



Kellogg's Type "L" Relay features—

- High operating force:** greater sensitivity, gram pressure, springs per pileup.
- Rear mounting:** for ease of wiring.
- Wide coil variety:** single or double wound, for any circuit needs.
- Bifurcated stationary springs:** for independent contact action and high reliability (single contacts also available).
- Heavy duty bronze yoke and stainless steel bearing pins:** for long life and stable adjustment.
- Single or double arm type armatures** available.
- Hermetically sealed models,** if desired.
- Operating speed:** minimum of 1-2 milliseconds.
- Contact points:** gold, silver, palladium, tungsten; others available.
- Residual:** adjustable and fixed.
- Time delay:** heel-end slugs and armature-end slugs for release time delay and operate time delay, respectively.
- Terminals:** slotted.
- Weight:** net, 2-1/4 oz.
- Dimensions:** 2-1/4" L x 1-1/8" W, height ranges from 17/32" to 1-1/16" (max.)
- Operating voltages:** up to 220 volts D.C.

Backed by Kellogg and International Telephone and Telegraph Corporation. Inquiries are invited. Send for a free catalog on Kellogg relays, components.



Kellogg Switchboard and Supply Company, 6650 South Cicero Avenue,
Chicago 38, Ill. Communications division of
International Telephone and Telegraph Corporation.
Manufacturers of Relays • Hermetically sealed relays • Switches

Literature of

MATERIALS

Zirconium-Copper Alloy. American Metal Climax, Inc., 61 Broadway, New York, N. Y. A unique zirconium-copper alloy, possessing excellent electrical conductivity and high-temperature strength properties, is described in a recent brochure.

CIRCLE NO. 250 READER SERVICE CARD

Microwave Insulators. Tri-Point Plastics, Inc., 175 I. U. Willets Road, Albertson, L. I., N. Y. Microwave insulators of Teflon styrenes, Kel-F and other high dielectrics, machined to tolerances of 0.001 in. and less, are described in the new bulletin 2895.

CIRCLE NO. 251 READER SERVICE CARD

Magnet Wire. Secon Metals Corp., 7 Intervale St., White Plains, N. Y. High temperature ceramic insulated magnet wire for service up to 1,000 F is the subject of a new 8-page brochure.

CIRCLE NO. 252 READER SERVICE CARD

COMPONENTS

Transistor Digital Circuits. Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass. An 8-page folder illustrates and describes the series 100 fully encapsulated transistor digital circuits which save time, cost and space.

CIRCLE NO. 253 READER SERVICE CARD

Microwave Power Tubes. General Electric Co., Schenectady 5, N. Y. Bulletin PT-29 lists the essential characteristics and typical performance data of unclassified GE microwave power tubes, both developmental and commercially available.

CIRCLE NO. 254 READER SERVICE CARD

Miniature Connectors. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif. A brief description of design data plus detailed instruction on contact crimping, insertion and removal are given in a recent booklet on

the Week

the DS series of reliable miniature electrical connectors.

CIRCLE NO. 255 READER SERVICE CARD

Capacitors. Good-All Electric Mfg. Co., 112 W. 1st St., Ogallala, Neb., has published a 46-page general capacitor catalog covering its entire line of tubular, ceramic disk and subminiature electrolytics.

CIRCLE NO. 256 READER SERVICE CARD

Inertia Switches. Inertia Switch, Inc., 311 W. 43rd St., New York 36, N. Y. Inertia switches, sensitive to acceleration axially, radially, or omnidirectionally over a wide range (from 0.01 g to 500 g), are described in a recent 4-page catalog.

CIRCLE NO. 257 READER SERVICE CARD

EQUIPMENT

Test System. DIT-MCO, Inc., 911 Broadway, Kansas City 5, Mo. The 64-page matrix chart brochure contains criteria for an ideal test system, a suggested test system flow diagram and an outline for setting up the DIT-MCO test system.

