June 16, 1961

electronics

Testing new electrodynamic loudspeaker in anechoic chamber (below). Unit has totally active radiating surfaces, p 49

Multiaperture ferrite cores provide nondestructive readout, p 62

A McGraw-Hill Publication 75 Cents

SINE WAVES
SQUARE WAVES
and PULSES

A Wide Range of Outputs From Two Compact Signal Sources

Type 1210-C Unit R-C Oscillator,* $180

with plug-in Type 1203-B Unit Power Supply, $50

- Wide Frequency Range: 20 cps to 500 kc in 5 ranges, either sine or square waves. Calibration accuracy: ±3%

- Three Outputs:

Sine Wave, low-impedance output
(for loads of 500 ohms and higher). Maximum open-circuit output is 7v. Output constant within ±1 db to 200 kc; distortion less than 1.5% over entire range; hum down 60 db.

Sine Wave, high-impedance output
(for loads of 10 KΩ and higher). Maximum open-circuit output is 45v. Output constant within ±1 db from 200c to 150 kc; distortion less than 5% from 200c to 200 kc; hum down 50 db.

Square Waves
0 to 30v peak to peak; rise time about ⅓ μsec; overshoot approximately 1%, hum down 60 db.

***Can be converted to a sweep oscillator** with addition of G-R Synchronous Dial Drive. Type 908-P1 Drive sweeps oscillator at a rate of one frequency decade in 70 sec. Price, $32.

Write For Complete Information

Type 1217-A Unit Pulser, $250

requires Unit Power Supply, $50

- **Repetition Rate:** 30 cps, 60 cps; 100 cps to 100 kc in X1, X2, and X5 steps; with external drive (1210-C Oscillator or equivalent), continuous from 15 cps to 100 kc. (minimum external drive is 10v to 10 kc, 25v to 100 kc)
- **Pulse Duration:** 0.2 μsec to 60,000 μsec.
- **Pulse Shape:** Rise time 0.05 μsec; decay time 0.15 μsec. Pulse top is flat to within 5% of maximum value.
- **Amplitude:** Adjustable from 0 to 20v open circuit for both positive and negative pulses, 50v negative pulse obtainable when positive terminal is grounded.
- **Jitter:** No observable jitter when one full period is displayed on scope.
- **Output Impedance:** 200 ohms for positive pulses; 1500 ohms for negative pulses.

Unit Pulser and Power Supply can be easily rack mounted with the Type 480-P4U3 Adaptor Panel ($12.00)
Same Adaptor-Panel Size accepts Unit R-C Oscillator, and Power Supply

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June 16, 1961

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

New approach to loudspeaker design improves frequency and transient response. See p 49 COVER

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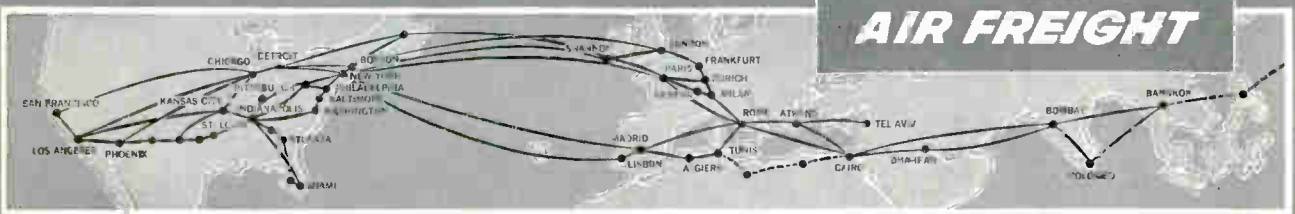

DESIGN WITH ARNOLD 6T CORES . . .

SAME-DAY SHIPMENT OF STANDARD DELTAMAX CORE SIZES

Arnold 6T tape cores (aluminum-cased and hermetically-sealed) offer you three very important design advantages. *One:* Maximum compactness, comparable to or exceeding that previously offered only by plastic-cased cores. *Two:* Maximum built-in protection against environmental hazards. *Three:* Require no supplementary insulation prior to winding and can be vacuum impregnated after winding.

Now we've added a fourth vital advantage: Maximum availability. An initial stock of approximately 20,000 Deltamax 1, 2 and 4-mil tape cores in the proposed EIA standard sizes (See AIEE Publication No. 430) is ready on warehouse shelves for your convenience. From this revolving stock, you can get immediate shipment (*the same day order is received*) on cores in quantities from prototype lots to regular production requirements.

