JULY 17, 1959

electronics

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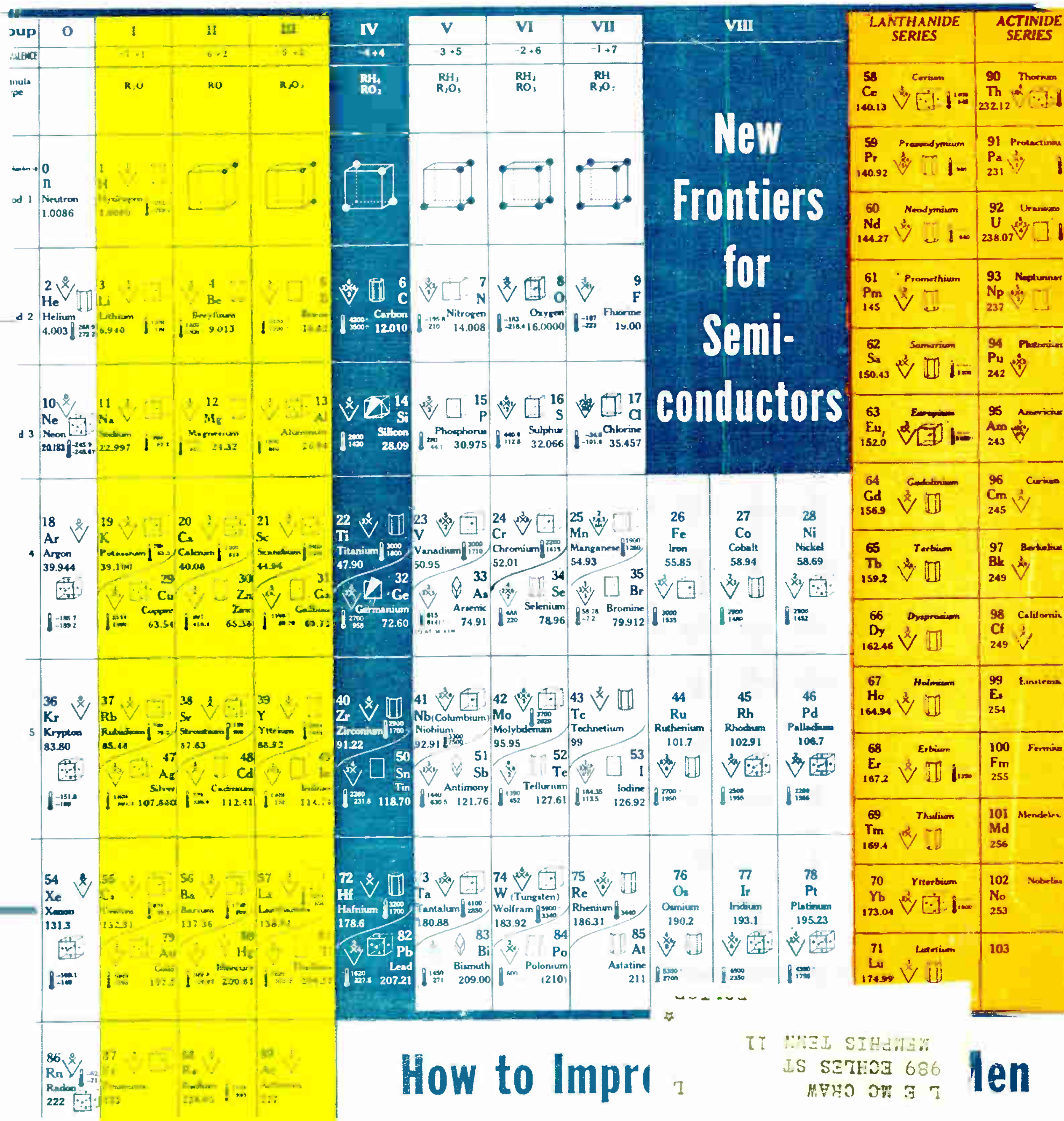

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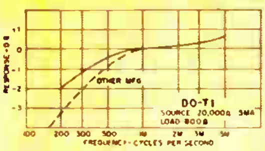

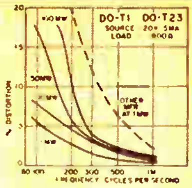

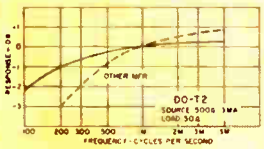

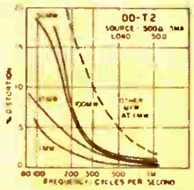

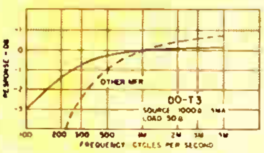

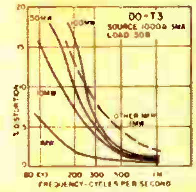

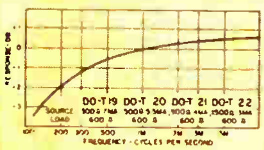

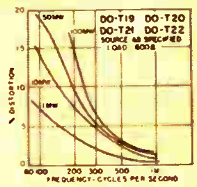

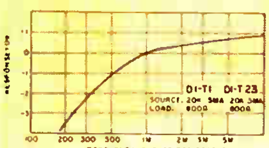

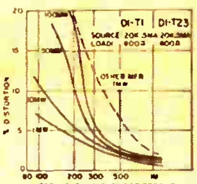

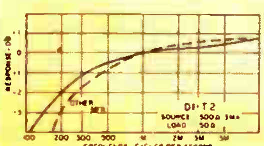

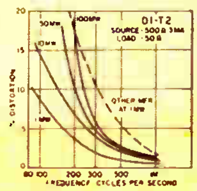

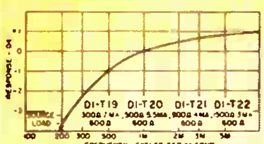

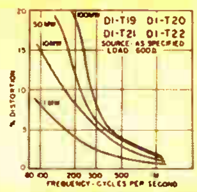

DO-T No.	MIL Type	Application	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res. DO-T	Pri. Res. DI-T	Level Mw.	DI-T No.
DO-T1	TF4RX13YY	Interstage	20,000 30,000	.5 .5	800 1200	850	815	50	DI-T1
DO-T2	TF4RX17YY	Output	500 600	3 3	50 60	60	65	100	DI-T2
DO-T3	TF4RX13YY	Output	1000 1200	3 3	50 60	115	110	100	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

DO-TSH Drawn Hipermalloy shield and cover for DO-T's, provides 25 to 30 db shielding, for DI-T's DI-TSH

‡DCMA shown is for single ended useage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)

*DO-T units have been designed for transistor application only . . . not for vacuum tube service. Pats. Pend.

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electronics

JULY 17, 1959

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Vol. 32 No. 29

Issue at a Glance

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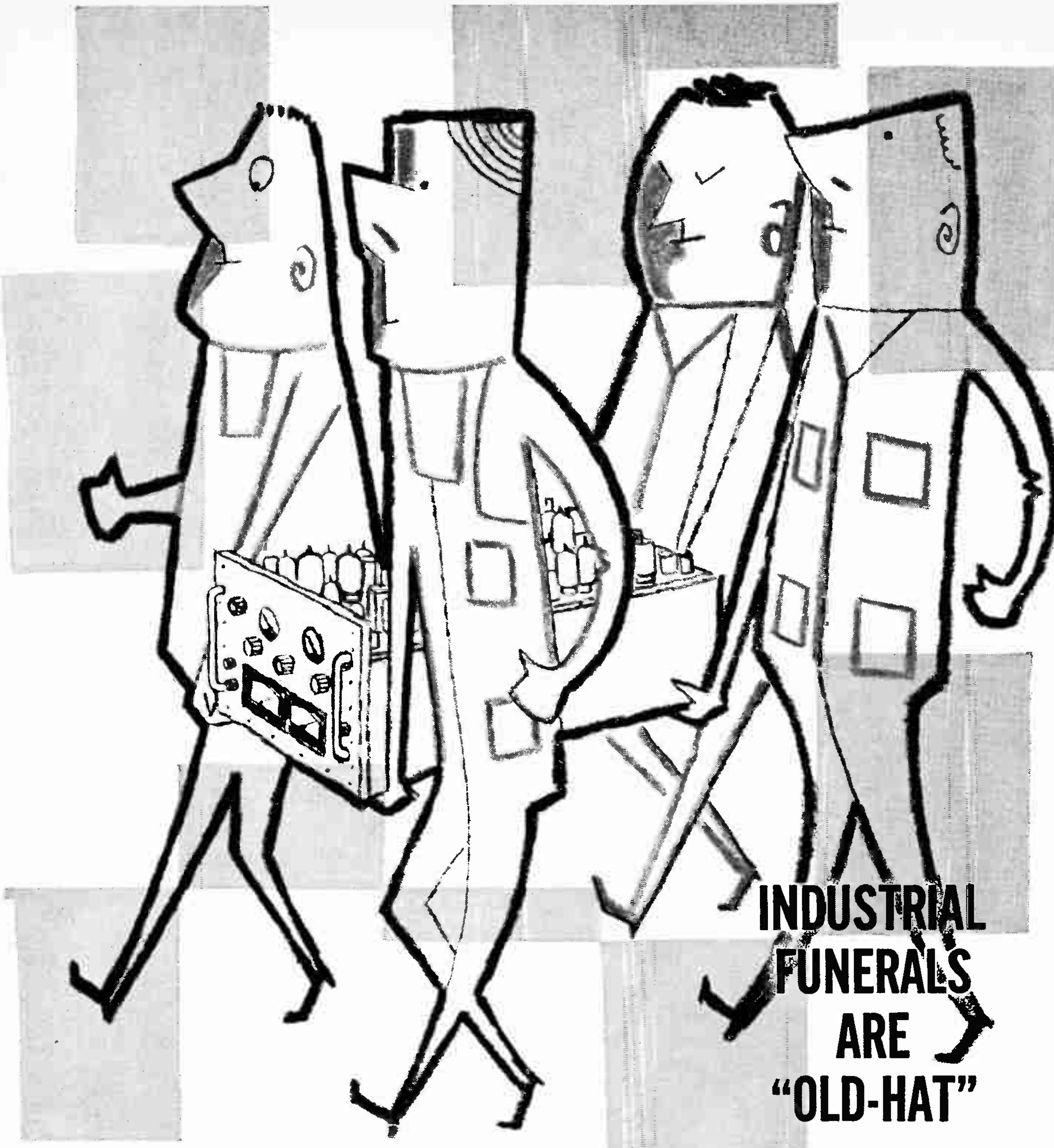
Engineering

Departments



While we're the first to admit that pallbearers have a definite place . . . we're last to agree that their place is in industry.

Certainly, when time is of the essence, old-fashioned repair and servicing techniques are about as efficient as horse-drawn carriages. Progressive manufacturers are dispensing with equipment-carrying pallbearers . . . turning instead to efficient Grant Slides.

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The new Burnell & Co. MT 34 and MT 35 microminiature Kernel toroidal inductors are made to order for the engineer who isn't content with outer husk solutions but gets right to the core of second generation missile communication problems.

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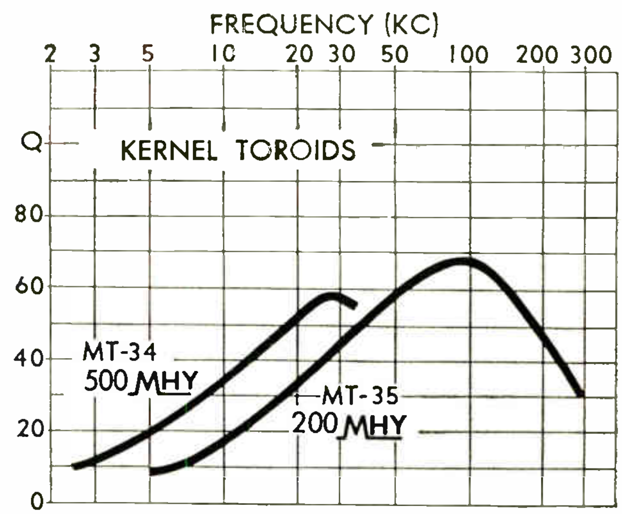
*missiles



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SHOPTALK . . . editorial

electronics

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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.

Plan '59

To modernize now for growth and profits

Goes Into High Gear

In 1959, industry will spend more money than ever before to modernize its plant and equipment. But it is not spending enough to do the job that needs to be done.

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.

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

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 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.

Donald C McGraw

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Direct, automatic power readings

CW or pulsed power
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-hp- 430C
Microwave Power Meter

Here is the finest, most dependable source of instantaneous microwave power readings available today. The *-hp-* 430C gives you power readings direct in db or mw and completely eliminates tedious computations or troublesome adjustment during operation. The instrument measures either pulsed or CW power on either waveguide or coaxial systems. Operation is entirely automatic, stability is extremely high, and the meter may be used with a wide variety of bolometer mounts having either positive or negative temperature coefficients. The broad nominal measuring range can be extended to higher powers by means of directional couplers and attenuators.

For measurements of CW or pulsed power, *-hp-* 430C uses either an instrument fuse, barretter or thermistor as a bolometer element. Operation may be at either 100 or 200 ohms. Power is read direct in milliwatts from 0.02 to 10 mw, or in dbm from —20 to +10 dbm.

SPECIFICATIONS

Power Range: 5 ranges, front panel selector. Full scale readings of .1, .3, 1, 3 and 10 mw. Also continuous readings from —20 to +10 dbm. (0 dbm = .001 watt). Power range may be extended with attenuators or directional couplers in microwave system.

External Bolometer: Frequency range depends on bolometer mount. Bolometers can operate at resistance levels of 100 or 200 ohms and can have positive or negative temperature coefficients. Any dc bias current up to 16 ma is available for biasing positive or negative temperature coefficient bolometers. Dc bias current is continuously adjustable and independent of bolometer resistance and power level range.
Suitable bolometers are:
Instrument fuses: *-hp-* G-28A and G-28B 1/100 amp fuse.
Barretters: Sperry 821, Narda N821B or N610B, PRD 610A, 614, 617 or 631C.
Thermistors: Western Electric D166382, Victory Engineering Co. 32A3, 32A5, Narda 333, 334.

Accuracy: ±5% of full scale reading.

Power: 115/230 v ±10%, 50/1,000 cps, 75 watts.

Dimensions: Cabinet Mount: 7⅜" wide, 11½" high, 14" deep. Rack Mount. 19" wide, 7" high, 12½" deep.

Weight: Net 14 lbs. Shipping 32 lbs. (cabinet mount).

Price: $250.00.

Data subject to change without notice.

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Use these precision *-hp-* instruments with *-hp-* 430C for greater coverage, convenience

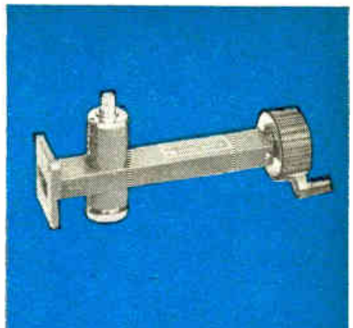
-hp- 752 Multi-Hole Couplers—For measuring average power 1 watt to 1 kw (with attenuator) in waveguide systems. Models cover all frequencies 2.6 to 40 KMC. Coupling factors of 3, 10 and 20 db available most bands. Directivity better than 40 db full range; accuracy of mean coupling ±0.4 db to 0.7 db full range. Primary guide SWR less than 1.10. $375.00 to $100.00.

-hp- 764-767D Dual Directional Couplers—For wide band coax reflectometer and power measurements. Four models cover frequencies 216 to 4000 MC. 20 db attenuation, coupling accuracy 0.5 db, max. primary SWR 1.1 to 1.25; max. secondary SWR 1.2 to 1.5. Minimum directivity (216 to 940 MC) 30 db; 26 db at higher frequencies. 50 watts CW capacity, 10 kw peak. Low insertion loss. $160.00 to $150.00.

-hp- 382A Precision Attenuators—For measurements up to 5, 10 and 15 watts, this revolutionary new broad band instrument may be employed. *-hp-* 382A attenuates from 0 to 50 db, full range, independent of frequency. Phase shift constant with attenuation. Accuracy within ±2% of db reading. Models cover frequencies 3.95 to 40.0 KMC, maximum dissipation 5 to 15 watts. SWR less than 1.15. $500.00 to $275.00.

-hp- 370 Waveguide Attenuators — Waveguide sections providing fixed amounts of attenuation. Used to extend power range of *-hp-* 430C. Models for frequencies 2.6 to 18.0 KMC, power dissipation 1.0 watts (1 kw peak), SWR 1.15; 3, 6, 10 or 20 db attenuation. $75.00 to $55.00.

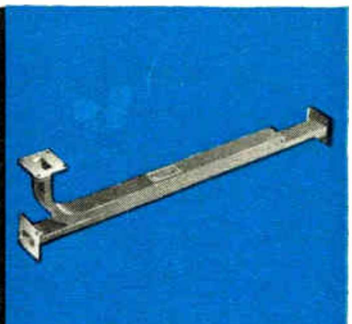
-hp- 487B Thermistor Mounts—Simplify setups, save time and insure maximum accuracy in waveguide power measurements. Models cover frequencies 3.95 to 40.0 KMC with full range SWR of less than 1.5 (except K, R band, 2.0). Permanently installed negative temperature coefficient thermistors. No tuning, large overload factor makes burnout virtually impossible $225.00 to $75.00.



-hp- 485 Detector Mounts

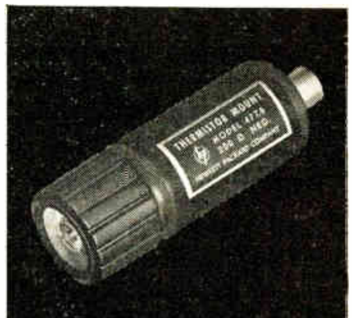
-hp- 382A Precision Attenuators

-hp- 476A Bolometer Mount



-hp- 752 Multi-Hole Couplers

-hp- 487B Thermistor Mounts



-hp- 477B Coaxial Mount

-hp- 477B Coaxial Mount — Thermistor mount providing full frequency coverage 10 MC to 10 KMC with SWR less than 1.5. Requires no tuning, uses long time constant elements for accuracy even on low duty cycle pulses. For use with 430C or other bolometer bridges providing negative temperature coefficient operation at 200 ohms. Requires 13 ma bias. Power range 0.02 to 10 mw. Uses Type N rf connector. $75.00.

-hp- 485 Detector Mounts — Single tuning control accurately matches waveguide section to bolometer element; instrument also detects rf energy with crystal substituted for bolometer element. Models for frequencies 2.6 to 12.4 KMC, SWR 1.25 to 1.5 All models employ crystal or barretter except P485 (thermistor only) and S485 (crystal only). $170.00 to $75.00.

-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.