CIRCLE NO. 258 READER SERVICE CARD


Test Chambers. Conrad, Inc., 141 Jefferson St., Holland, Mich. A new 8-page brochure contains information and descriptive data concerning temperature-vibration test chambers and temperature-altitude-vibration testing chambers.

CIRCLE NO. 259 READER SERVICE CARD

FACILITIES

WWV and WWVH. Specific Products, 21051 Costanso St., Woodland Hills, Calif. Bulletin S-159 describes services available from, and detailed information regarding National Bureau of Standards radio stations WWV and WWVH, time intervals and signals, frequencies and graphic illustrations depicting schedule of broadcasts by the minute, hour, day and year.


CIRCLE NO. 260 READER SERVICE CARD



★ ULTRA LOW capacitance & attenuation

| TYPE | μF/ft | IMPED.Ω | O.D. |
|------|-------|---------|-------|
| C1 | 7.3 | 150 | .36' |
| C11 | 6.3 | 173 | .36' |
| C2 | 6.3 | 171 | .44' |
| C22 | 5.5 | 184 | .44' |
| C3 | 5.4 | 197 | .64' |
| C33 | 4.8 | 220 | .64' |
| C4 | 4.6 | 229 | 1.03' |
| C44 | 4.1 | 252 | 1.03' |

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NEW 'MX and SM' SUBMINIATURE CONNECTORS
 Constant 50Ω-63Ω-70Ω impedances

TRANSRADIO LTD. 138A Cromwell Rd. London SW7 ENGLAND CABLES: TRANSRAD, LONDON

CIRCLE NO. 129 READER SERVICE CARD

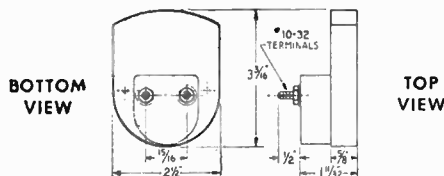
BEEDE-E-25 EDGEWISE METER



ACTUAL SIZE

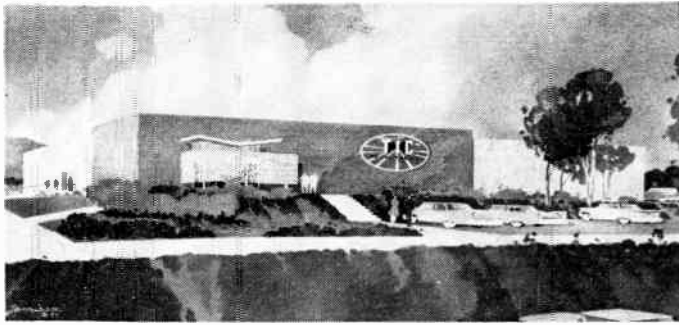
... can be used in either Horizontal or Vertical position — may be paired for comparative reading.

Conserves Space where panel area is limited
 Contains the Magcentric Self Shielding Movement



BEEDE ELECTRICAL INSTRUMENT CO., INC.
 PENACOOK, N. H.





TIC Building New Facility

TECHNOLOGY INSTRUMENT CORP. OF CALIFORNIA, manufacturer of precision potentiometers and a division of Technology Instrument Corp., Acton, Mass., is building an ultramodern plant at Newbury Park in the Janss Corp. Conejo Light Manufacturing and Research Center in southern California. The new plant was designed and equipped to provide optimum environmental conditions for the production of precision components and instrumentation.

Initial construction will cost \$500,000 and provide a 24,000 sq ft facility. Ultimately, 91,000 sq ft of office, engineering laboratories and production space will be built.

This plant combines facilities for the design, development and manufacture of missile-age precision components, including linear and non-linear potentiometers, pressure transducers, accelerometers and small subsystem packages of the foregoing components, as well as electromagnetic potentiometer-clutch-brake assemblies.

A complete engineering department (equipped with an environmental laboratory), precision prototype machine shop facilities, comprehensive high-vacuum metal deposition equipment and basic measurement equipment for accurate determination of fundamental physical measurements, will be provided to expedite the growth of new product lines.