Use Arnold 6T cores in your designs for improved performance and reduced cost. They're guaranteed against 1000-volt breakdown . . . guaranteed to meet military test specifications for resistance to vibration and shock . . . guaranteed also to meet military specifications for operating temperatures. The 6T hermetic casing method is extra rigid to protect against strains.

Let us supply *your* requirements. Full data (Bulletin TC-101A and Supplements) on request. • Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Ill.*

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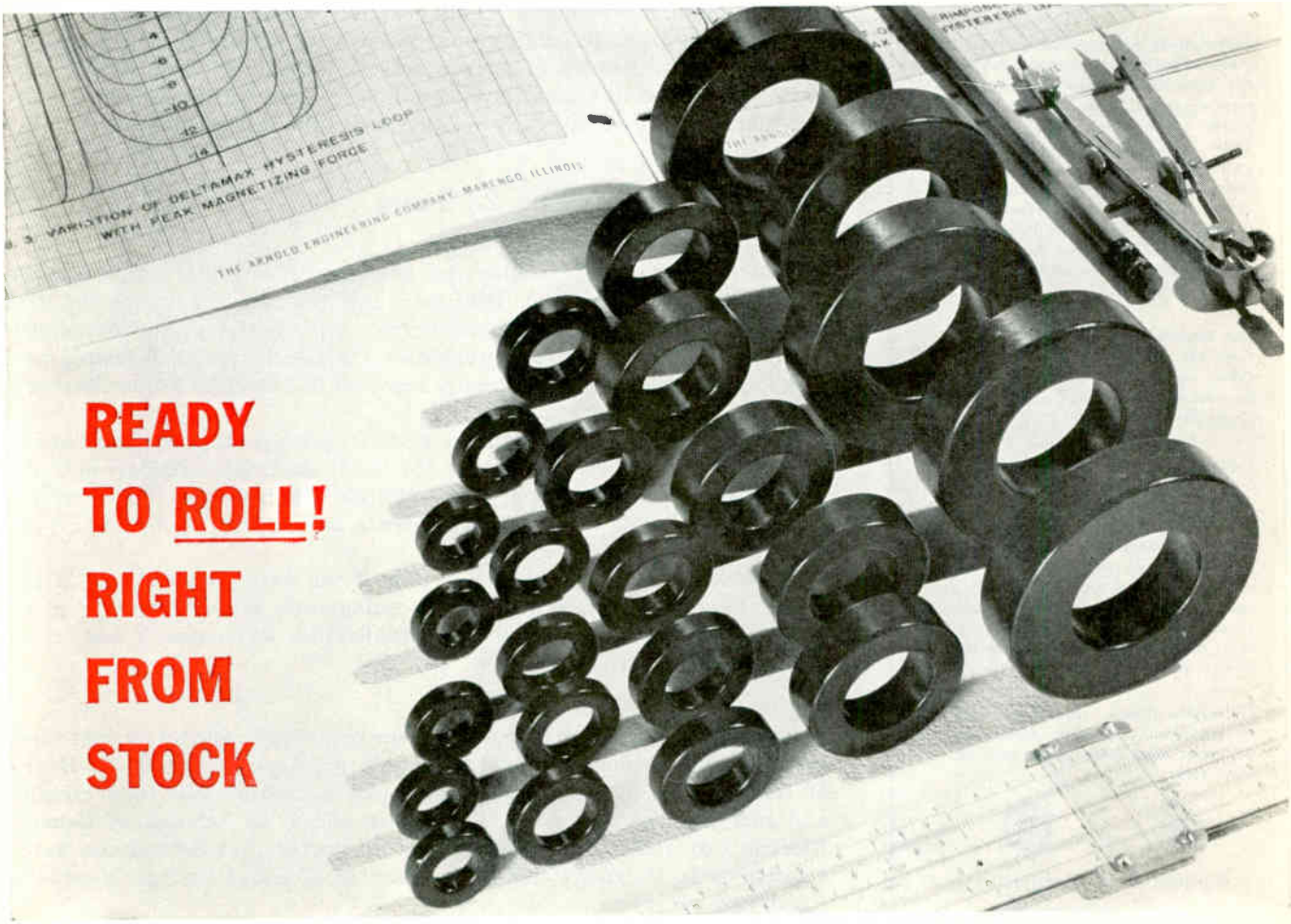

electronics
June 16, 1961 Volume 34 Number 24

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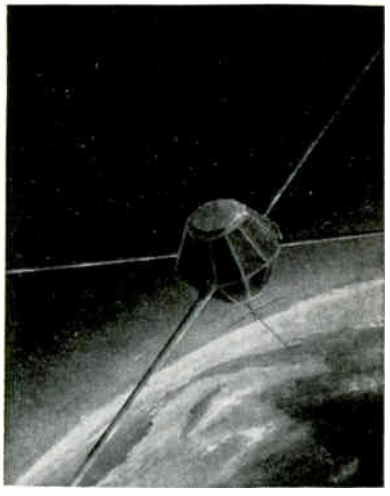