-hp- 764/7D Dual Directional Couplers

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

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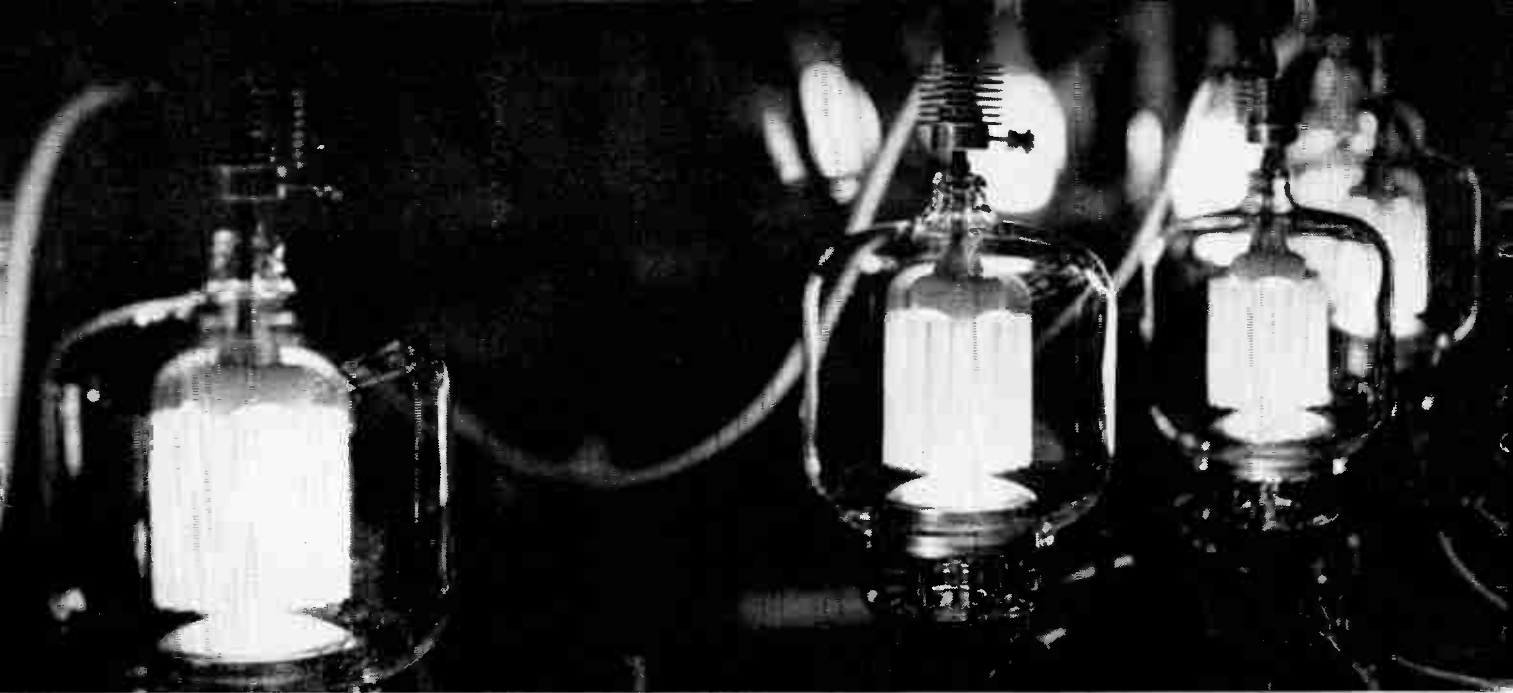

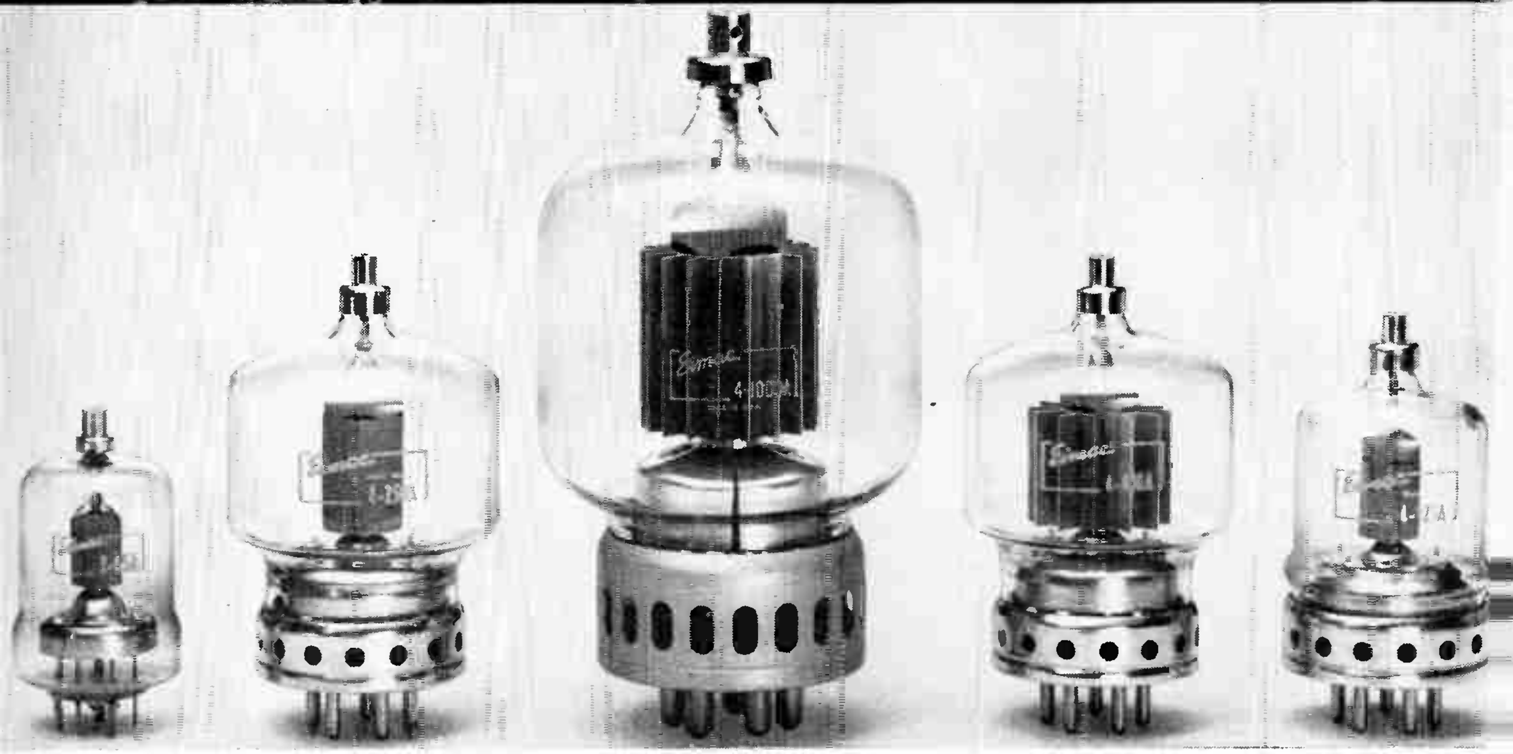

EIMAC PIONEERED INTERNAL-ANODE TETRODES PERFORMANCE LEADERS FOR OVER A DECADE

Developed and introduced to the industry in the mid 1940's, Eimac's line of internal-anode radial-beam tetrodes immediately received widespread and enthusiastic acceptance. Well over a million have been sold since that time. These tubes, quality leaders from the very start, still maintain that position through advanced processing techniques, inherently sound design and continuing concern with production refinements.

Clean electrode design, for example, and the exceptionally hard vacuums achieved on Eimac-developed rotary vacuum pumps, result in consistently reliable tubes with an exceptional ability to withstand high momentary overloads and peak powers. Rugged filament design with high reserve emission contributes greatly to their reliability and long life.

Stable operation at high frequencies is assured by low inter-electrode capacitances and low lead inductances. Driver requirements and associated circuitry are simplified by the high power gain and low driving power requirements of these tube types.

These features, plus other Eimac design innovations such as the Pyrovac* plate and non-emitting grids make Eimac internal-anode tetrodes your logical choice for new equipment designs, as well as tube replacements, when exceptional performance and reliability are required. Most types available for immediate delivery.

*Registered Trademark

EITEL-McCULLOUGH, INC.

Eimac

San Carlos, California

ELECTRONICS NEWSLETTER

ATOMIC CLOCK, of the amonia 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 ½ 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 $½-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 $1½-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 ¼ 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 armament 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 coordinate 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 reconnaisance 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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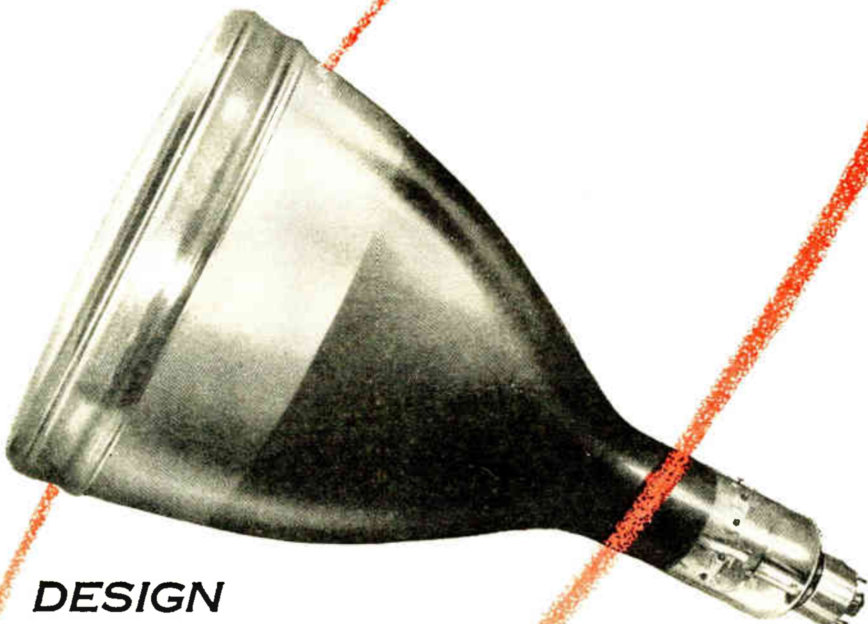

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Remove the speed limitations of magnetic deflection from radar read-out—extend capabilities through ultra-fast Du Mont electrostatically deflected and focused radar tubes for accurate, complete surveillance of fast-moving orbital, guided or manned objects. These new Du Mont radar tubes offer jump-sweep capabilities in larger screen sizes to meet all modern radar read-out requirements, including hi-resolution, deflection uniformity and reduced deflection defocusing.

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HOW LOUIS ALLIS DOUBLED THE BENEFITS OF SIL-FOS BRAZING

Higher operating temperatures and output demands in electric motors have prompted Louis Allis of Milwaukee, Wisconsin, to switch from soft solder to SIL-FOS 5 brazing on their stator windings. No stranger to SIL-FOS, Louis Allis has brazed rotor end rings for years. Now they get these benefits on both vital parts of their motors:

STRENGTH—The strength of a properly designed and brazed SIL-FOS joint exceeds that of the metals joined. Furthermore, joints do not "creep" even when hot. Here are some typical values:

at 300° F in copper:	30,000 psi.	In brass:	35,000 psi.
at 400° F in copper:	28,000 psi.	In brass:	31,000 psi.

CONDUCTIVITY—Tightly fitted standard lap joints are fully as conductive as copper.

DUCTILITY—SIL-FOS joints have exceptional ductility; enabling them to withstand stresses and strains of vibration, shocks and radical temperature changes fully as well as the metals they join.

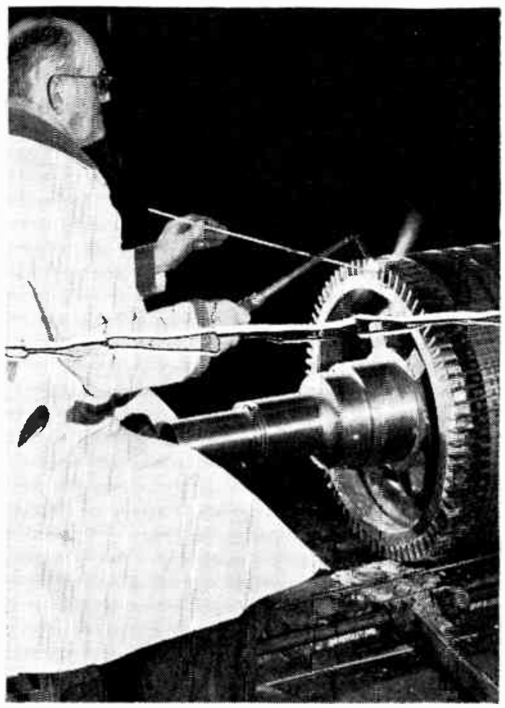
EASY INSTALLATION—FAST PRODUCTION—With SIL-FOS you can get any production you want—you have a choice of heating methods, jigging setups, inspection techniques, etc.

ECONOMY—Low flow point, fast brazing action, reduced labor costs, and vastly reduced reject rate, plus the small amount of alloy needed to make a joint put SIL-FOS in a low-cost category unequaled by other methods.

Alloy	Silver Content %	Type	Starts to flow at °F	°C	Free Flowing at °F	°C
SIL-FOS	15	Wide Melting Range	1185	641	1300	704
SIL-FOS 5	5		1195	646	1300	704

For use in joining ONLY nonferrous metals. Used particularly on copper, brass and bronze. Specially effective in joining pipe and tubing and on electrical work.

Here, operator hand brazes a winding on a motor stator. Increasing motor output requirements demand greater overall operational reliability. With SIL-FOS 5 brazed joints *reliability is assured.*



Rotor ring hand brazing with SIL-FOS has long been the practice at the Louis Allis Co. The success achieved here has been applied to the above with equally excellent results.

Further details on SIL-FOS and SIL-FOS 5 can be had in the form of Technical Literature from Handy & Harman. **Send for Bulletin 20.** Our research and engineering people are ready and willing to help you with any metal joining problem or plan you may have.

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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.

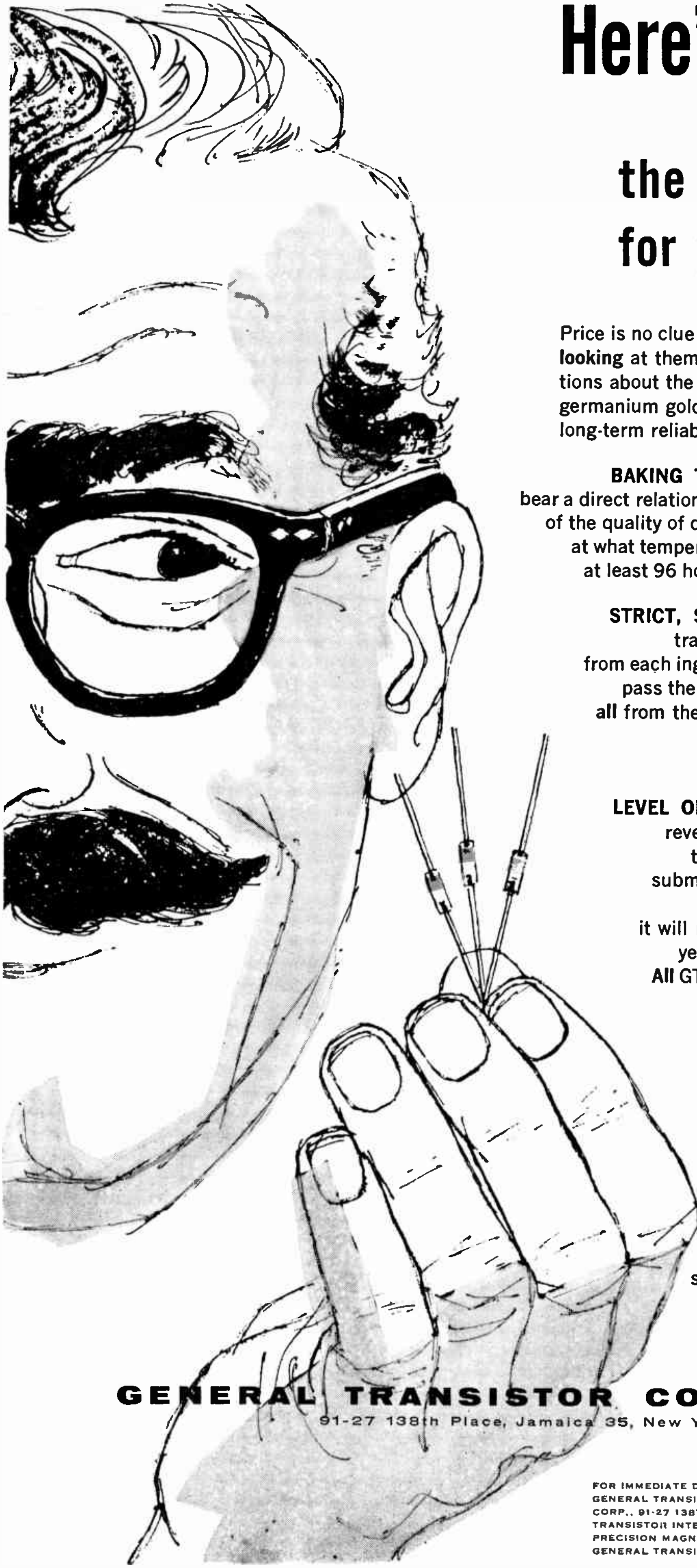
This will be followed by public hearings, a tentative decision, opportunities for aggrieved parties to object, and—finally—an official determination of what elements of the missile industry (if any) have to pay what minimum wage.

- **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.

Here's how to pick the best DIODES for your money



Price is no clue when diodes sell for about the same, and just **looking** at them tells nothing. But if you ask the right questions about the three key factors in the production of **quality** germanium gold bonded diodes, you have your clues to more long-term reliability for your money. Here they are:

BAKING TIME AND TEMPERATURE
bear a direct relationship to long-term stability. You get a measure of the quality of diodes by asking: "How long do you bake, and at what temperature?" (**All** GT diodes are baked at 140°C for at least 96 hours—the highest and longest in the industry!)

STRICT, STATISTICAL, HISTORY LOGGING
traces the progress of every single wafer made from each ingot of germanium. At GT, if a few wafers fail to pass the stringent GT quality tests along the way, then **all** from the ingot are suspect and can be identified and pulled out. There are no "stowaways" in a shipment of GT quality diodes.

LEVEL OF TESTING STANDARDS
reveals the level of quality. Ask about "everyday" test standards. (In the GT Seal Test, diodes are submerged in a penetrant-dye solution for 24 hours under 75 psi. This test is so sensitive that it will reveal a leak so small it would take over 300 years for 1 cc of gas to diffuse through the case.) **All** GT quality tests—100% electrical, 100% shock and vibration, and 100% temperature cycling—are at the highest industry level... and as a final mark of quality, the color bands on GT Germanium Gold Bonded Diodes are baked on to stay.