Joseph M. Looney, Jr., president of TIC of California, cites four major reasons for the move to Conejo Valley. 1. Favorable land values for the firm's 10-acre site in the Janss Corp. development. 2. Easy access to the Los Angeles metropolitan market. 3. Desirability of the Conejo Valley as a place to live, which will contribute to the ease of attracting new employees for further expansion and provide present employees and their families with pleasant surroundings. 4. Accessibility to existing plants in North Hollywood and Santa Monica.

ASQC Elects MacCrehan

THE AMERICAN SOCIETY FOR QUALITY CONTROL, at its 13th annual convention in Cleveland, Ohio, elected William A. MacCrehan, Jr., chairman of the aircraft and missile division. This divisional activity of ASQC is intensely involved in national affairs dealing with astronautics and aircraft electronics of the Space Age.

MacCrehan is manager of quality for the aviation products department of Bendix Radio in Baltimore.



S-C Chooses Chief Engineer

DAVID Y. KEIM was recently named chief engineer-military products of the electronics division of Stromberg-Carlson, Rochester, N. Y. Stromberg-Carlson is a division of General Dynamics Corp.

Keim previously served as engineering department head for microwave and electronic equipment for the Sperry Gyroscope Co. Before joining Sperry he was employed by Sylvania Products Co.



Appoint Miller Liaison Engineer

PACKARD BELL ELECTRONICS CORP., Los Angeles, Calif., has named Hal V. Miller liaison engineer at Redbank, N. J., for the technical products division.

Before joining Packard Bell, Miller was employed as a product engineer for the National Scientific Laboratories in Washington, D. C. He previously served as an engineer for the Western Electric Co. in Winston-Salem, N. C.

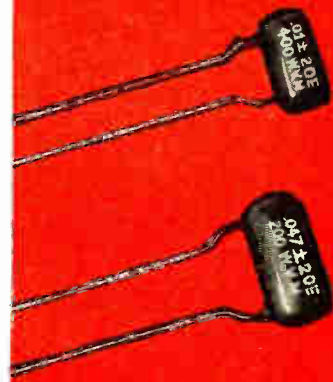
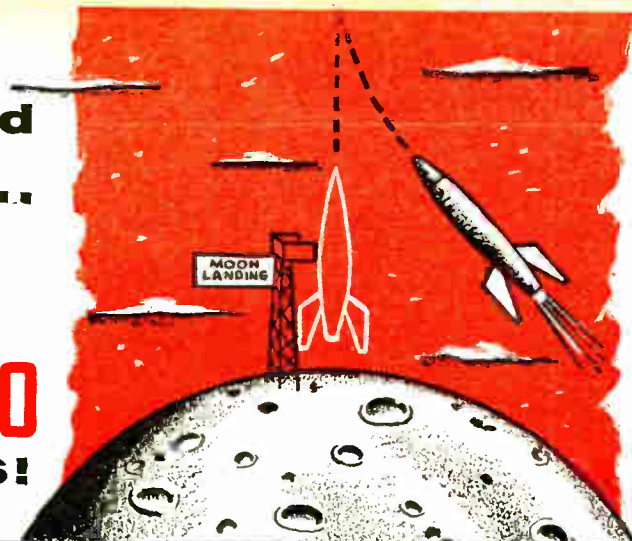
Sorenson Joins Budd Subsidiary

GORDON R. SORENSON has been appointed engineer-in-charge, transducer department, Tatnall Measuring Systems Co., Phoenixville, Pa., a subsidiary of The Budd Co. Prior

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happen...

with

El-Menco
CAPACITORS!



NEW

Mylar-Paper Dipped

CAPACITORS

**TYPE
MPD**

INSURE FAILURE-PROOF PERFORMANCE!

Only 1 Failure In 7,168,000 Unit-Hours for 0.1 MFD Capacitors *

Setting a new standard of reliability!

*Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 100°C with rated voltage applied — have yielded a failure rate of only 1 per 716,800 unit-hours for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield **ONLY 1 FAILURE IN 7,168,000 UNIT-HOURS.**

SUPERIOR FEATURES!