MEASURING the ionosphere's electron density from above is no simple task, but a satellite ionosounder (drawing) will be specially equipped to do it. This conception of how the tiny satellite will look, antennas protruding as it whirls through space, was drawn by GE artist Robert Dockendorff. Present plans call for flight testing of a three-frequency sounder in August. A rocket will carry the sounder 600 miles into space. Data on system operation and character of the received echo will be recorded. And this information will help in construction of the satellite model. Next week read our article entitled "Satellite Sounder and Telemeter Chart Ionosphere Electron Density," by S. Horowitz and L. Humphrey of GE's Defense Electronics division.

WANT STANDARDS. Plea for standardization of transistor parts, especially header assemblies, was made the other day by executives of Sylvania's parts division in Warren, Pa. At present, these are made in a wide variety of configurations and materials, according to the desires of each individual transistor designer. Transistor parts are generally made on a custom basis, on low-speed machines requiring operators and, in many cases, hand-loading. This penalizes the entire electronics industry, Sylvania feels, by adding unnecessarily to transistor prices and by causing underutilization of parts plants facilities. The comparable tube parts, pin leads, are mass produced in a relatively few standard sizes and materials which are used by almost all tube manufacturers.

Coming In Our June 23 Issue

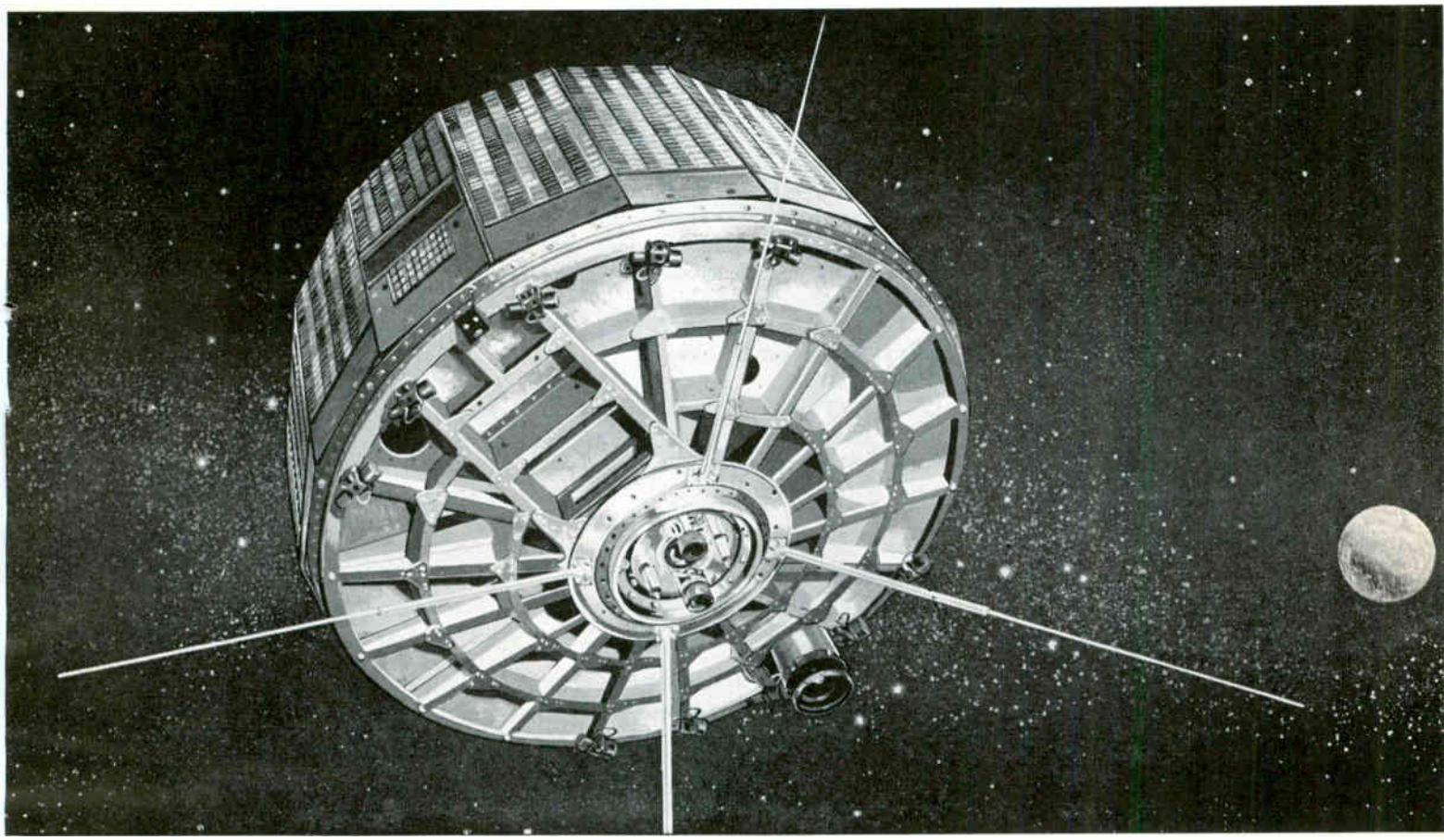
MEDICAL ELECTRONICS. Under the heading "Electronics in Surgery—The Radio Knife", our Oct. 1930 issue told the story of one of the first applications of electronics to medicine. In describing high-frequency cutting needles, the article by engineer Charles Underhill foreshadowed many of the developments currently reported in Associate Editor Bushor's series on medical electronics.