GT is equipped to supply diodes tested to individual customer requirements, such as JAN Qualification Inspection Tests and many others.
To get the full measure of quality in Germanium Gold Bonded Diodes, see your GT representative; or write directly to the company with know-how **NOW.**

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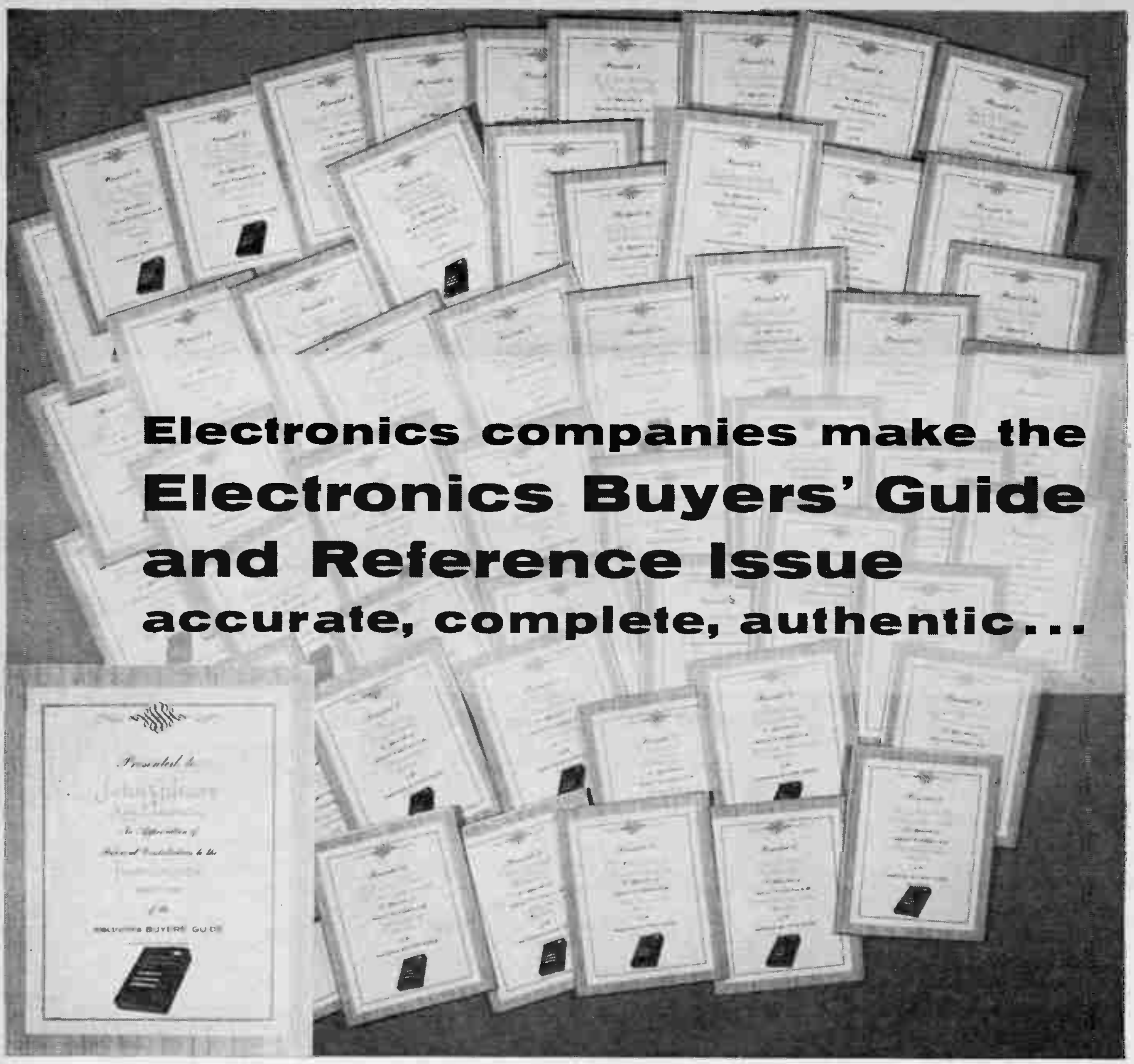

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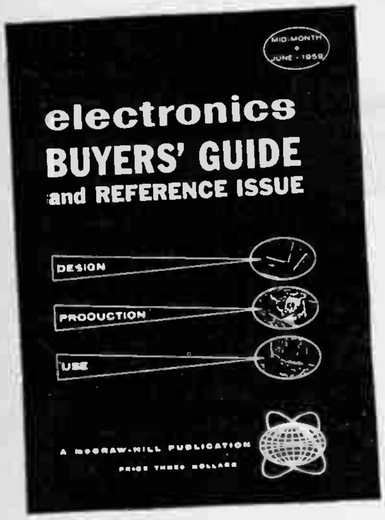
accurate, complete, authentic...

For nineteen years, firms in the electronics industry have made direct contributions to the accuracy, completeness and authenticity of the BUYERS' GUIDE.

Recently, the staff of the BUYERS' GUIDE decided to award plaques to express appreciation to those in the industry who had made direct contributions to improve the product listings. The photograph above represents a few of the awards that have been made.

The awarding of the plaques is but one indication of how the BUYERS' GUIDE evolved over the years . . . a *cooperative effort between the publication and the industry it serves.*

Only through years of experience can a buyers' guide reflect the needs of an industry as complex and dynamic as electronics . . . one more reason why the BUYERS' GUIDE is the ONE accepted product and data book in the field.



Published mid-year as the 53rd issue of **electronics**

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IN-HER-ENT, *adj.* Firmly infixed; esp., involved in the essential character of anything.

Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision resistors retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

For all applications demanding resistors that meet or surpass MIL specifications, you can depend on Dalohm.

WIRE WOUND • PRECISION • POWER DALOHM TYPE RS RESISTORS

When space is at a premium, and precision and power are needed, specify DALOHM RS Type resistors.

Configurations: Type RS with radial leads and in most ratings and resistances shown; Type RLS with axial leads for printed circuits, and Type RSE for clip mounting.

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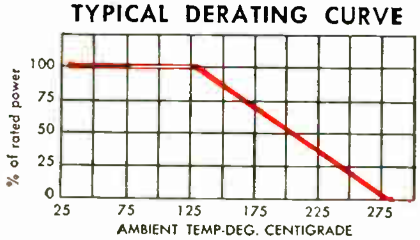

- Rated at 1, 2, 3, 5, 7, and 10 watts
- Resistance range from .05 ohm to 175K ohms, depending on type
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%
- Temperature coefficient within 0.00002/degree C.
- Operating temperature range from —55° C. to 275° C.
- Smallest in size, ranging from 3/32" by 13/32" to 3/8" by 1-25/32". Nine choices.
- Completely protected, impervious to moisture and salt spray
- Complete welded construction from terminal to terminal
- Silicone sealed, offering high di-electric strength and maximum resistance to abrasion.
- Surpass requirements of MIL-R-26C.

Write for Bulletins R-23, R-25 and R-30, with handy cross-reference file cards.

SPECIAL PROBLEMS?

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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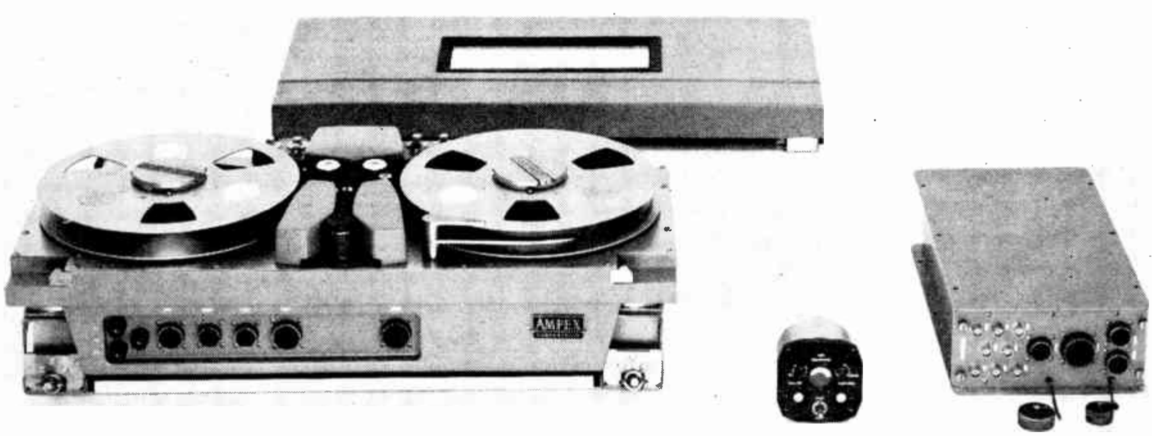

For precise acquisition of data under extreme environments...maximum reliability with minimum size and weight...the complete 7-track AR-200 system above includes transport, amplifiers, power supplies, remote control, shock mounts and tape in three compact units... weight? just 90.5 pounds...volume? only 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...

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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 1959. 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	70½	65¼	69⅞
Sperry Rand	821	26⅛	25⅛	26
Univ Controls	784	19⅞	18¼	19¾
Int'l Tel & Tel	749	41	38⅛	40¼
Raytheon	730	60⅛	57	57⅜
Avco Corp	677	15⅞	14⅝	15⅝
Burroughs	567	38⅝	35¼	36⅜
Gen Tel & Elec	493	70¼	69	69¾
Gen Dynamics	461	56¼	54⅜	55¾
Emerson Rad & Ph	454	22⅜	18⅝	21½
Gen Electric	379	80⅞	79⅝	80¾
Int'l Resist	343	19⅝	17⅛	19½
Elec & Mus Ind	328	7⅝	7¼	7¼
Standard Coil	317	20½	19	19
Victoreen Inst	310	15⅜	13	15⅛
Westinghouse	287	95½	91	95
Gen Instr	286	33⅜	31⅝	32
Dynamics Corp	278	10¾	9⅜	10¼
Philco	266	32⅜	30½	31¼
Admiral	257	25¼	23	24⅞
Hoffman Elect	256	36⅞	34⅞	35¾
Texas Inst	256	153¾	144	148½
Zenith	230	129¾	125	125¾
Motorola	222	118½	108¼	116
Servo Corp Am	212	34⅞	30	31½

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.

Now 4 CHR High Temperature TEFLON® Tapes

Temp-R-Tape adheres securely to bar heated to 520°F during high temperature resistance test.

Pressure-Sensitive TEFLON Tapes

easy to apply in both electrical and mechanical applications

The electrical uses of Temp-R-Tape include slot lining, interlayer 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*

CHR

Leader In Fabrication of Silicone Rubber

CONNECTICUT HARD RUBBER COMPANY

Main Office: New Haven 9, Connecticut

ADVANCED RESEARCH PROJECTS AGENCY'S ESTIMATED OBLIGATIONS

	FY 1959	FY 1960
	(Millions of	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	$128.1
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

RISING 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	288,041	250,224	+78.1%
Auto sets	126,022	122,227	+117.5%

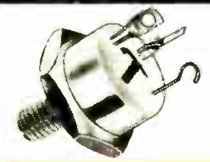
STOCK PRICE AVERAGES

(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%

5 EXCITING NEW SILICON TRANSISTOR

1. HI-POWER STUD-MOUNTED SILICON TRANSISTOR

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.



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

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

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

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.

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_{CB} = Rating
Output Capacitance	C_{ob}	—	8	12 μμf	V_{CB} = 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

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

Type	Typ. Alpha Cutoff (Mc)	Beta Typical	Co (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

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.

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

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

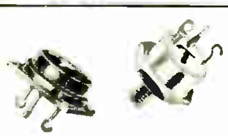
SILICON TRANSISTORS

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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CIRCLE NO. 25 READER SERVICE CARD

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 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

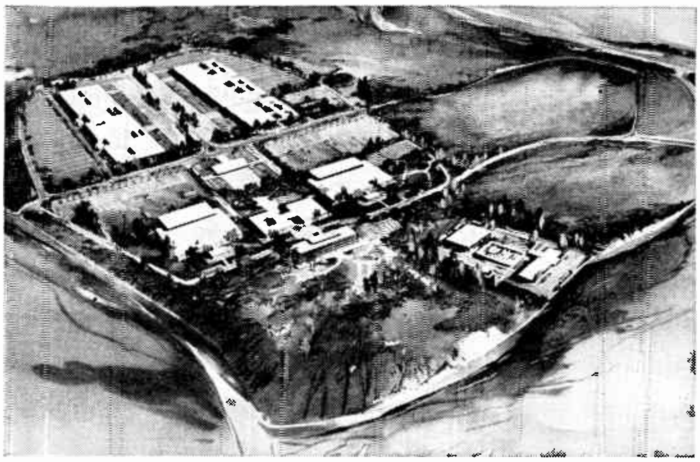
The company should have ready at this time a written resume of the principal executives and key technical personnel, along with a list of its main customers. Also listed should be individuals involved in the various branches of the Armed Forces with whom the company has contact—if the company has or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

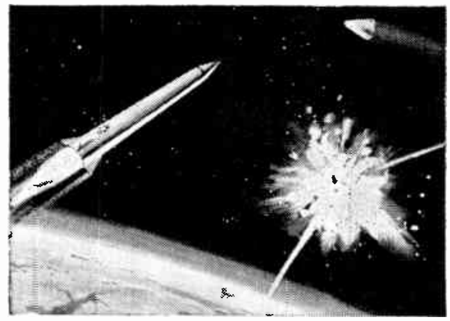
One of the primary interests of the venture capitalist or investment banker is the overall size of the market to which the company sells and also the possible degree of future expansion there may be in that market. If the company has

(Continued on p 31)

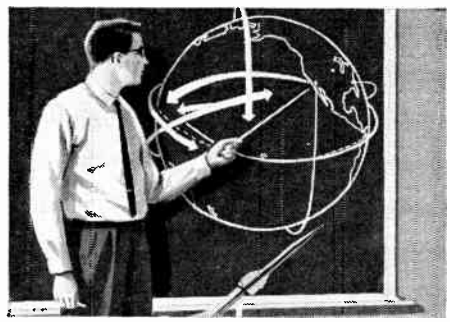
ANNOUNCES A NEW
SPECIALIZING IN PRODUCTS
SPACE AGE



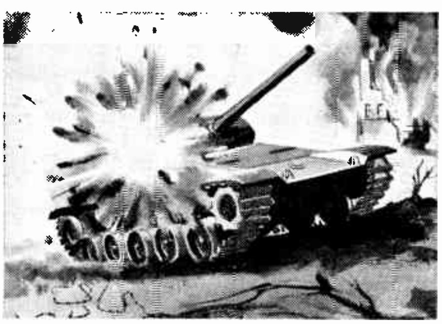
NEW 200-ACRE ENGINEERING AND RESEARCH CENTER. An artists' concept of Aeronutronic's new 20-million dollar Research Center under construction at Newport Beach in Southern California. Here, Ford resources provide the finest facilities for carrying out complete engineering, research and prototype manufacturing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



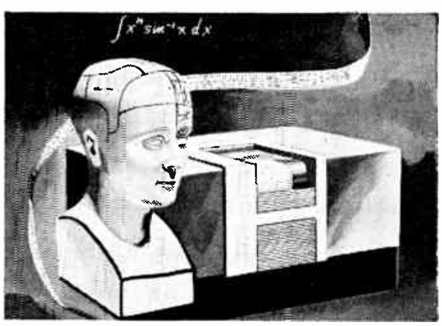
OFFICE OF ADVANCED RESEARCH. Basic research is conducted in areas of long-range company interests, with special emphasis in the fields of atomic and molecular physics, physical chemistry and atmospheric physics.



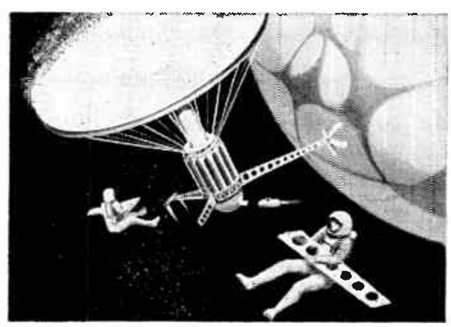
RANGE SYSTEMS OPERATIONS provides total capability to study and plan missile range instrumentation and to staff and manage complete missile range operations for U. S. military and civilian agencies.



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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Fledglings Study Electronics

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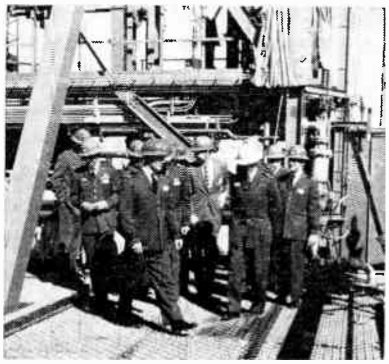
delve into circuits . . .



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 plantary 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.

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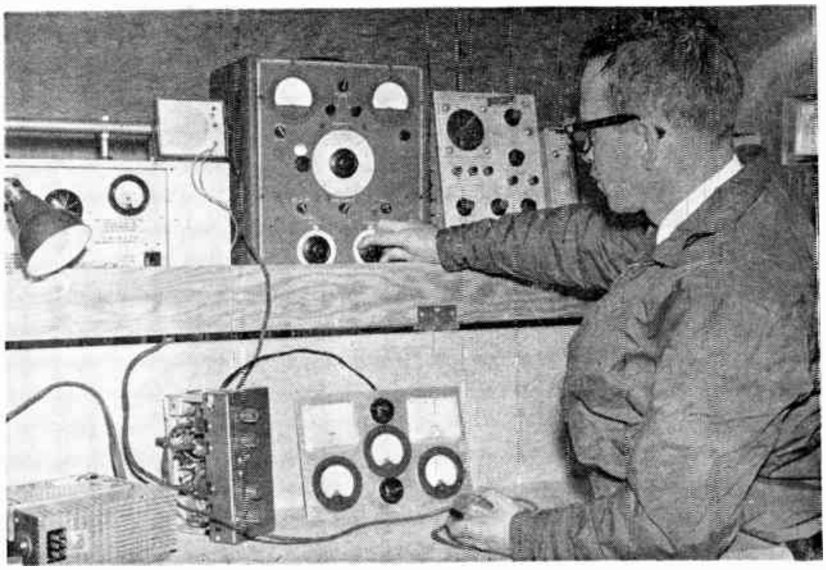
More Transistors for

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.

3.5-millimicrosecond risetime

with these

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-mμsec risetime, 0.1-v/cm sensitivity, and 0.01-μsec/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 μμf 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 μμf 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 μsec/cm to 2 sec/cm in 24 steps, with 5-x magnifier to increase calibrated range to 0.01 μsec/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 μsec 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.

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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.

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

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.