• Five case sizes in working voltages and ranges:

| | |
|-------------|------------------|
| 200 WVDC — | .018 to .5 MFD |
| 400 WVDC — | .0082 to .33 MFD |
| 600 WVDC — | .0018 to .25 MFD |
| 1000 WVDC — | .001 to .1 MMF |
| 1600 WVDC — | .001 to .05 MFD |

SPECIFICATIONS

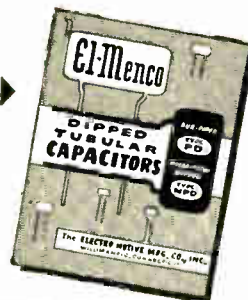
- ◆ **TOLERANCES:** ±10% and ±20%. Closer tolerances available on request.
- ◆ **INSULATION:** Durez phenolic resin impregnated.
- ◆ **LEADS:** No. 20 B & S (.032") annealed copper-weld crimped leads for printed circuit application.
- ◆ **DIELECTRIC STRENGTH:** 2 or 2½ times rated voltage, depending upon working voltage.
- ◆ **INSULATION RESISTANCE AT 25°C:** For .05MFD or less, 100,000 megohms minimum. Greater than .05 MFD, 5000 megohm-microfarads.
- ◆ **INSULATION RESISTANCE AT 100°C:** For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microfarads.
- ◆ **POWER FACTOR AT 25°C:** 1.0% maximum at 1 KC.

Write for Technical Brochure Giving Complete Information on the El-Menco Tubular Dur-Paper Line.

THESE CAPACITORS WILL EXCEED ALL THE ELECTRICAL REQUIREMENTS OF E.I.A. SPECIFICATION RS-164 AND MILITARY SPECIFICATIONS #MIL-C-91A AND MIL-C-25A.

FOR FAILURE-PROOF PERFORMANCE... COUNT ON EL-MENCO MYLAR-PAPER DIPPED CAPACITORS... FROM MISSILE GUIDANCE SYSTEMS TO DATA PROCESSING EQUIPMENT!

*Registered Trade Mark of DuPont Co.



El-Menco
Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

WILLIMANTIC CONNECTICUT

Manufacturers of El-Menco Capacitors

- molded mica • dipped mica • mica trimmer • dipped paper
- tubular paper • ceramic • silvered mica films • ceramic discs

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- ★ THORIATED TUNGSTEN
- ★ MOLYBDENUM
- ★ SPECIAL ALLOYS

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OUR SPECIAL ROLLING TECHNIQUE

Note: for highly engineered applications—strips of TUNGSTEN and some other metals can be supplied

ROLLED DOWN TO .0003 THICKNESS

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to joining Budd, he was a consulting engineer associated with William T. Bean, Jr., with headquarters in Detroit, Mich.



GIC Selects Divisional V-P

MAURICE FRIEDMAN was recently named vice president and general manager of the General Instrument semiconductor division, with plant and headquarters at Newark, N. J. He has headed the division since its formation in 1955.

Friedman has spent nearly 20 years in the electronics industry in development and production of electronic and electrochemical components.

Plant Briefs

Announcement is made of the organization of the Caswell Electronics Corp., San Jose, Calif., which will specialize in the development and production of microwave transmission line components and subassemblies.

American Electronic Laboratories, Inc., Philadelphia, Pa., recently completed construction of an additional plant on a 50-acre tract in Colmar, Pa.

Burton Mfg. Co., Santa Monica, Calif., has acquired Trans Electronics, Inc., Canoga Park, Calif., through an exchange of common stock on a share for share basis. As a wholly owned subsidiary, Trans Electronics, Inc. will continue to design and produce elec-

MEET ROLLY



Associate Editor electronics

CHAREST

RESUME:

Charest, Roland J., Boston University, BS in Journalism. Formerly New England editor for electronics. Navy sonarman. Writer, reporter, editor for Lynn Item, Boston Globe, Boston Traveler. Won a New England Associated

Press (AP) award in 1955 for writing feature articles in the major city newspaper class.