Next week, the series continues with a roundup on prosthetic devices for the senses. You'll learn about the latest electronic artificial aids for persons wholly or partially deprived of sight and hearing. These include hearing aids, artificial ears, and guidance devices and reading machines for the blind.

Incidentally, in case you missed any of the first three articles in the series, here's the list: p 49, Jan. 20 (diagnostic measurements); p 46, Feb. 3 (monitoring, analysis and visualization techniques); and p 54, Feb. 24 (therapeutic devices).

IN ADDITION. Feature material to appear next week includes: a controlled rectifier that produces quarter-megawatt pulse power by H. G. Heard of Radiation at Stanford; a random pulse generator that tests circuits and encrypts messages by B. K. Eriksen and J. D. Schmidt of General Electric Co; and a portable propeller flowmeter that determines water velocity by L. Molyneux and J. M. Edington of Kings College, Newcastle Upon Tyne, England.

"WEATHER EYE" IN SPACE



RCA-NASA Development of TIROS Advances Progress in Worldwide Weather Forecasting

From its vantage point in space, TIROS is sending down to earth new, more definite pictures and data of the world's everchanging weather patterns to aid man in his ageless efforts to control the elements.

Incorporating revolutionary and advanced electronic equipment, TIROS was designed, developed and built by RCA's Astro-Electronics Division for National Aeronautics and Space Administration. Within its small circumference are miniature TV cameras, tape recorders, TV transmitters, command receivers, timing mechanisms, beacons and telemetry equipment. In addition, it carries new scanning and non-scanning Infra-red Sensing Devices, developed by NASA, to measure and record the heat radiation of the earth and its cloud cover, and a revolutionary new Magnetic Orientation Device to capitalize on the effects of the earth's magnetic field and maintain favorable orientation of the satellite for long periods.

RCA developments in miniaturization, reliability, computing and overall electronic activities are contributing to many of the nation's leading space and missile projects. For information describing new RCA scientific developments, write Dept. 434, Defense Electronic Products, Radio Corporation of America, Camden, N. J.

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RADIO CORPORATION OF AMERICA

COMMENT

Computers Today

I found your special report on data processing ("Computers Today, p 63, Apr. 28) a very thorough and helpful updating of the industry. Even for rank laymen it served to bring together and interpret the very broad range of development going on in electronic data processing. I will find it, I am sure, a most useful reference work.

We all appreciate the fact that you found Telex's activities worthy of mention. . . .

ALLAN J. WASH JR.
KERKER-PETERSON INC.
MINNEAPOLIS

. . . (This report) seems like an extremely complete job, another of the kind that you are becoming justly famous for. . . .

GENE RICHNER
EASTMAN KODAK
ROCHESTER, N. Y.