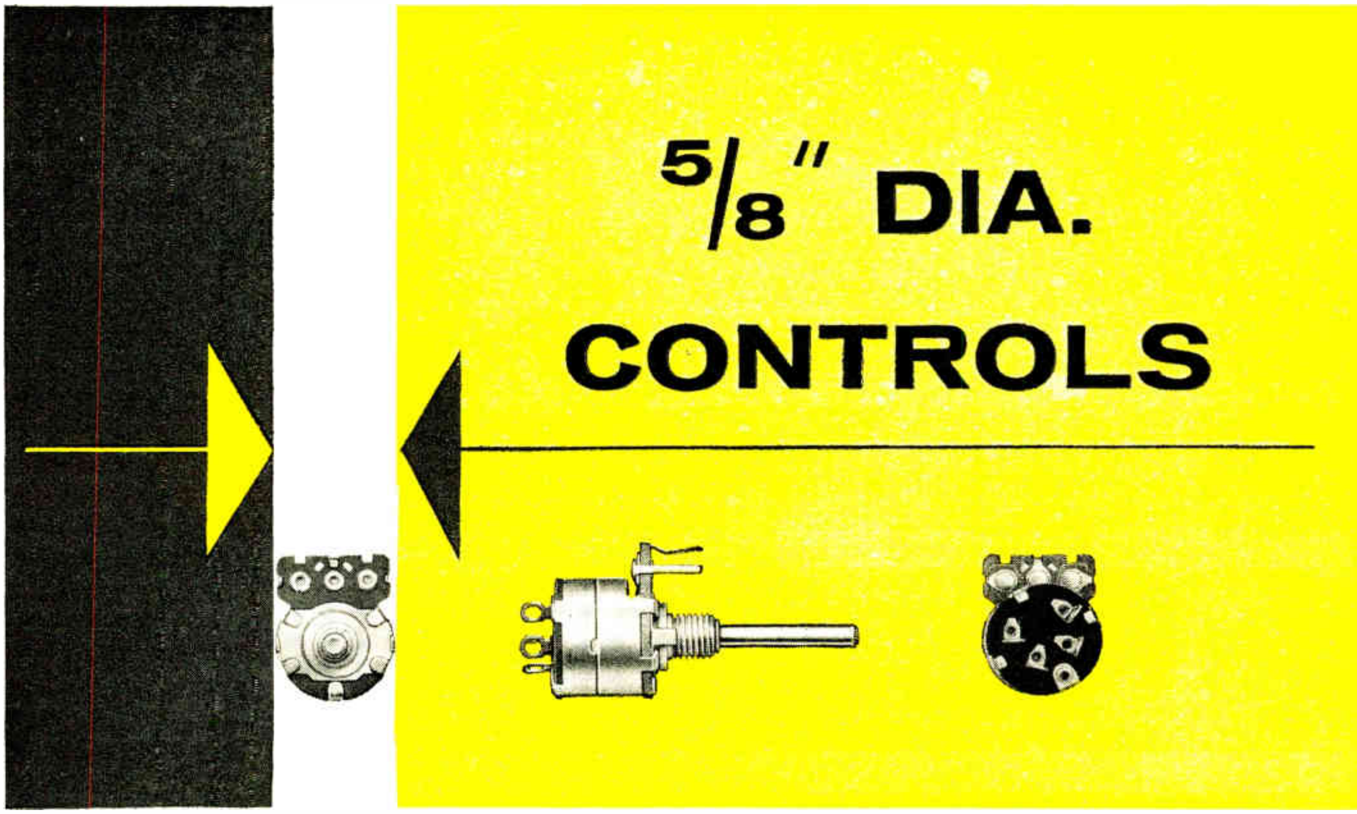
Sept. 17-18: Nuclear Radiation Effects in Semiconductors, USASRDL, Western Union Auditorium, N. Y. C.

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.



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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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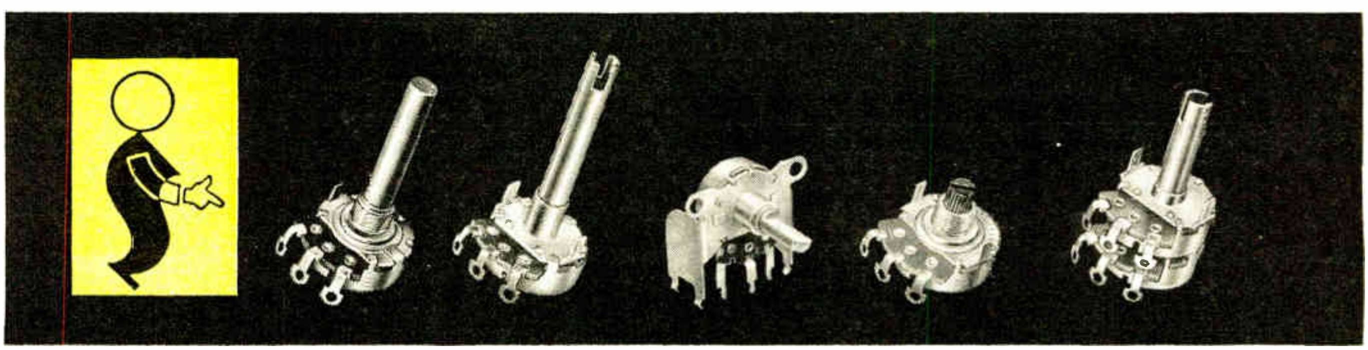

CIRCLE NO. 41 READER SERVICE CARD

NEW FROM PHILCO

HIGH FREQUENCY NPN SILICON DIFFUSED-BASE TRANSISTORS*

30mc PULSE RATE SWITCHES

Type Number	hfe	Typical Power Gain	Typical Switching Times (Saturated Test Circuits)
2N1199	12-60 (DC)		t_r 35 mμsec t_s 10 mμsec t_f 25 mμsec
2N1267 2N1268 2N1269	6-18 11-36 28-90	25 db at 4.3 mc	
2N1270 2N1271 2N1272	6-18 11-36 28-90	25 db at 12.5 mc	
Maximum V_{cb}—20 V Maximum temperature—150° C Maximum dissipation—100 MW			

60mc AMPLIFIERS

2N1199

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.

2N1267-68-69

The high gain characteristics of these units make possible the design of high efficiency IF amplifier circuits for communications equipment. These devices have unusually low collector capacitance . . . typically 1.5 μμf . . . and are available with restricted beta ranges to simplify design problems.

2N1270-71-72

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.

Immediately available for prototype design from your Philco Industrial Semiconductor Distributor.

Write Dept. E-759, Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa.

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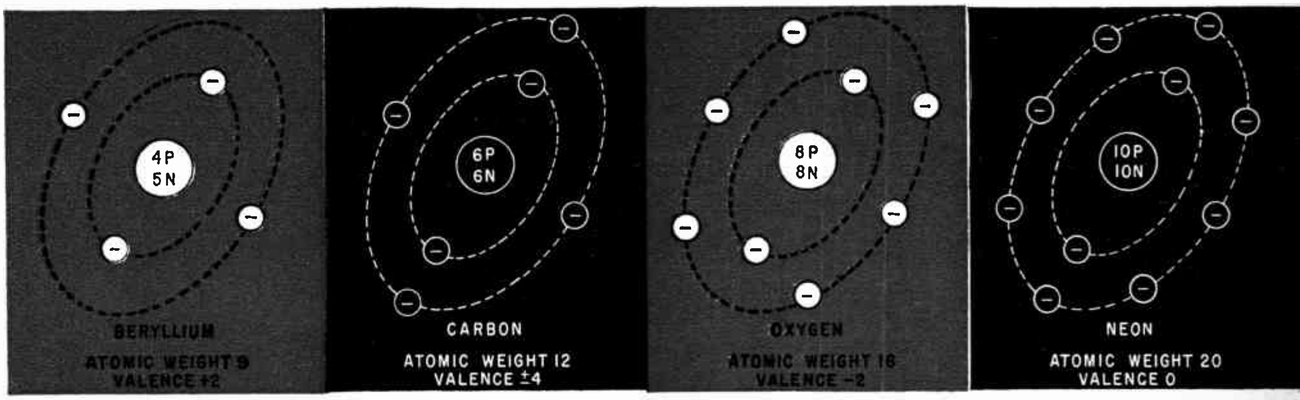


FIG. 1—Oxygen and beryllium can share each other's valence electrons to form stable compound BeO

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 O. 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.

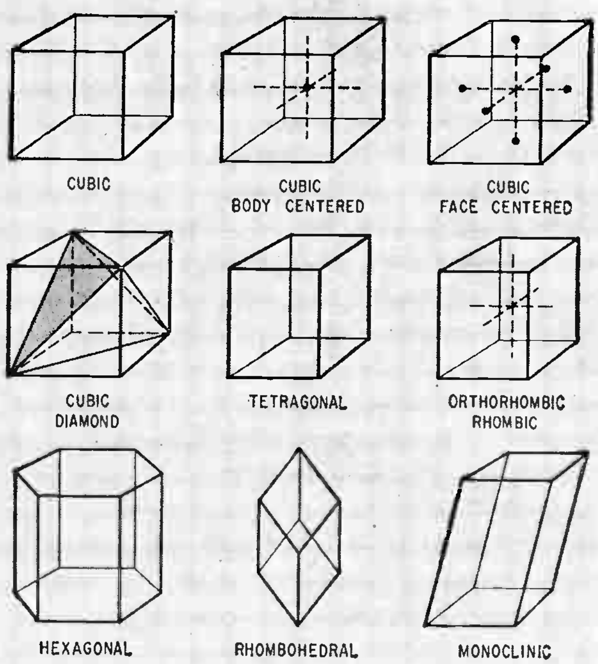
The foregoing illustrates the immense job which confronted the chemist in producing satisfactory materials for the production of semiconductors. It also shows the extent of the job still confronting chemists in producing new combinations that may be tested for their semiconductive properties.

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 occuring 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.

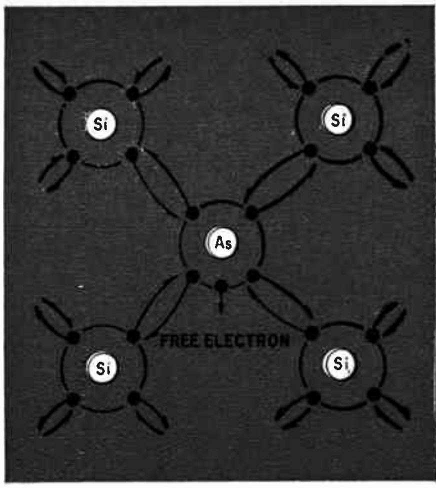


FIG. 2—Arsenic atom fits into silicon crystal lattice to increase number of free electrons

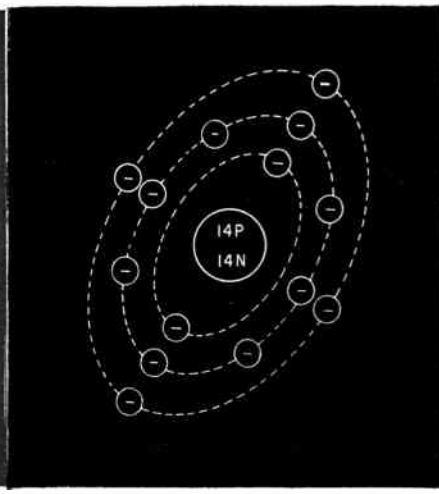


FIG. 3—Pure silicon atom having an atomic weight of 28 and a valence of 4

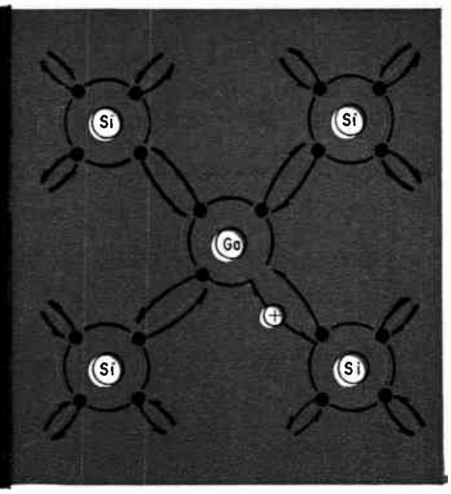


FIG. 4—Gallium added to silicon showing how hole is generated

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.

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

Energy Gap (ev)	Element	Mobilities (cm^2/v-sec) Electrons	Mobilities (cm^2/v-sec) 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

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.

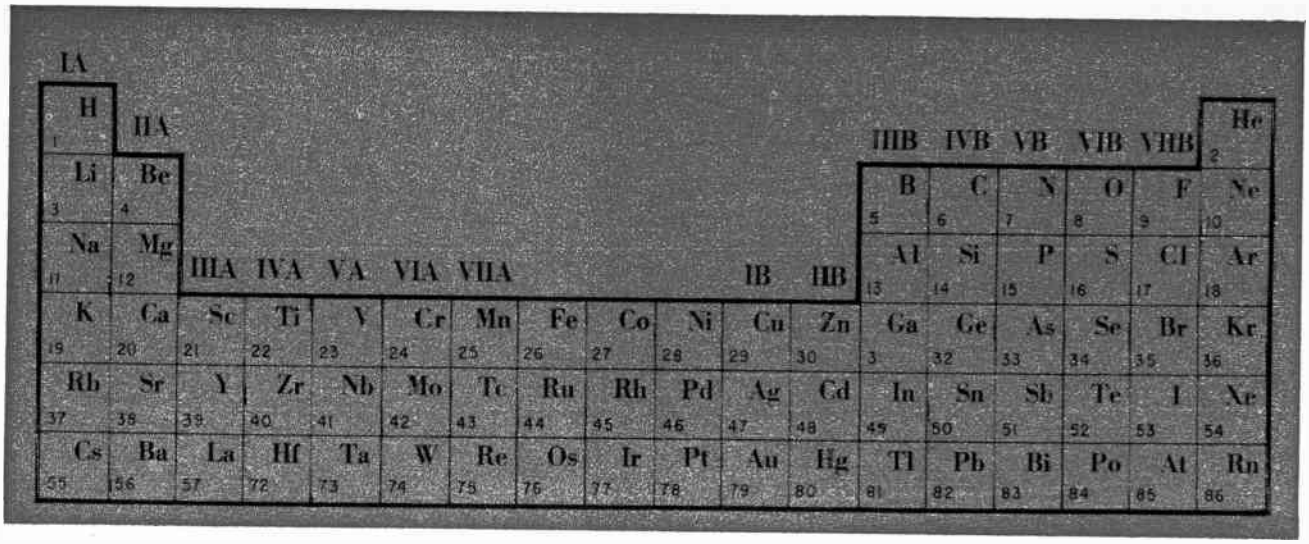


FIG. 5—Abbreviated form of periodic table. The elements in subgroup A are largely metallic and conducting. The lower atomic number elements of subgroup B of columns IV, V and VI form nonmetallic crystals that are elemental semiconductors

Another property which distinguishes a semiconductor from a conductor is the variation of resistance with temperature. A conductor almost always shows an increase in resistance with a rise in temperature. A semiconductor, however, shows a decrease of resistance (increase in conductivity) with an increase of temperature. This is an intrinsic property of a semiconductor and is one of the most important properties which differentiate semiconductors from conductors.

OTHER COMPOUNDS—Any crystalline substance in which the valence bands of the atoms are full should be a semiconductor providing the material has an energy gap within the required range.

Semiconductors should be found among combinations of elements from Groups III and V, Groups II and VI, and Groups I and VII. Such combinations have been found and the more important known data are given in Table II for semiconducting compounds of Groups III and V, and II and VI. Compounds of Groups I and VII, formed as they are from strongly electropositive elements from Group I and strongly electronegative elements from Group VII have large energy gaps and large binding energies. Few promising semiconductor compounds of the I—VII type have been found and this type of combination does not appear to have as great a potential as other types.

Semiconducting compounds may also be formed from two atoms of a group II element and one of a group IV element, as well as many other combinations. Some of the many compounds which have shown semiconducting properties are listed in Table III. Examination of the table indicates that even the principal valences can fail to be indicative of semiconductive properties, since some of the compounds listed utilize secondary valences of the elements of which they are composed. Neither are the effects limited to combinations of only two elements since some of the compounds are formed of three elements. Though the intermetallic compounds have shown the best semiconductive characteristics, organic compounds may also demonstrate similar properties. The best semiconductive properties have so far been shown by members of group IV and by some of the III—V compounds so the bulk of the present investigatory work is being directed toward these groups.

Different end uses emphasize different properties. Power rectifiers require a low internal resistance, a relatively high operating temperature and a high back-voltage requirement. This will immediately rule out the low-melting point compounds. High-frequency crystals require high carrier mobilities which narrows the field of possibilities. Other special applications have their own special requirements and a compound that may be well fitted for one type of application may be totally unsuited to another.

MATERIALS PROBLEM—The present state of the theory is such that no accurate prognostications can be made. In most cases we are dealing with a mate-

Table II—Semiconductor Compounds from Elements of Groups II-VI and III-V

Energy Gap (ev)	Compound	Mobilities (cm^2/v-sec)	
		Electrons	Holes
3.7	ZnS		
3.2	ZnO	200	180
3.0	AlP		
2.6	ZnSe	100	
2.4	CdS	210	
2.4	GaP		
2.2	AlAs		
2.2	ZnTe		50
1.8	CdSe		
1.6	AlSb	1,200	300
1.5	CdTe	600	50
1.4	GaAs	4,000	250
1.25	InP	3,400	650
0.8	GaSb	4,000	850
0.4	InAs	30,000	200
0.18	InSb	77,000	1,250
0.16	HgSe	15,000	
0.08	HgTe		

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 infinitestimal 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_2Se_3	V, VI	0.35	600	
Bi_2Te_3	V, VI	0.15	800	400
Cd_3As_2	II, V	0.6		
CdSb	II, V	0.5		400
Cs_3Sb	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	
$HgIn_2Se_4$	II, III, IV	0.6		
LiMgBi	I, II, V	0.4		
Mg_2Ge	II, IV	0.74	520	100
Mg_2Sb_3	II, V	0.8	80	20
Mg_2Si	II, IV	0.77	370	70
Mg_2Sn	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_2Te_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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Telemetering scheme in handling photocell output helps determine daylight intensity at remote location. System can be used in industrial process control with visible light, infrared or ultraviolet input. Prf rate of blocking oscillator is controlled by photocell output

By E. F. HASLER and G. SPURR, Central Electricity Research Laboratories, Leatherhead, Surrey, England

Ways to Measure Light

MANY INDUSTRIES require measment of illumination intensities ranging from ultraviolet through the visible spectrum to the infrared. Most of these uses are for process control and similar applications where a simple on-off operation is desired. Sometimes it is necessary for intensity measurements to be made with a high degree of accuracy and repeatability over a long period of time. This latter requirement has usually been met only by use of complex apparatus incorporating highly-stable amplifiers.

The simple illumination measuring device to be described has an inherently high degree of accuracy and stability. It is a local indicator for an instrument developed for making measurements of daylight level in a form suitable for transmission over telephone lines at distances ranging up to many miles from the measuring site.

Oscillator

The circuit is based on a blocking oscillator whose prf is controlled by a photocell[1,2]. A blocking oscillator is basically an over-coupled continuous-wave oscillator whose prf is determined by the value of grid resistance[3]. Since the resistance of the photocell varies with the applied illumination, the blocking oscillator prf will then be determined by the illumination intensity. Maximum illumination will provide the highest prf.