PRESENT OCCUPATION:

Rolly Charest supports Managing Editor Jack Carroll for editorial content accuracy and expediting putting each weekly issue to bed. Rolly reworks headlines for greater readability, is involved in makeup, and helps polish editorial content. Rolly's across-the-board background assures you accuracy in the face of journalistic pressures; articles in this week's issue that could be held over to the next deadline, but are not. The readers' interests come first!

REFERENCES:

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Since 1923

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ELECTRONICS • JULY 17, 1959

tronically regulated power supplies and test equipment for many of the nation's airframe, missile and system manufacturers.

U. S. Semiconductor Products, Inc., Phoenix, Arizona, has purchased a 35,000 sq ft adjacent facility and expects to double its present work force of 102 within a year.

News of Reps

The following recent rep appointments are announced by Vis-U-All Products Co., Grand Rapids, Mich., manufacturers of a line of tube testing equipment:

Vines & Co. of Denver, Colo., covering Colorado, southeastern Idaho, Utah and Wyoming; Technical Sales Associates of San Francisco, covering northern California and northern Nevada; and David A. Fillmore Co. of Arcadia, Calif., covering southern California and southern Nevada.

LEL, Inc., Copiague, N. Y., announces appointment of the following reps:

Industrial Associated Electronics, Inc. of Ft. Worth, Texas, for Texas, Oklahoma and New Mexico; Walter F. Marsh & Associates of Oak Park, Ill., for eastern Wisconsin, northern Illinois, northern Indiana, and eastern Iowa; OEM Sales Co. of Indianapolis, Ind., for St. Louis, Mo., southern Illinois, and southern Indiana; Paramount Agencies of Seattle, Washington, for Idaho, Oregon and Washington; Production Specialties Co. of Detroit, Mich., for Michigan; J. A. Reagan Co., Inc. of Albany, N. Y., for northern New York State (above Poughkeepsie); Jake Rudisill Associates of Charlotte, N. C., for North Carolina and South Carolina; and H. J. Schuft Co. of Newtonville, Mass., for Massachusetts, Vermont, Rhode Island, Maine, New Hampshire and Connecticut.

Autotron Inc., Danville, Ill., has appointed the Tyler Griffin Co. of Devon, Pa., as sales rep in the Philadelphia area, southern New Jersey, Maryland and Washington, D. C. areas.

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advancement
in instrument
design



**VERSATILE
MULTI-RANGE
METER TESTER**

Model M-2

... POWER SUPPLY ... LIMIT BRIDGE

Precise, self-contained unit for laboratory and production use. For DC instrument calibration from 25 μ a full scale to 10 ma full scale, and 0-100 VDC; sensitivity and resistance measurement; DC current-voltage source; limit or bridge measurements from 0-5000 ohms. Regulated power supply. Stepless vacuum tube voltage control. Accuracy exceeds $\frac{1}{4}\%$ (current), $\frac{1}{2}$ ohm or $\frac{1}{2}\%$ (resistance). For 115V, 60 cycle AC. Complete — needs no accessories. Bulletin on request. Marion Instrument Division, Minneapolis • Honeywell Regulator Company, Manchester, N. H., U. S. A.

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| flyback tester | speaker systems |
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SILVER PAINT AND SILVER PASTE

Take the "bugs" out of the application of conductive silver coatings. Use Drakenfeld silver paint and silver paste tailored to meet your needs. We formulate special compositions for glass and ceramic bodies and other materials. Let us know your specific requirements. Samples will be supplied to fit them. Your inquiry will receive prompt attention.