. . . Frankly, I feel that perhaps it is the best roundup of our industry that I have seen. . . .

THOMAS D. ANGLIM
REMINGTON RAND UNIVAC
BLUE BELL, PENNA.

. . . I read the report while on a plane enroute to the Western Joint Computer Conference and enjoyed it very much.

You have done an excellent and comprehensive report on a very difficult subject. I am sure all your readers found the special report interesting . . .

M. L. MELVILLE
NATIONAL CASH REGISTER
DAYTON, O.

Measuring R-F

In the May 12 issue of your excellent magazine on p 90 there appeared an interesting and well-written article entitled "Accurate Measuring Technique for R-F Voltage."

I should like to call your attention to the fact that Altron Electronics is currently manufacturing a series of eight voltage range uhf coaxial thermoconverters similar to those described, except for the frequency range which has been extended to 900 Mc by the use of special construction techniques and a specially designed thin-film high-frequency resistor as the series impedance.

One advantage of our uhf coaxial thermoconverters for a-c/d-c transfer measurements is the almost complete electrical isolation of the input and output circuits.

Measurements performed here show that for each pair of converters, the relative a-c/d-c differences were independent of the applied voltage to 0.02 percent, and were less than 0.2 percent up to 60 Mc. Our 0.1-0.25-volt model measured at less than 0.05 percent to 30 Mc without evidence of systematic error. The response of our 0.5-to-1.4-volt unit, using a precision d-c differential voltmeter connected to the output, was determined to better than 0.5 percent at frequencies up to 600 Mc by the use of the bolometer bridge developed by Selby and Behrent of National Bureau of Standards.

It might also be added that for several years we have been working on the uhf coaxial thermocoverters, particularly rugged units for field use and for remote monitoring of a-f and r-f voltages.

C. M. SEWARD JR.
ALTRON ELECTRONICS
CHESTER, PENNA.

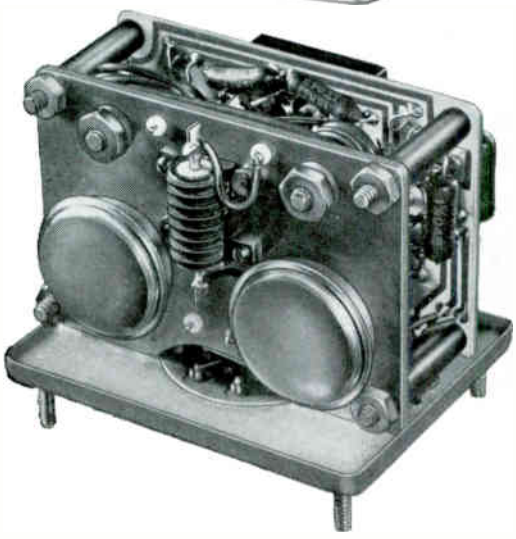
Distance Measurement With Light

A new "electro-optical distance-measuring system" is described in "Distances Are Measured with Modulated Light," p 84, May 5; it is claimed to be a recent Czechoslovakian development. This claim appears to the writer as somewhat farfetched, since such a system, and some additional types, were developed in the early '50s by professor Arne Bjerhammar and his research team at the Royal Institute of Technology in Stockholm. The writer was privileged to be a member of that team up to 1955 . . .

G. ZELINGER
CANADIAN MARCONI
MONTREAL, QUE.

We're grateful to reader Zelinger for setting the record straight. We have discovered many instances where developments reported from behind the Iron Curtain as new were duplications of existing work (frequently of work done previously in Scandinavia, in fact) or merely propaganda.

INLAND



first with solid state 100-watt d-c amplifier

Inland's new **Model 579.35** d-c amplifier has a high power output of 100 watts when used with low impedance loads requiring direct current. And this completely transistorized amplifier is packaged in a hermetically sealed can only **2½" x 3 3/16" x 2½"**.

Designed for use with d-c torquers, in one typical application Model 579.35 provides 65 db power gain between the output of a d-c driver stage and the input terminals of a permanent magnet torque motor. This amplifier has these outstanding performance characteristics:

- The d-c output has magnitude and polarity proportional to the input signal.
- All amplifier circuits use a combination of silicon and germanium transistors (all-silicon models also available).
- Amplifier null and gain are stable and independent of temperature.

Inland also makes a complete line of rotary amplifiers for matched use with Inland's distinctive pancake shape d-c torquers.

A brochure on this new high-power amplifier is available. For your copy and complete data on Inland torquers and amplifiers, write Dept. 12-6.