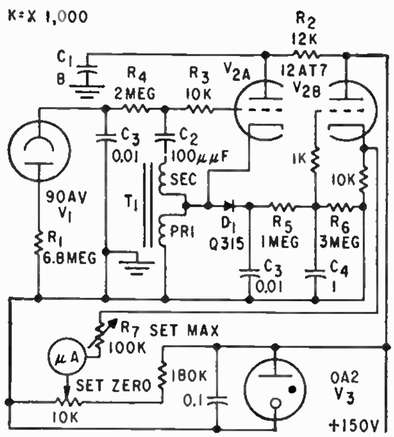
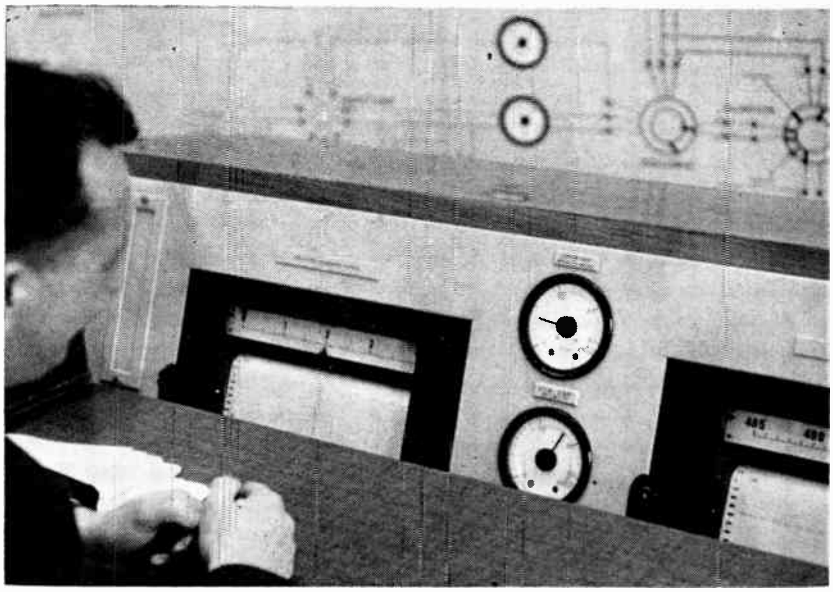


FIG. 1—Blocking oscillator pulses are averaged by filter network and passed through cathode follower to meter

The circuit of the device is shown in Fig. 1. To obtain a compressed characteristic at the full-scale end of the meter, limiting resistor R_1 is in series with the photocell to limit the maximum pulse rate. At low illumination levels when the apparent resistance of the photocell is large compared to R_1, the instrument is most sensitive to changes in the illumination level. With suitable aperture, half the maximum pulse rate is produced by an illumination intensity of just over 10 kilolux as shown by Fig. 2.

The blocking oscillator circuit provides an inherently high degree of accuracy and stability. During peak conduction of V_{2A}, a voltage almost equal to the plate supply voltage appears across the primary of transformer T_1. This transformer is similar to a television horizontal blocking oscillator transformer having a primary inductance of 0.5 hy and a turns ratio of 3 to 1. The mean current in the circuit is very small and the drop across decoupling resistor R_2 is negligible. The peak current is high but its duration is extremely short therefore C_3 prevents variation in the plate potential. The plate supply is stabilized at 150 v by regulator V_3.

Since the turns ratio of T_1 is fixed, grid capacitance C_2 will be charged to the same peak voltage from each successive pulse and with the photocell illuminated at a constant level, will require the same time to discharge back to the oscillation point. There will be slight random fluctuation due to noise at the grid but the high peak voltage



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

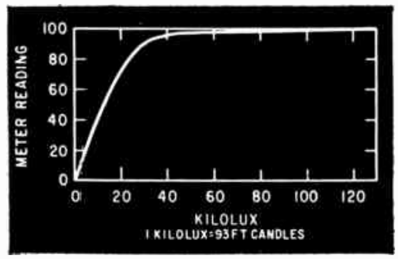


FIG. 2—Non-linear response shows limiting effect of photocell series resistor

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_3 in series with the internal tube grid-cathode forward impedance. Resistor R_3 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 photocell[4]. 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_4 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_5, C_4 and R_6. The smoothed direct voltage obtained increases linearly with pulse rate up to the saturation value. This voltage is applied 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 follower[5] or other comparable cathode follower[6]. Potentiometer R_7 is used to compensate for line resistance.

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

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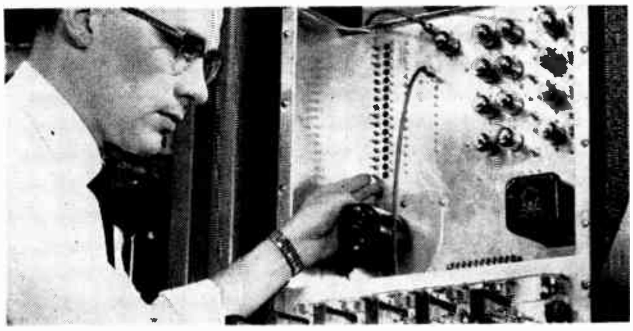
Testing High-Speed



Engineer uses switches to change word generator output

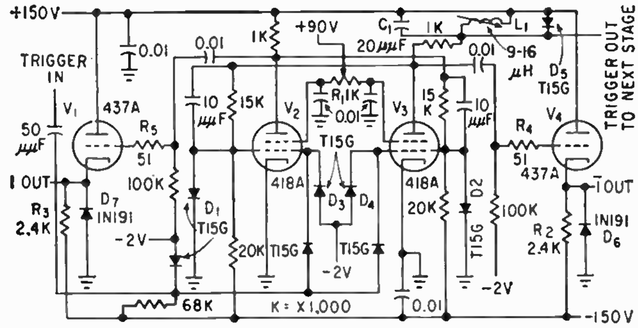


FIG. 2—One of four identical binaries used in word generator

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 changing from one state to the other.

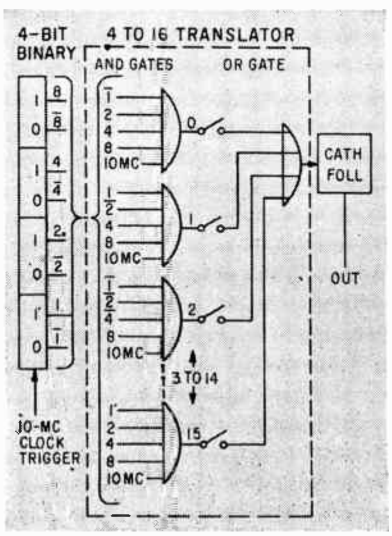


FIG. 1—Generator words are selected in translator by manual switching

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

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,
Staff Research Engineer, Denver Research Institute, University of Denver, Denver, Colo.

followers are returned to −2 v to protect the 437A tubes in the event of binary signal loss. Resistors R_4 and R_5 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.

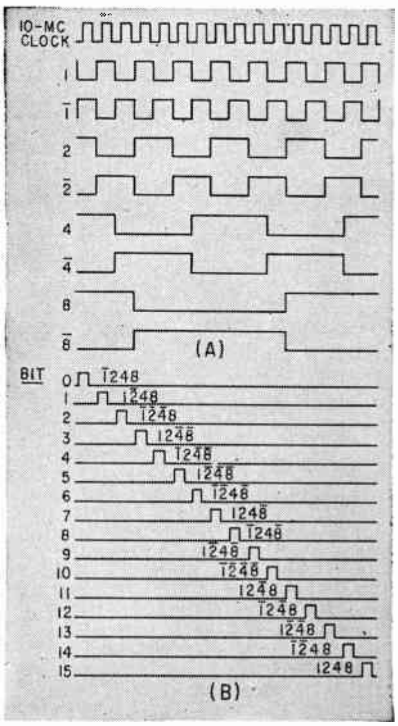


FIG. 3—Translator input (A) and output (B) waveforms

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 function 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 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.

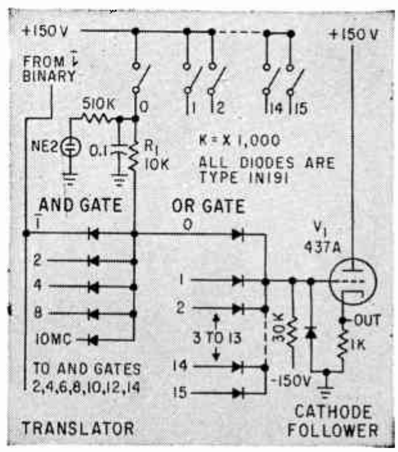


FIG. 4—Translator uses diode switching

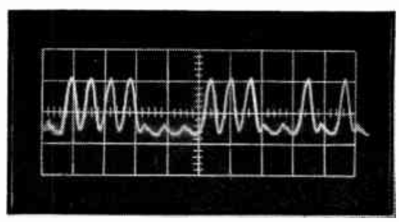


FIG. 5—Typical generator output word. Scales are 0.16 μsec and 5 v per division

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 publication[1] 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 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

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/cm²-sec	NA	10^{10}	10^{10}
time (hr)	NA	1,000	1,000
Gamma photon flux level			
photon/cm²-sec	NA	10^{11}	10^{11}
time (hr)	NA	1,000	1,000
Thermal neutrons		*a*	*a*
Pulse Radiation			
Neutron flux level (fast)			
neutron/cm²-sec	10^{17}	10^{17}	NA
time (μsec)	80	80	NA
Gamma flux level			
Roentgens/sec	10^{8}	10^{8}	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

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/cm²	NA	NA	NA	165	165	165	165	165
Moisture	All groups: 100% relative humidity with condensation; Method 106 of MIL-STD-202A for 10 complete cycles							
Salt Atmosphere	All groups: 96 hours in accordance with Method 101A of MIL-STD-202A							
Explosive Atmosphere	All groups: test in accordance with Procedure I of MIL-E-5272							
Fungus Resistance	All groups: non-nutrient; no damage or deterioration using Procedure I of MIL-E-5272							
Sand and Dust	All groups: applies only to moving parts; test by Procedure I of MIL-E-5272							
Flammability	All groups: 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							
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)	½	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 semiconductors: 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 ¼-inch of 35% boron carbide or ⅛-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.

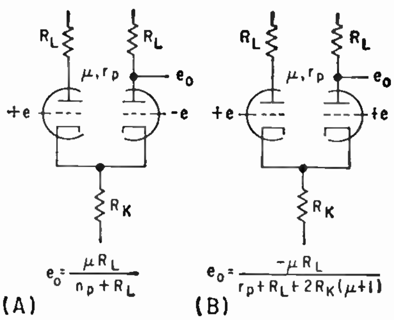


FIG. 1—Amplifier with push-pull input (A) and with common-mode input (B)

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

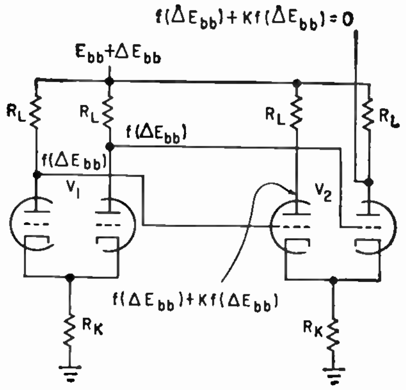


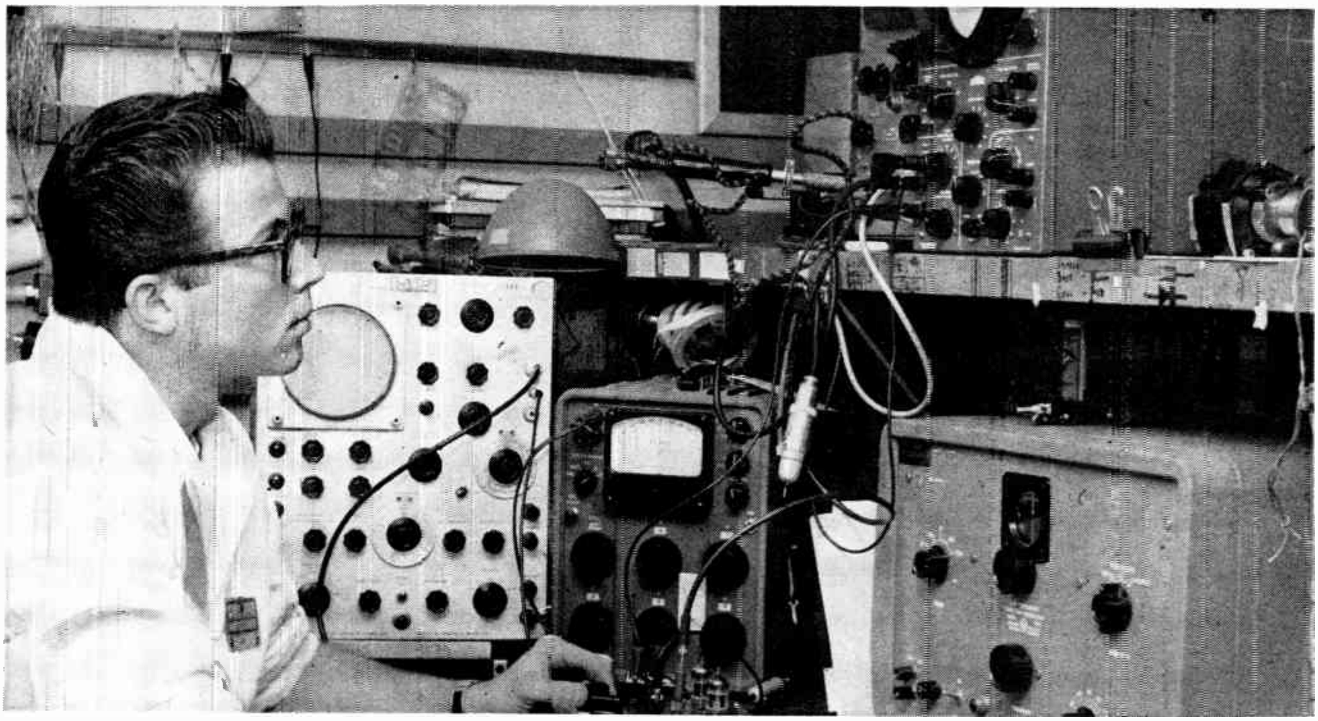
FIG. 2—Differential amplifier circuit illustrates cancellation principle

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 μv. This output corresponds to an equivalent-input noise signal of 10 μv 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.

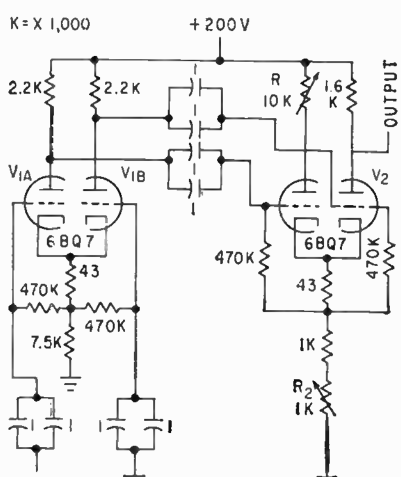


FIG. 3—Practical differential amplifier circuit reduces output fluctuations due to power-supply variation at its output

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.

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.

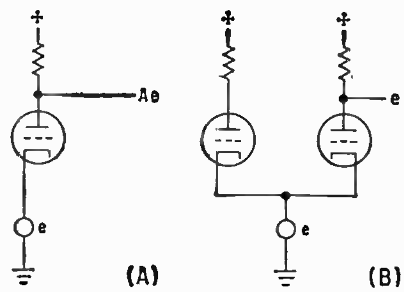


FIG. 4—Equivalent circuits of standard amplifier (A) and differential amplifier (B) show effect of heater-voltage variation

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.

COHERENT 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 nonchanging 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; improper 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 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 oscillator 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 μsec. When gating an oscillator in synchronism with a phase-locking pulse, the oscillator is slow 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.

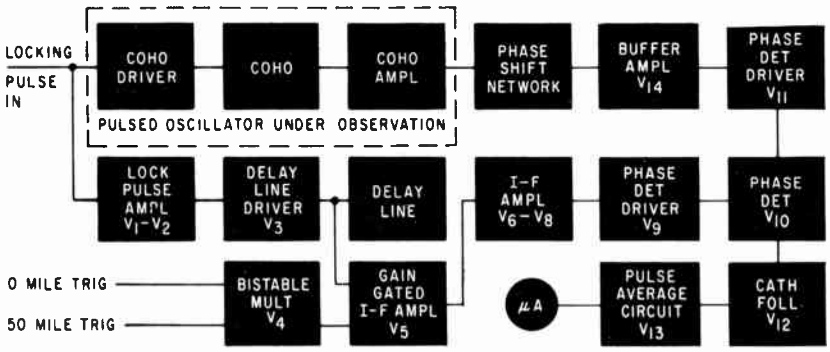


FIG. 1—Locking pulse synchronizes COHO and excites delay line. Phase detector output depends on COHO and delay line signals phase relationship. Difference is averaged and displayed on meter

Moving Target Radar

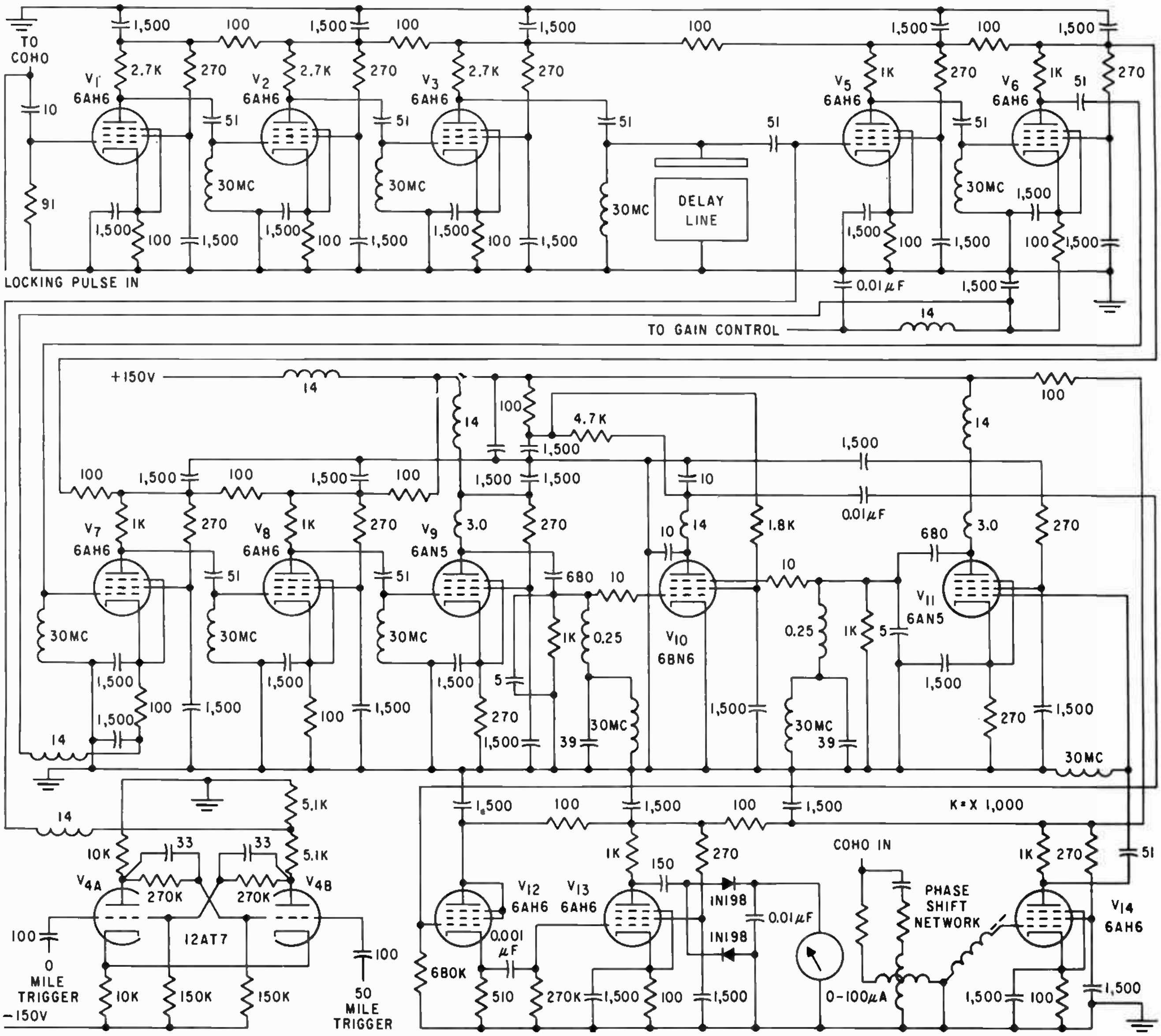


FIG. 2—Gated-beam phase detector V_{11} receives COHO signal via phase-shift network and gated locking pulse signals. Any difference in phase is averaged and then shown on meter

A free-running COHO is generally used in MTI systems that employ a pulse width that is long enough with respect to time to force the oscillator to oscillate in phase with the locking pulse. Though there are several methods used in gating a free running oscillator, all methods attempt to make the oscillator extra sensitive or more susceptible to the influence of the phase-locking pulse.