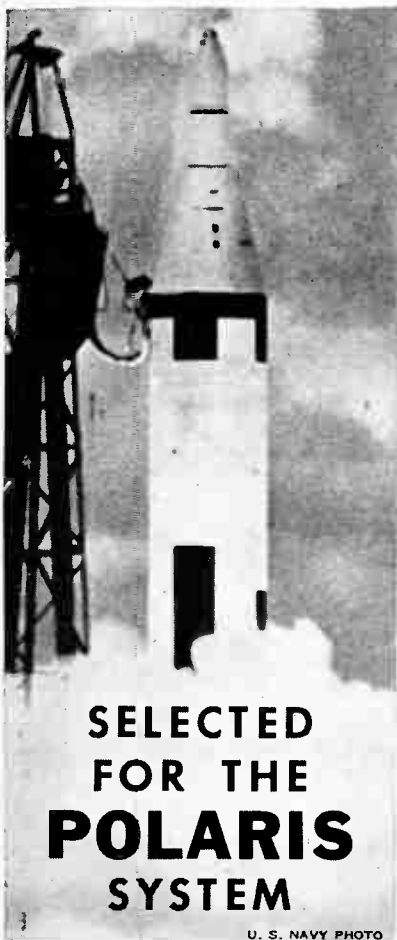
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Industrial Division

Now part of eight missile systems, packaged American Blower Air-Moving Units help prevent breakdowns from self-generated heat in sensitive electronic equipment. Your choice of numerous sizes and designs. All can be modified to solve your particular problems. Or we can design and build units to fit the requirements of your electronic equipment. For individual specification sheets write, detailing your requirements, or send for Bulletin No. 5412. American-Standard* Industrial Division, Detroit 32, Mich. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario.

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AMERICAN-Standard
INDUSTRIAL DIVISION

AMERICAN BLOWER PRODUCTS • ROSS PRODUCTS • KEWANEE PRODUCTS

COMMENT

An Extra C

(Re: "Joy Stick Control Aids Telescope Tracking," by R. L. Shaum and S. W. Savage, p 87, Apr. 24) . . .

Unfortunately Mr. Shaum's name was somehow misspelled in the by-line. Please note this error . . . for your author index.

W. F. CARSTENS

SANDIA CORP.

ALBUQUERQUE, N. M.

Noted. We put an old leftover c in the name, thereby making it Schaum.

The Nav-Aid Fight

(Re: "U. K. Presses Nav-Aid Fight," p 29, May 22) . . .

One point cannot, we feel, be allowed to pass without some comment. You say "American observers have several answers (to British charges that present standards of safety cannot be maintained with VOR-DMET without reducing efficiency). They cite compatible Doppler VOR gear for use at the relatively small number of VOR locations where natural or man-made obstructions cause siting difficulties."

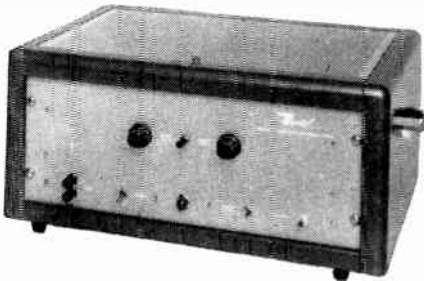
Is it possible that even now, after all the words and newsprint expended on this subject, it is still not clear that the siting of VORs has very little to do with the matter? . . .

Maximum utilization of airspace . . . demands that aircraft be given the facility to fly close parallel tracks—a fact clearly established by the Curtis Committee, the ICAO Jet Operations Requirements Panel and the International Federation of Airline Pilots Associations, to mention only some of the aviation authorities involved.

VOR, from a good site, has an overall accuracy (quoting from American working papers at Montreal) of ± 4.3 deg, which is ± 4.3 miles at 60 miles distance from the beacon. At the same distance from the master station of a Decca chain,

NEW BENDIX

VOLTAGE-CONTROLLED OSCILLATOR FOR MISSILE & INDUSTRIAL APPLICATION



What it does: produces a pulsed output whose frequency is proportional to input voltage.

Where it can be used to advantage:

- Analog to FM telemetry.
- Driving FM data handling system directly from uncompensated potentiometer sensor.
- Converting EPUT meter to digital voltmeter.
- Providing 0.1% FM readout for voltage sensor.
- Acting as voltage integrator with cumulative counter.
- Checking response of pulse-averaging discriminators.
- As sweep frequency generator when driven by integrator-connected DC amplifier fed with square wave.
- As highly stable, variable frequency trigger source with input potentiometer.
- As reference element in wide band feedback discriminator.