TYPICAL SPECIFICATIONS

Maximum Power Output, watts (6 ohm load)	100
Power Gain	4,000,000
Current Gain	200,000
Voltage Gain	15
Frequency Response	DC to 1000 cps
Input Impedance, ohms	50,000
Dimensions, inches	2½ wide 3 3/16 long 2½ high
Operating Temperature Range in °C	minus 50° to plus 50°

INLAND MOTOR

INLAND MOTOR CORPORATION OF VIRGINIA • A SUBSIDIARY OF KOLLMORGEN CORP., NORTHAMPTON, MASS.

NEW HIGH-POWER TRAVELING

1 w OUTPUT FOR

hp 491C High-Power
Traveling-Wave Tube Amplifier

The new hp 489A (1 to 2 GC) and 491C (2 to 4 GC) are broad band, low noise Traveling-Wave Tube Amplifiers providing at least 1 watt output for 1 milliwatt input over their full frequency range.

These compact, rugged, dependable instruments are supplied in the new hp universal module cabinet combining, in one single instrument, a lightweight, portable bench amplifier and a neat, clean rack mounted unit.

Both Models 489A and 491C incorporate new, permanent-magnet TWTs, offering low power consumption and solving the heat problem of previous TWT amplifiers. Specially designed circuitry provides amplitude modulation from dc to 100 KC, with internal amplification so that small modulation signals cause a large output power change.

Besides allowing amplification with small input signals, the modulation circuitry can provide leveled power output by using external elements completing a feedback loop.

SPECIFICATIONS

Model:	489A	491C
Frequency Range:	1 - 2 GC	2 - 4 GC
Price:	$1,970.00	$1,970.00

Common Specifications

Output for 1 mw Input:	At least 1 watt
Maximum rf Input:	100 mw
Small Signal Gain:	Greater than 30 db
Amplitude Modulation Passband:	DC to 100 KC
Modulation Sensitivity:	Approx. 20 db rf chonge for a 20 v peak mod. sig.
Input Impedance:	50 ohms, SWR less than 2.5
Output Impedance:	50 ohms, SWR less than 2.5
Connectors:	Type N, female
Front Panel Controls:	Gain
Meter Monitors:	Anode, helix, collector and cathode current
Dimensions:	16¾" x 5½" x 18⅜" deep (cabinet convertible to rock mount) 19" x 5¼" x 16⅛" deep behind panel (rack mount)

-WAVE TUBE AMPLIFIERS

1 mw INPUT!

OR MEET YOUR REQUIREMENTS WITH ONE OF THESE BENCH-PROVEN hp TWT AMPLIFIERS

hp Models 490B, 491A, 492A and 494A TWT Amplifiers use a simple broad-band coupling method employing input and output coupling helices. Full energy transfer is effected, even though there is no mechanical connection to the inner helix. A similar helix is used for a coupled attenuator which surrounds the central portion of the tube, preventing amplified energy from causing regeneration. Encapsulated replacement tubes including integral coupling helices are available and are delivered factory-tested and ready to install.

hp490B TWT Amplifier, 2 to 4 GC, provides at least 10 mw output, 30 db gain with noise figure of less than 25 db, excellent pulse modulation characteristics and helix modulation.

hp491A TWT Amplifier, 2 to 4 GC, has a full range output of 1 watt, with minimum gain of 30 db. Combined with a 1 mw S-Band signal generator such as hp616A it provides a versatile full watt source for high power testing.

hp492A, 4 to 8 GC, and hp494A, 7 to 12.4 GC, are 30 db gain TWT amplifiers providing 20 mw output. Offering amplitude, pulse, phase or FM modulation, they are ideal for use as broadband amplifiers or isolating buffer stages.

	hp 490B	hp491A	hp492A	hp494A
Frequency Range:	2 to 4 GC	2 to 4 GC	4 to 8 GC	7 to 12.4 GC
Gain:	30 db min.	30 db min.	30 db min.	30 db min.
Output Power:	10 mw min. into 50 ohm load	1 watt min. into 50 ohm load	20 mw min. into 50 ohm load	20 mw min. into 50 ohm load
Noise Figure:	Less than 25 db	Less than 30 db	Less than 30 db	Less than 30 db
Pulse Rise & Decay Time:	Approx. 0.015 μsec.	Mod. not provided	Approx. 0.015 μsec	Approx. 0.015 μsec.
Input Impedance:	50 ohms, SWR less than 2	50 ohms, SWR less than 2	50 ohms, SWR less than 2	50 ohms, SWR less than 2
Output Internal Impedance:	50 ohms, SWR less than 3	50 ohms, SWR less than 3	50 ohms, SWR less than 3	50 ohms, SWR less than 3
Price (including tube):	$1,400.00	$1,400.00	$1,500.00	$1,800.00

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

Call your hp representative today for full information on these versatile TWT Amplifiers.