Most other instability factors can be minimized by using a well designed vibration and shock mounted oscillator chassis, nonmicrophonic tubes for the COHO and driver, d-c filament supply for the COHO and driver when necessary, careful component layout, particularly the oscillator tuning components, and good COHO and driver design.

Measurement of the capabilities of an MTI system is expressed in sub-clutter visibility. Thus, a 40 db sub-clutter visibility MTI system is capable of displaying a moving target on an indicator (which is masked in clutter at a specified range) whose signal strength is 40 db below the signal strength of the clutter. Clutter is a conglomeration of random targets such as noise, clouds, mountains, rain or dust, that engulfs the desired target. Measurement of coherent oscillator instabilities essentially amounts to measuring the phase difference between starting time and at some time after starting. This phase difference presents unwanted pulse variations at the leading and trailing edges of the video target pulses. This phase difference can be called jitter where the term jitter includes 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 detector[2]. By shifting the phase of the COHO 180 deg the only time that the phase detector will produce an output is when there is a phase difference present in the system. Any phase difference detected by the phase detector represents COHO instability or jitter[3].

Hum Modulation

When the normal amount of jetter 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 μsec 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 tube[4]. 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 indicated 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 meter[4].

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 millisec	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

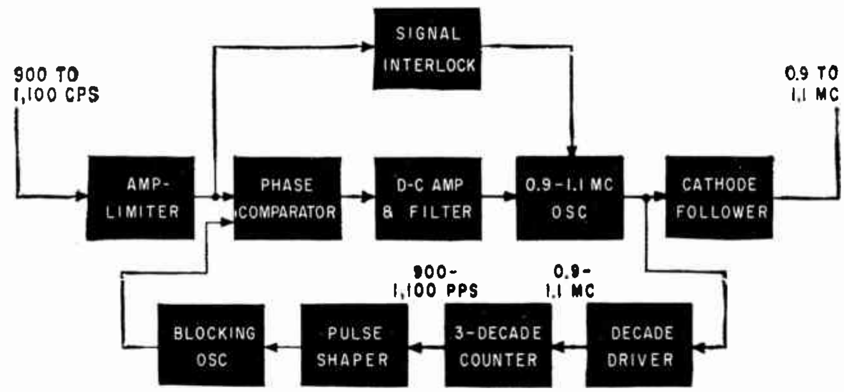

FIG. 1—Digital feedback method of frequency multiplication

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 bandpass 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-controlled 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 oscillator 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-μsec wide. A phase comparator is gated by this 1-μsec signal. The phase comparator also receives the input signal, which has first been amplified and

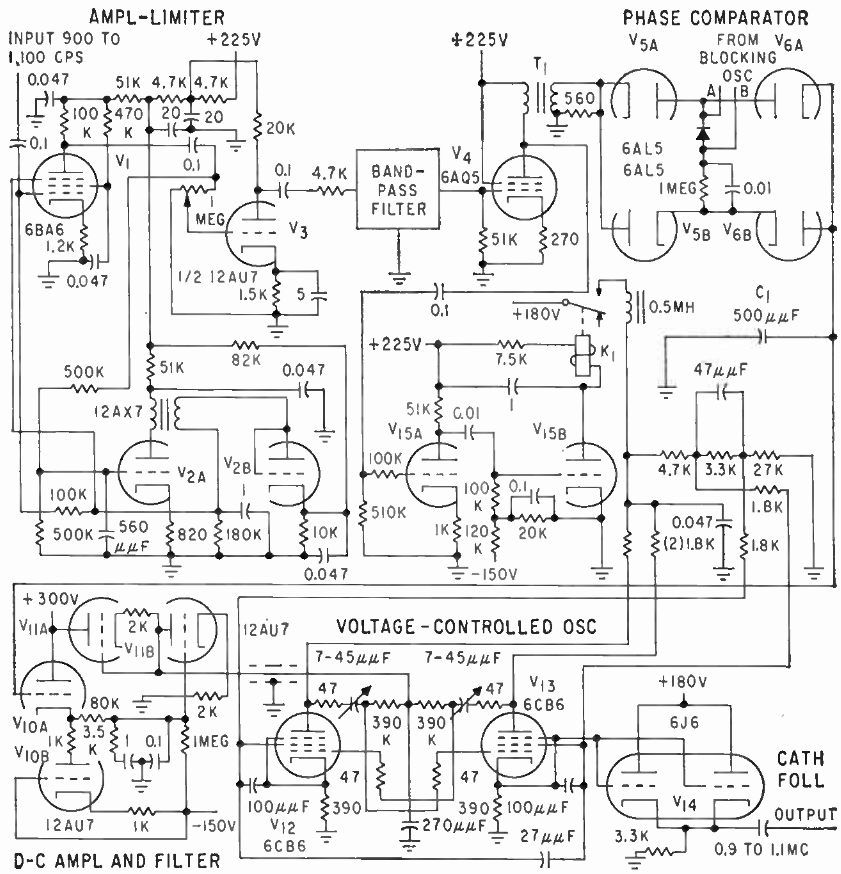

FIG. 2—Control signal is developed in phase comparator. Amplified signal is used to regulate voltage-controlled oscillator

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

By W. O. BROOKS,
Ramo-Wooldridge Division, Thompson Ramo Wooldridge Inc., Los Angeles, California

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 bandpass filter. The filter is a commercially available unit and is used to 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}.

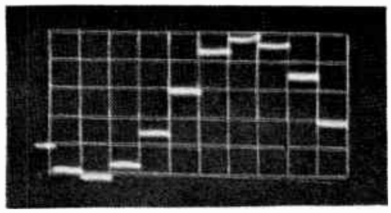

FIG. 4—Stair-case output of phase comparator

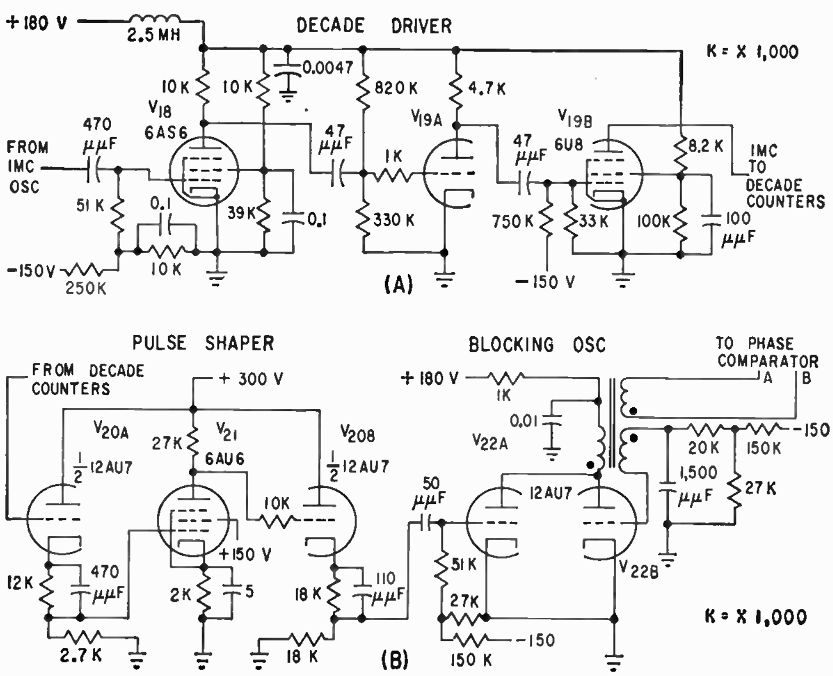

FIG. 3—Feedback circuit divides by 1,000 and triggers blocking oscillator

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 the decade driver circuit. For accurate triggering, the first decade counter requires a signal of approximately 80 v p-p and 1-μsec rise time. This is accomplished with tubes V_{18}, V_{19A} and V_{19B}. 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 μsec 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-μsec and the amplitude must be 150 volts peak-to-peak. The pulse-shaping circuit (tubes V_{20A}, V_{21} and V_{20B} of Fig. 3B) accomplishes this. Clipping is used in V_{21} while cathode followers V_{20A} and V_{20B} 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 μsec.

Blocking oscillator V_{22} is a conventional circuit, triggered through a differentiating network. Output of the blocking oscillator is a pulse 1 μsec wide, with 0.05-μsec rise time and 75 volts peak.

Phase Comparator

The signal to control the multivibrator is developed by the phase comparator. In Fig. 2, this is the balanced bridge circuit of V_5, and V_6. 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

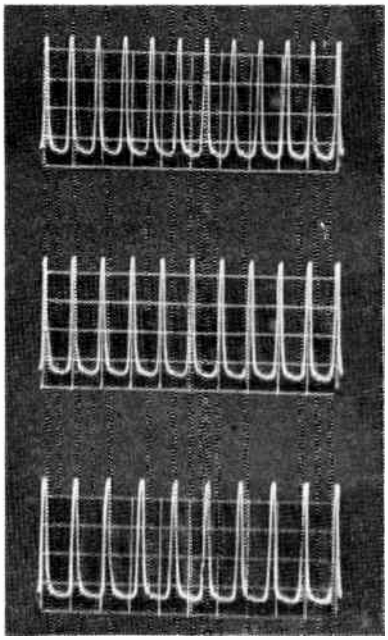

FIG. 6—Oscillator output for varying input frequencies. Top to bottom: 1,100 cps, 1,000 cps, 900 cps

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-μsec 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 compacitor 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_{11B} to near zero. The plate of V_{11B} 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.[1] 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_3 and V_4 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.

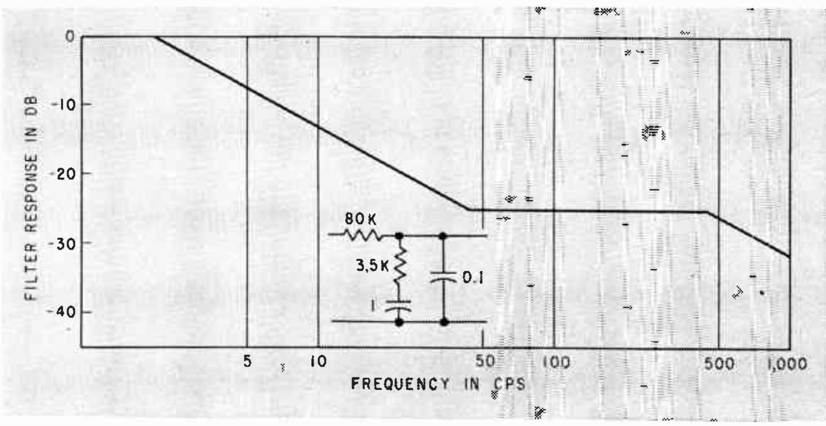

FIG. 5—Filter characteristics for 1 kc meet stability requirements

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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

By W. J. McDANIEL* and T. L. TANNER,

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

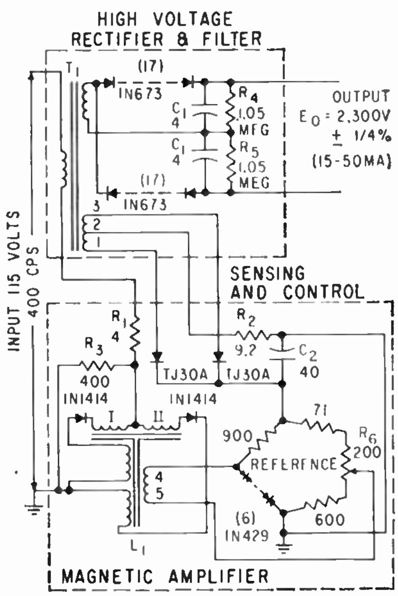

FIG. 1—Control of output is accomplished with self-saturating magnetic amplifier in series with primary of transformer T_1

Rectifier Circuit

The high-voltage rectifier and filter shown in Fig. 1 is the conventional full-wave voltage-doubler circuit, which is generally advantageous for high-voltage circuits of moderate-wattage capacity.[3]

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-μf capacitor of 2,000-v rating in each doubler section.

Magnetic Amplifier

The magnetic amplifier configuration is a doubler-circuit[3] 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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* On assignment with Bell Labs, Whippany, N. J.

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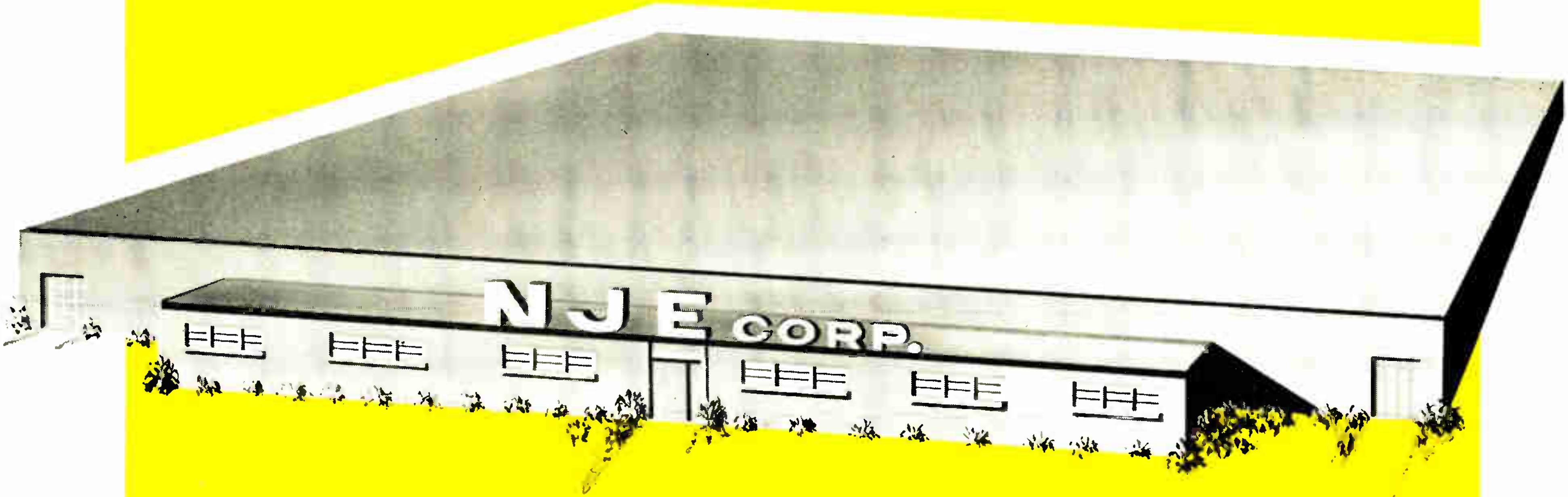

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Designing a Power Density Meter

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.

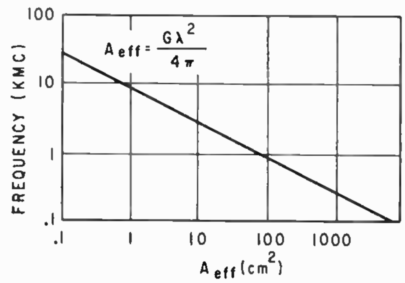


FIG. 1—Effective area is plotted as a function of frequency for an isotropic radiator

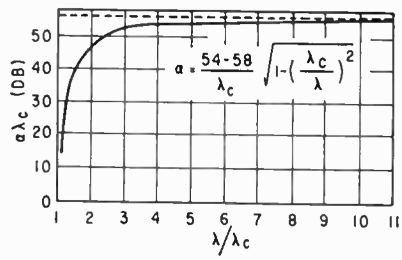


FIG. 2—Plot shows attenuation for a waveguide below cutoff

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.

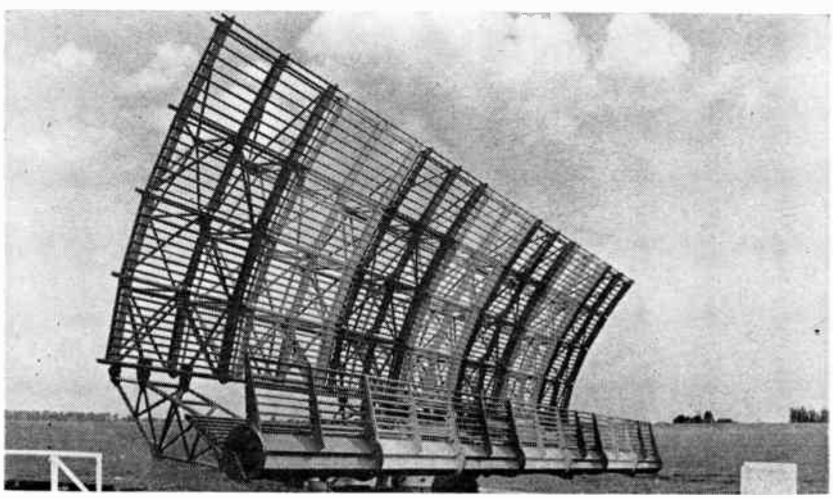
Using a waveguide beyond cutoff requires very adequate shielding and shaping of the attenuation curve as a function of frequency, to get constant power level into the power bridge.

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.