Its performance characteristics:

Input Range..... 0 to +100 volts; d.c. to 1 KC.
 Output Range..... 10 KC to 110 KC.
 Output Pulse..... 0.5 μ sec pulse, 0.1 μ sec rise time. 80 volts amplitude, either polarity.
 Linearity..... Maximum deviation +0, -0.2% of full scale from straight line through 10 KC and 110 KC. May be corrected to best straight line giving maximum deviation of $\pm 0.1\%$ of full scale.
 Frequency Response... Response to a step input of any amplitude is within one period of the state frequency corresponding to the step input.
 Input Impedance..... Greater than 1000 megohms at any input level.
 Stability..... Drift over a 24-hour period is 0.1% of full scale maximum after initial warm-up period.
 Power..... 100-125 volts, 60 cycle.

For further information write to: Dept. J7-17

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the accuracy in the worst conditions would be ± 100 yd.

The inaccuracies of VOR, therefore, even from the optimum site, do not and cannot permit the provision of the close lateral track route structure required for complex areas. Adding DME to VOR still does nothing to improve azimuth accuracy, and it is on azimuthal information that the route structure must be based.

All this was made abundantly clear at Montreal, particularly by Captain Masland. We cannot believe that any unbiased observer who listened to Captain Masland or read the transcript of his speech would fail to conclude that, irrespective of all the specious reasons advanced in support of VOR/DME for busy air traffic control areas, it is a long way from being good enough.

He showed that the New York area is saturated with VORs at this moment to the extent that, in the last year, the U.S. has had to install two m-f beacons to supplement the facilities there. Even so there are not sufficient routes, nor is there any possibility of providing more if VOR is used as the basic nav-aid.

It must be emphasized that we are speaking of busy areas where the density and complexity of air traffic demands a flexible multi-route structure. In less busy terminals, the problem does not arise, and for such places we have no doubt that VOR can and does meet the requirement adequately.

Captain Masland also stressed what many of us have long recognized: that radar as a primary navigational aid is simply not a proposition, especially when the vastly increased speeds of modern aircraft are taken into account...

TED BONNER

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As we pointed out in an earlier article (p 30, Feb. 27) most of the technical and philosophical arguments put forth on either side mask basically economic points of view.

At any rate the decision to stick to VOR/DMET (or Vortac) stands in the record.

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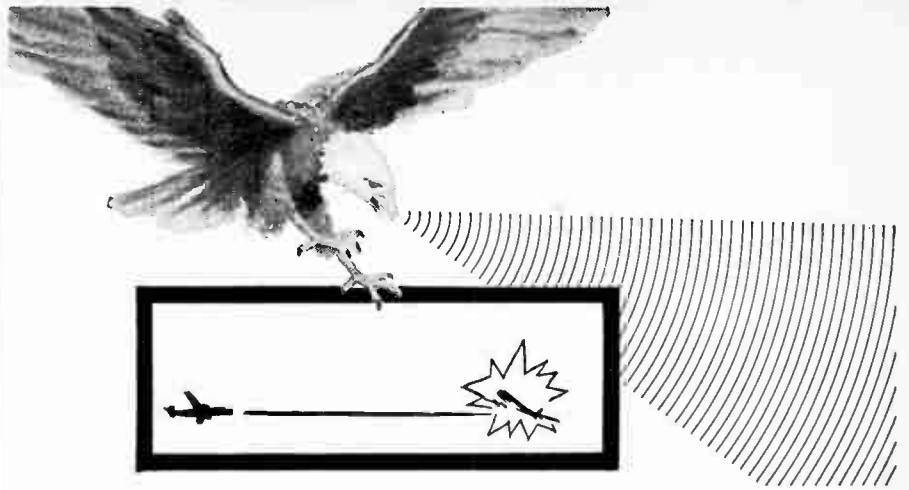
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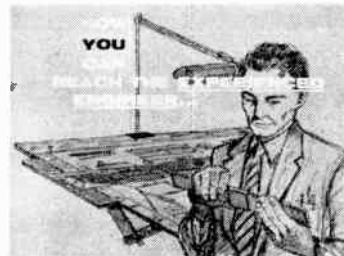
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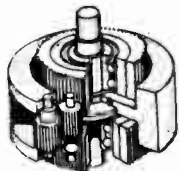
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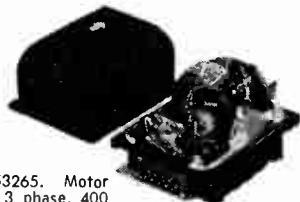
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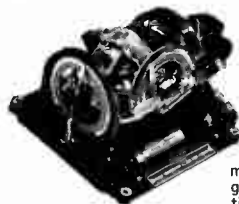
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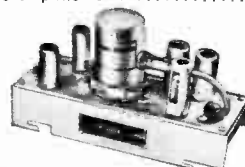