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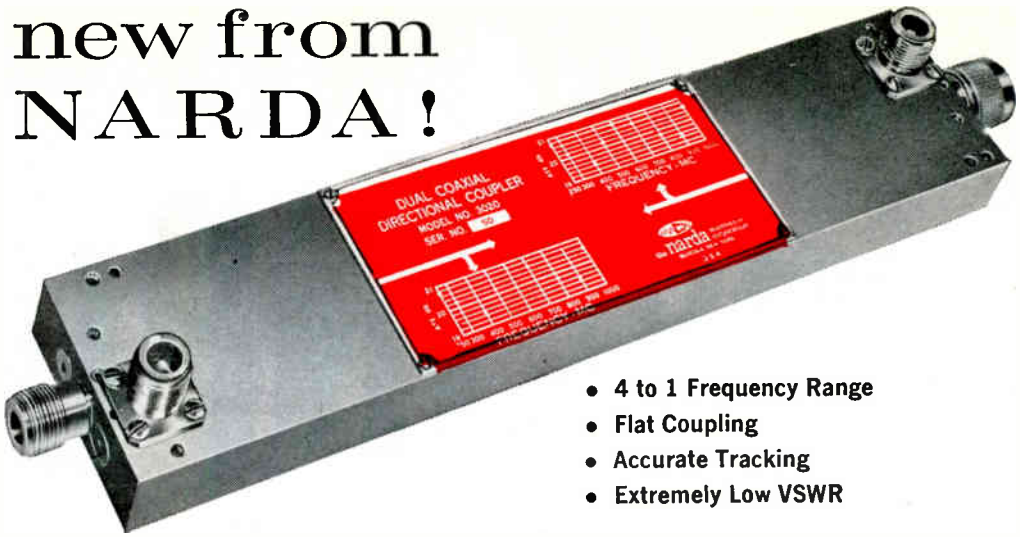
new from NARDA!



- 4 to 1 Frequency Range
- Flat Coupling
- Accurate Tracking
- Extremely Low VSWR

high-directivity coax couplers

Specifically designed for REFLECTOMETER applications!

- Here are two brand new coax couplers, specifically designed by Narda to provide the extremely high directivity needed in Reflectometer set-ups. And when we say "extremely high directivity", we mean it! For example: Model 3020 (250 to 1000 mc) has a directivity of 35 db minimum, which means a maximum error in VSWR of only 1.035 can occur as a result of the finite directivity. Main line VSWR is held to 1.05 maximum; secondary line VSWR is 1.10 maximum!

- What's more, each model covers two full octaves; each features extremely accurate tracking (0.3 db maximum change in difference between forward and reverse coupling over the band); each has a power rating of 100 watts CW, 10 kw peak. Check the table for full specifications—and compare with any other units available.

- These are just two examples of the complete line of unusually fine microwave and UHF instrumentation available from Narda. Write today for your free copy of our newest catalog. Address: Dept. E-61-4.

SPECIFICATIONS	MODEL 3020	MODEL 3022
Frequency	250 to 1000 mc	1000 to 4000 mc
Directivity	35db min	30db min
Coupling—both arms	20db nominal	20db nominal
—Frequency sensitivity	±0.6db approx.	±0.6db approx.
Max VSWR—main line	1.05	1.10
Max VSWR—secondary lines	1.10	1.15
Power Rating	100W cw 10kw peak	100W cw 10kw peak
Tracking	0.3db total	0.3db total
Price	$200.	$185.

the narda microwave corporation

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ELECTRONICS NEWSLETTER

Voice System Handles 700 Users on 4-Mc Band

A VOICE COMMUNICATIONS system which can accommodate 700 users on a 4-megacycle band, thus effecting an 85-percent reduction in spectrum requirements, primarily from full utilization of the frequencies at all times, is reported by the Martin Co.'s Orlando Division.

Called RACEP (random access and correlation for extended performance) the system uses a pulse-modulation technique.

Working on a line-of-sight principle, a one-watt power source will give a 15-mile range. First use of this system may come from the military for combat use.