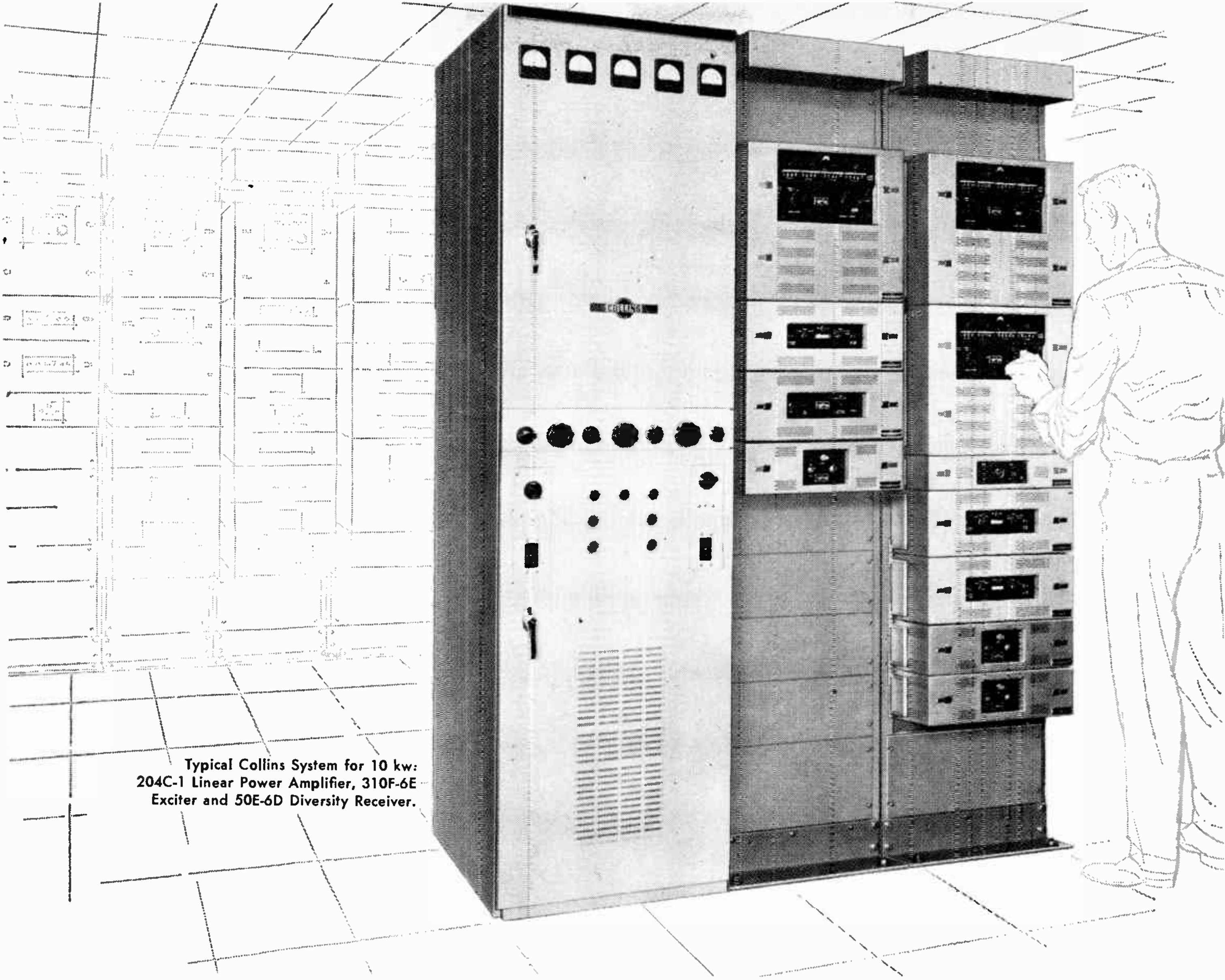
For 750 to 4,000 mc and for 3,750 to 10,000 mc, conical horns with variable concentric probes are used. By proper choice of cone angle and cone length, and by proper positioning of the conical probe, the characteristics of these antennas can be modified to correlate with the requirements of the power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

CIRCLE NO. 67 READER SERVICE CARD→



Typical Collins System for 10 kw: 204C-1 Linear Power Amplifier, 310F-6E Exciter and 50E-6D Diversity Receiver.

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.

Improving Microwave Tube Efficiency

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

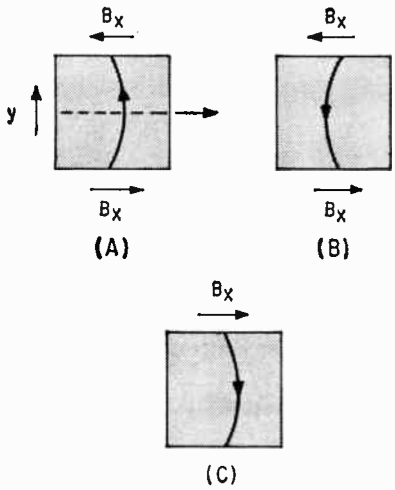


FIG. 1—Converging and diverging effects of magnetic lens, arranged to produce fields shown in A and B are cancelled when magnetic field lines at the two gaps are curved as in A and C

ALTERNATE GRADIENT focussing[1], 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 undulator[2] 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_x 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 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:

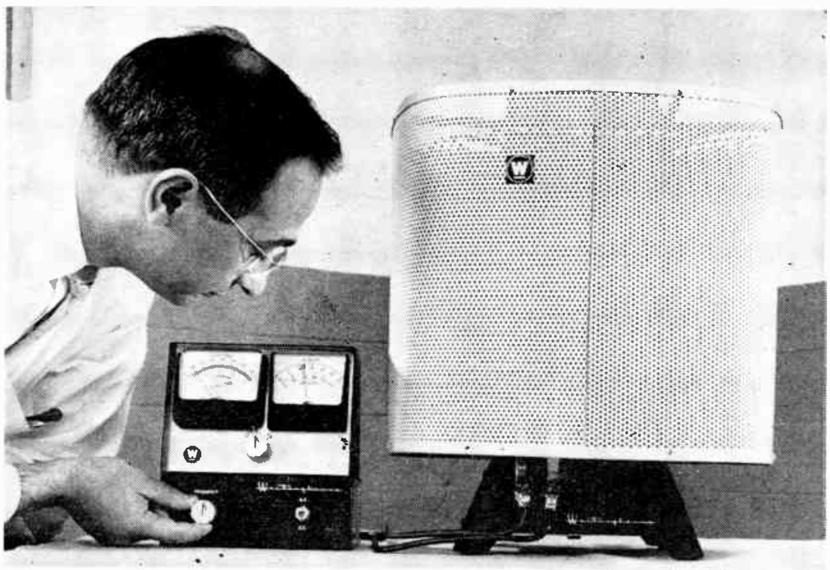
$$f_1 = -f_2 = \frac{mv}{c\, t_o \frac{B_y}{x}}$$

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

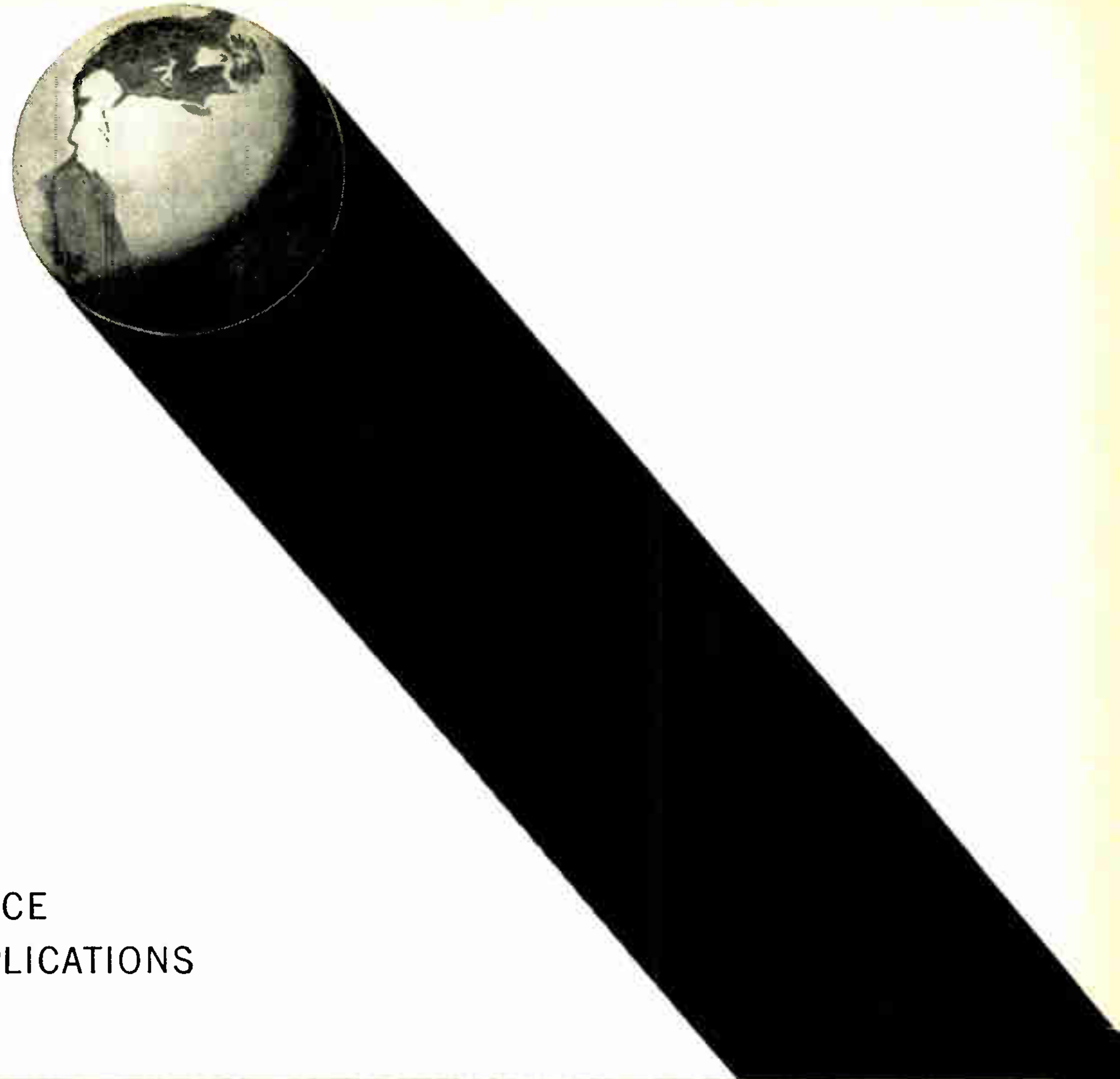
Emergent Beam

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



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-change 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 tubes[3], 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 known[4] 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 $1 - (d/f)^{2-1}$ 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 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	125×10^3 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: 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.

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

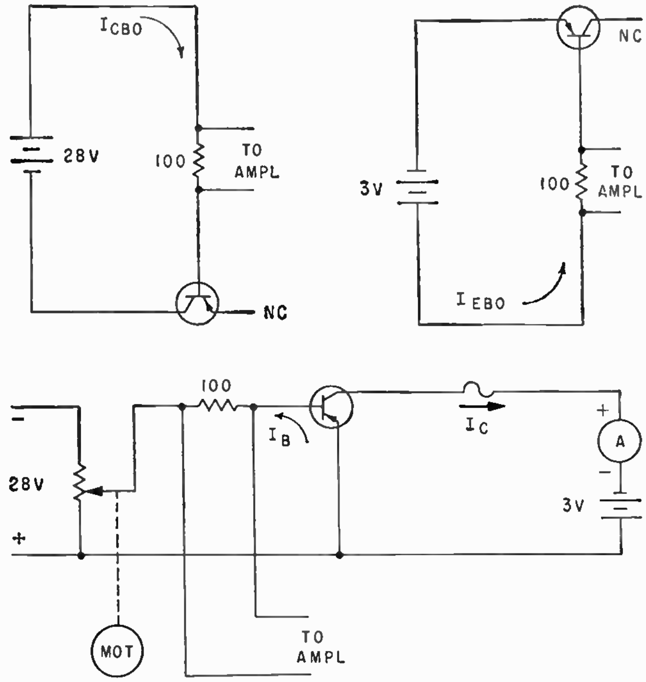


FIG. 2—Test circuits used in analyzer. I_{CBO} and I_{EBO} are determined directly; beta is found as ratio of I_C to I_B

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 ¼ that required by manual methods.

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

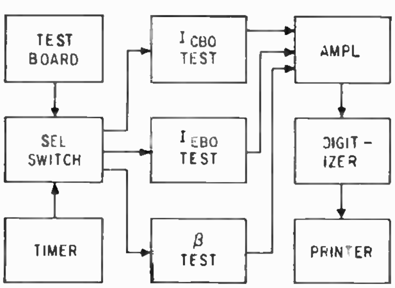


FIG. 1—Block diagram of system

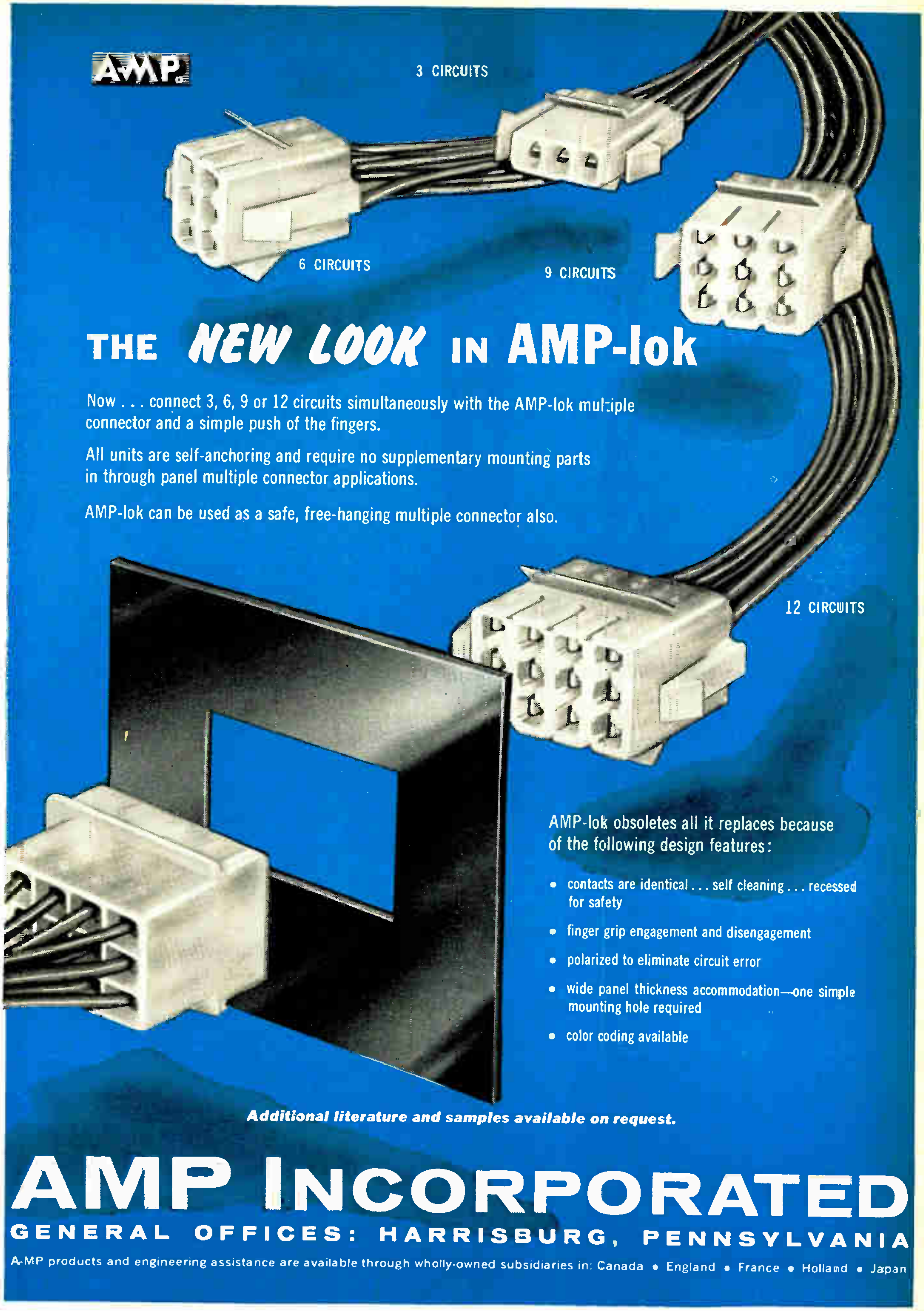
Fig. 1 is a block diagram of the system and Fig. 2, the test circuits. The control unit is seen as the bottom deck in the photo. The control unit panel contains 30 lights indicating the number of the transistor under test or the control signal (lights 29 and 30), 3 lights indicating which parameter is being measured, 5 toggle switches to select polarities for *npn* or *pnp* 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 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.

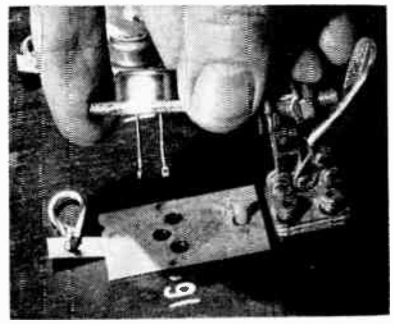
Test record is transcribed into log

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


A-MP
3 CIRCUITS
6 CIRCUITS
9 CIRCUITS
THE NEW LOOK IN AMP-lok
Now . . . connect 3, 6, 9 or 12 circuits simultaneously with the AMP-lok multiple connector and a simple push of the fingers.
All units are self-anchoring and require no supplementary mounting parts in through panel multiple connector applications.
AMP-lok can be used as a safe, free-hanging multiple connector also.
12 CIRCUITS
AMP-lok obsoletes all it replaces because of the following design features:
• contacts are identical . . . self cleaning . . . recessed for safety
• finger grip engagement and disengagement
• polarized to eliminate circuit error
• wide panel thickness accommodation—one simple mounting hole required
• color coding available
Additional literature and samples available on request.
AMP INCORPORATED
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA
A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

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.

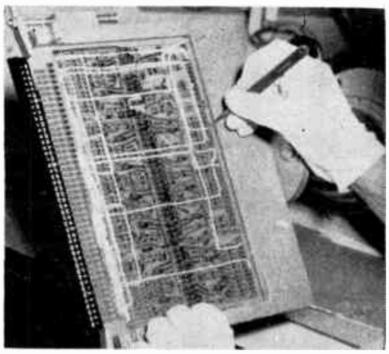
Beta measurement is generally during *off*. However, if no beta is obtained due to some fault, an artificial beta reading is introduced to at the *on* point insure that there is a line of data for each transistor. The relay ammeter senses the preselected beta current at which the d-c beta is measured, 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 1/16 inch Bakelite. Four U-shaped and tapered pins or bars are riveted to the strip, as shown in Fig. 1.