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AM-1023 Made by Gilfillan Bros., Inc. Useful for computers . . . for polarity inversion . . . for isolation . . . and to amplify voltages from DC to 10 cps. Useful closed-loop gain is from 0.1 to 500. Maximum output range is from -150 v to +150 v. Drift less than 10 mv/hour. Input point tends to go to ground potential because of the feedback loop and internal circuitry; therefore determines the input impedance. Accuracy of the gain figure is important in instrumentation. It is the closed-loop gain divided by the open-loop-gain of 200,000; accuracy to match, a predetermined gain of 500 is accurate to 1/4%, and lesser gains exceed the accuracy of practicable obtainable resistors. The amplifier is complete with tubes, chopper and circuit diagram. The circuit diagram gives the voltages to be furnished by an external power supply. The Brown Converter ("For Continuous Balance System") is the late type 6-pin plug-in with twin side connector. Complete amplifier unit . . . \$49.50



MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)



Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2 1/2 million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-71/64. Price \$22.50

VARIABLE SPEED BALL DISC INTEGRATORS No. 145

Forward & Reverse 2 1/4-0-2 1/4. Input shaft spline gear 12 teeth 9/32" dia. x 3/8" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x 3/8" long. Cast aluminum construction. Approx. size 3" x 3" x 2 3/4" . . . \$17.50

No. 146

Forward & Reverse 4-0-4. Input shaft 5/16" dia. x 3/4" long; Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4 1/2" x 4 1/2" x 4". (All Shafts Ball Bearing Supported) \$18.50 ea.

SMALL DC MOTORS



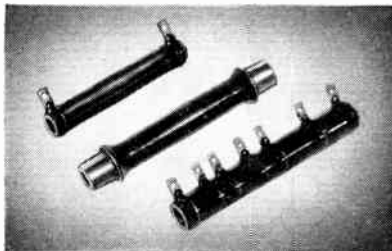
- (approx. size overall 3 3/4" x 1 1/4" dia.):
- 5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm. \$7.50
- 5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled 15.00 ea.
- 5069600 Delco PM 27.5 VDC 250 rpm 12.50
- 5069230 Delco PM 27.5 VDC 145 rpm 15.00
- 5068750 Delco 27.5 VDC 160 rpm w. brake 6.50
- 5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2") 5.00
- 5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled 15.00 ea.
- 5072735 Delco 27 VDC 200 rpm governor controlled. 15.00
- 5BA10A11B GE 24 VDC 110 rpm 10.00
- 5BA10AJ37 GE 27 VDC 250 rpm reversible 10.00
- 5BA10AJ52 27 VDC 145 rpm reversible 12.50
- 5BA10AJ50, G.E., 12 VDC, 140 rpm 15.00
- 5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., .7 amp. contains brake 15.00
- 5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp 15.00
- S. S. FD6-21 Diehl 24 VDC PM 10,000 rpm. 1" x 1" x 2". 4.00

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