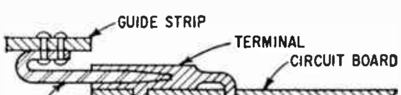
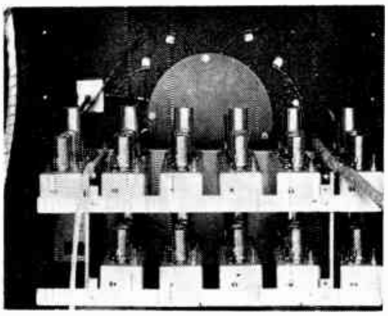


FIG. 1—Cross section through a guide mounting pin

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 μsec per tap to 50 μsec 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

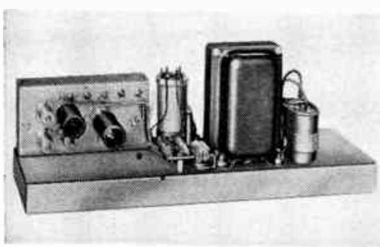
Voltmeter expanded scale

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

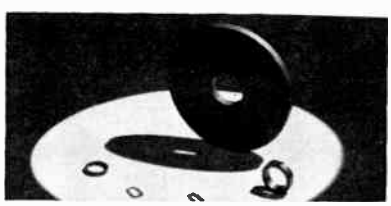
ADLER ELECTRONICS, One LeFevre Lane, New Rochelle, N. Y. Type VCA-1 amplifier provides a minimum gain of 40 db on any vhf tv channel in the 54-88 mc frequency range. At Channel 6, the noise figure is 3 db. The amplifier also features 10,000-hr tubes for reliability and remote crystal-control monitoring. The compact 12-lb unit may be either pole, rack or chassis mounted.



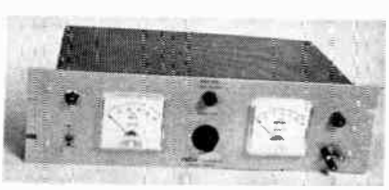
CIRCLE NO. 202 READER SERVICE CARD

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 continuously 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 μsec; line regulation, less than

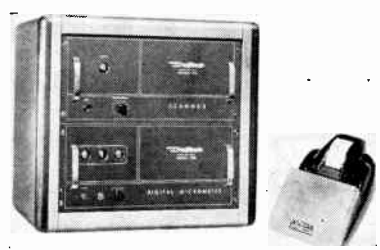
0.1 percent; load regulation, 25 mv typical; ripple, less than 0.02 percent; output impedance, 0.5 ohm maximum d-c to 5 kc; input 105-125 v, 60-400 cps. Weight of the unit is 15 lb.

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.

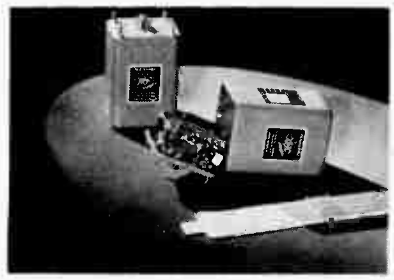
CIRCLE NO. 206 READER SERVICE CARD

(Continued on p 84)

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-

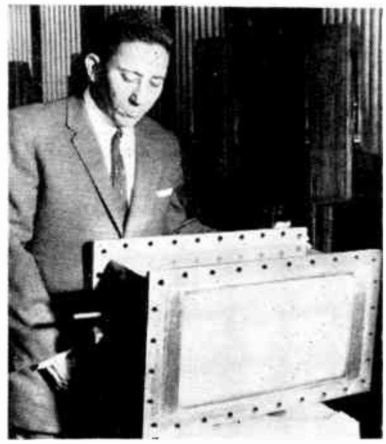
tivity, precision integral discriminator, and built in line frequency test circuit. Price is $595.

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

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 a 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.

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

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Company__________
Address__________
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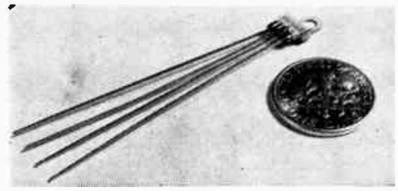
CIRCLE NO. 87 READER SERVICE CARD

15,000 v at 4 ma. Accuracy and linearity, better than 1 percent.
CIRCLE NO. 212 READER SERVICE CARD

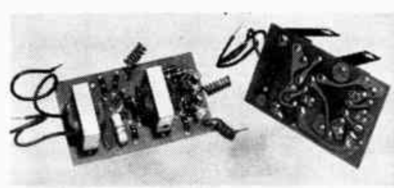


Rectifiers five standard types

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 μa 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 $\frac{1}{16}$ in. up to $\frac{5}{8}$ in. with maximum lift of 12 oz, continuous duty; 19 oz, intermittent. Coil voltages range from 6 to 230 v, a-c. Small size, $\frac{7}{8}$ 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

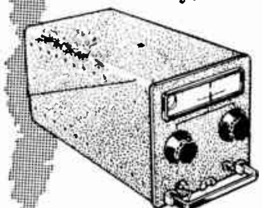


D-C Amplifiers compact units

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

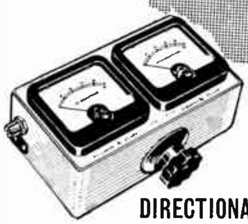
A.W.A ELECTRONICS

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

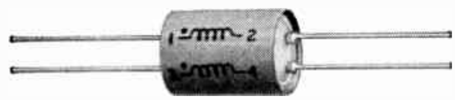
CIRCLE NO. 122 READER SERVICE CARD

Pulse Notes

Introducing a New Sub-Miniature Pulse Transformer

This is the Micro-Stat*

in epoxy...

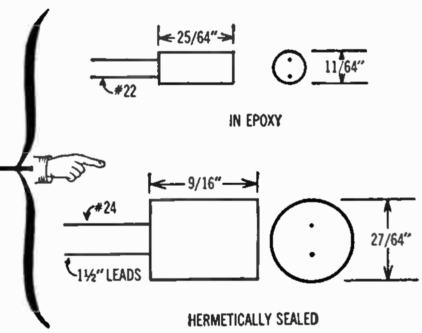


...hermetically sealed

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

Faster reset and less B_r • 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.

560 ROBERT AVENUE • SANTA CLARA, CALIFORNIA

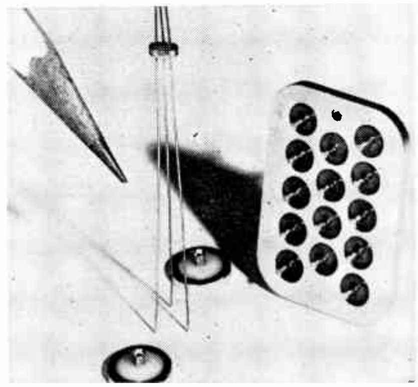
*REGISTERED TRADEMARK, PATENTED CONSTRUCTION

8

CIRCLE NO. 89 READER SERVICE CARD

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.

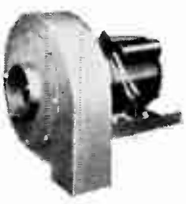
CIRCLE NO. 217 READER SERVICE CARD

Servo Amplifier plug-in type

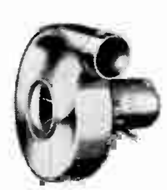
WESTAMP, INC., 11277 Massachusetts Av., Los Angeles 25, Calif., announces a high performance silicon transistor servo amplifier. Model A411 plug-in unit is de-

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.

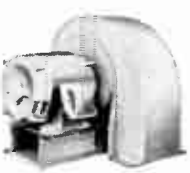
Contact us today!
We're interested in your inquiry!



Electronic Cooling



No-Corrosion Aluminum Construction



Heavy Machinery Cooling

Insulated For Temperatures

Peerless Electric

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CIRCLE NO. 123 READER SERVICE CARD

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 μv to 100 mv across a 50Ω termination. OUTPUT ACCURACY: Incremental, 0.2 db: within 2 db overall. LEAKAGE: Negligible; allows full use of 0.1 μv 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

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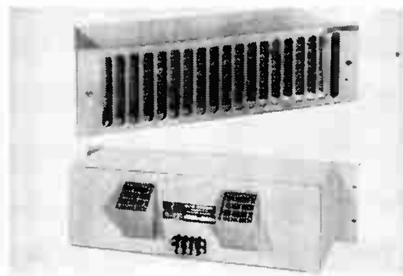
Canada: Canadian Marconi Co. Marconi Building, 2442 Trenton Ave., Montreal 16
MARCONI INSTRUMENTS LTD · ST. ALBANS · HERTS · ENGLAND

TC159

CIRCLE NO. 91 READER SERVICE CARD

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 1¼ by 1¼ by 3 in. high yet is capable of a generous 6 w output.

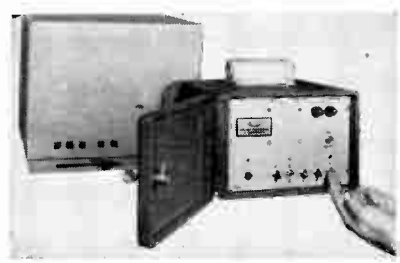
CIRCLE NO. 218 READER SERVICE CARD



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

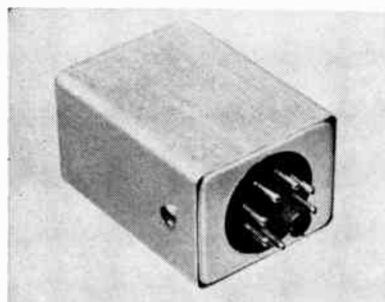
then be set to recognize any one of the markings as the cartons pass at speeds up to 180 ft per sec. The code may be printed on the cartons at the same time other printing is done; no special inks are required.

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 $1\frac{7}{16}$ in. by $1\frac{7}{8}$ in. by $2\frac{1}{2}$ in., and houses an MC6. Heater voltage is 115 v, a-c, with low inductance windings and stability of $\pm$ 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

Expanding the Frontiers of Space Technology in

TELEMETRY

■ Telemetering 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.

ENGINEERS and SCIENTISTS

Lockheed Missiles and Space Division has complete capability in more than 40 areas of science and technology. Its programs reach far into the future and deal with unknown environments. It is a rewarding future with a company that has a record of continual progress. Engineers and scientists of outstanding record are invited to join us in contributing to the nation's progress in space technology. If you are experienced in one of the above areas or in related work, please write: Research and Development Staff, Dept. G1-22, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

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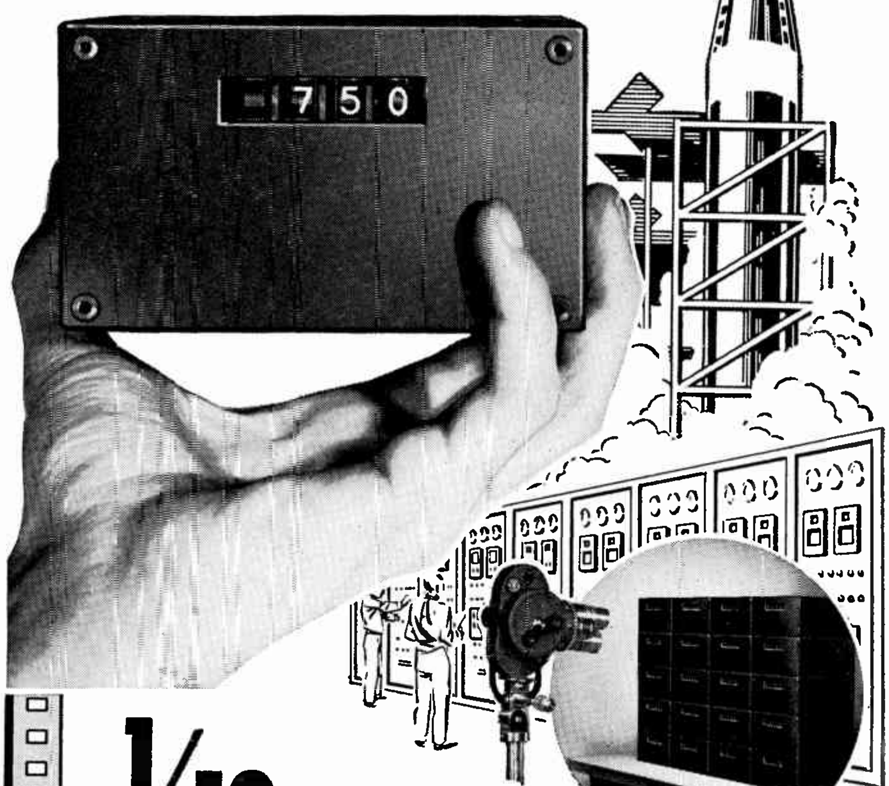
The NEW Series BH100

MILLI-V-METER*

THE INSTRUMENT with the TAPE-SLIDEWIRE



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10 TIMES THE ACCURACY
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- LABORATORY PRECISION for the operating plant.
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- For strain gage, linear differential transformer, thermocouple, thermistor, resistance thermometer, pulse or variable frequency circuits or systems.
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Full Information is available for the asking!

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TORONTO, ONT. (George Kelk Ltd.), MITCHAM, SURREY, ENGLAND (Bryans Aeroquipment Ltd.)

CIRCLE NO. 95 READER SERVICE CARD

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.

CIRCLE NO. 223 READER SERVICE CARD

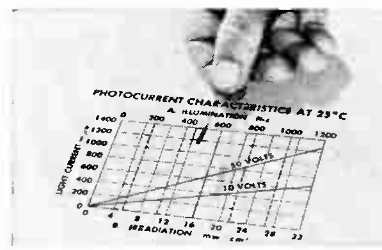

Photo-Duo-Diode highly sensitive

TEXAS INSTRUMENTS INC., P.O. Box 312, Dallas, Texas. The 1N2175 subminiature silicon photo-duo-diode passes up to 1,200 μa when exposed to 1,200 ft-candles of light. In darkness it will pass less than 0.5 μa. 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 *npn* 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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electronics

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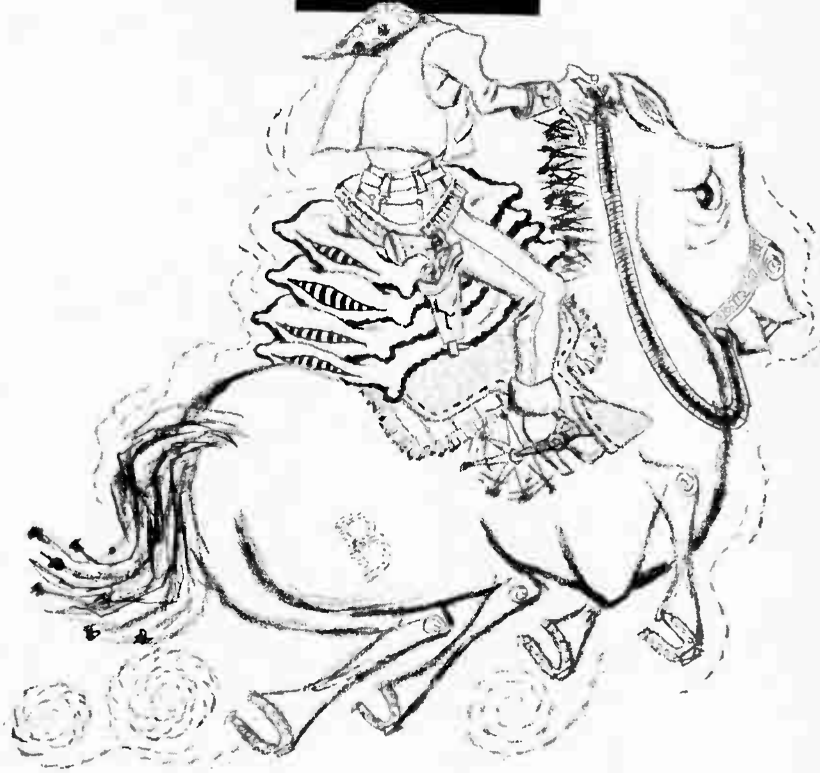


STUD MOUNTED INSULATED BASE

a new solution to an old rectifier problem

The first engineer who "integrated" an eraser with a pencil inspired Bradley's latest accomplishment. Our boys took a hard look at the mess of washers, grease, and sundry hardware required in a conventional rectifier heat sink assembly, and decided to make engineering history again. Between coffee breaks, they tested 163 varieties of alumina-loaded ceramic wafers, found the right combination of electrical insulation + heat transfer characteristics, and brazed together a one-piece, insulated base rectifier that cuts assembling labor, shrinks bridge size, and out-performs other heat sink methods. *If you'd like to unfold the sheet that bares the facts about our new 6 and 12-amp REDTOP® rectifiers, drop us a card.*

BRADLEY SEMICONDUCTOR CORPORATION

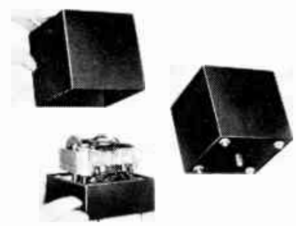
Formerly Bradley Laboratories Inc.

Bradley®

275 WELTON STREET, NEW HAVEN 11, CONNECTICUT

case, with delay time variable from 3 to 30 μsec. 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 μsec 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 ther 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.

CIRCLE NO. 226 READER SERVICE CARD

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 μsec 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 $5\frac{1}{4}$ by $1\frac{1}{2}$ by $5\frac{1}{2}$ in. overall.

CIRCLE NO. 227 READER SERVICE CARD

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 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

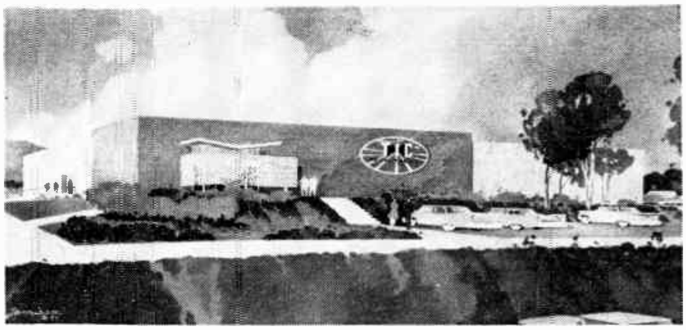
Test Chambers. Conrad, Inc., 141 Jefferson St., Holland, Mich. A new 8-page brochure contains information and descriptive data concerning temperature-vibration test chambers and temperature-altitude-vibration testing chambers.
CIRCLE NO. 259 READER SERVICE CARD

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

CIRCLE NO. 129 READER SERVICE CARD

CIRCLE NO. 103 READER SERVICE CARD



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 nonlinear 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

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 electronically 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.

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 byline. 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 manmade 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, 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 multiroute 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
DECCA NAVIGATOR LTD.
NEW MALDEN, SURREY, U.K.

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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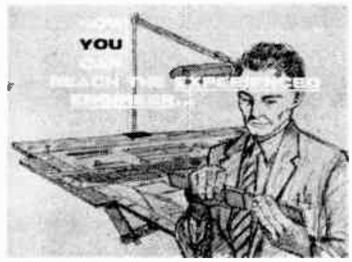

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