There are factors with the new system that still have not been resolved. For example, the antijamming capabilities of the system, its compatibility with existing communications systems and FCC frequency assignments, when and if the system is integrated into commercial usage.

Probe Luminescence Degrading in Materials

PHENOMENON of photoluminescence degradation in organic materials due to damage by ionizing radiations is described this week in an Air Force research report. It is demonstrated that pressed wafers of anthracence and of p-quaterphenyl can be employed together to cover the required dose range.

Ultraviolet light (3,650 A) is used to excite the photoluminescence, which is observed in a narrow band at 4,420 A. Some recovery of photoluminescence with time after x-ray irradiation is observed, and heat treatment is proposed as a method of reducing this effect.

Also studied were degradation of luminescence in biphenyl, p-terphenyl, fluorene, and naphthalene.

Sounder Radar Using Different Technique

NEW TECHNIQUE for measuring characteristics of the ionosphere over hf and lower vhf frequencies is being used by propagation research scientists at AF Cambridge Research Labs.

High-frequency radars (4 to 64 Mc) are used for oblique incidence sounding of ionosphere. Electronically switched, step frequency radars have been developed by Granger Associates for the experiments. The 160 individual frequencies are each transmitted with peak power output of 30 Kw.

First of these sounder radars was installed at Plum Island, Mass. Another will be located at Mayaguez, Puerto Rico. Receiver only has been installed at Stanford in Palo Alto, and second receiver will be set up in Buenos Aires. Network will provide means for investigating hf and vhf propagation phenomena over low altitude and trans-equatorial goemagnetic paths.

Freon Leak Unit Finds 5-PPM Concentration

A 21-LB PORTABLE Freon leak detector suitable for air and spacecraft applications—showing an experimental response 10 times more acute than acceptable military standards—has been developed by the Naval Research Laboratory.

The device operates as follows: air from the vicinity of a leak probe is pumped through a four-element thermal-conductivity bridge block connected to a nullpoint indicator. When the probe passes over a leak and Freon is mixed with in-drawn air, contact with the first pair of filaments unbalances the bridge causing the nullpoint indicator to kick to one side.

The air-Freon mixture then moves past and unbalances two filaments on the opposite side of the bridge, causing another indicator kickback. Unbalances cause flashing of red and white lights.

Bridge excitation is by a regulated a-c power supply and the a-c output signal goes to a five-stage R-C coupled transistorized amplifier when the bridge is unbalanced.

The apparatus gives clear response to a Freon concentration of four to five ppm, whereas detection of Freon concentrations of 50 ppm is satisfactory in most cases.

Check Sputtering Yields To 10^{-5} Atoms/Ion

A SPECTROSCOPIC METHOD that permits instantaneous measurement of sputtering yields down to 10^{-5} atoms/ion has been developed for the Air Force.

Measurements were made under nitrogen, hydrogen and neon ion bombardment at energies up to 1 Kev and of sputtering at very low ion energies (50 to 600 ev).

It was established that physical sputtering yields at 10 ev bombarding energy become so small that erosion effects in a satellite surface are negligible.

Urges U. S. to Plan R&D On 10-Year Basis

"THE U. S. should stop talking in one-year budget cycles and fighting for dollars. Instead, the country should gear its R&D programs to a 10-year basis after giving careful consideration to final objectives. Congress must recognize more clearly that R&D is not a pushbutton operation."

So spoke former Assistant Secretary of the Army Richard S. Morse last week at the Armed Forces Communications Electronics Association meeting in Washington. We are lagging, not leading—losing ground every day, he warned.

Air Force Survey Urges Improved Delay Systems

MICROWAVE acoustic propagation is one of the more promising new delay techniques, despite its requirement of cryogenic, or very

(*Continued on page* 12)

cold, operating temperatures, says an Air Force state-of-the-art survey of electronic delay techniques.

While quartz ultrasonic delay devices represent today's best techniques for wideband signal processing, improvements are needed in such parameters as delay time, bandwidth, spurious response and insertion loss, the report notes.

The report also cites techniques based on microwave propagation in a plasma or the use of electron, ion or molecular beams on microwave as having "unique" merit, but underscores the need of considerable experimentation in these techniques.

British Trade Fair Makes Hit in Moscow

SOME 725 exhibitors left Moscow last week after participating in the 17-day British Trade Fair. It was the most successful commercial fair ever held in the Soviet Union. However, there was no sign the exhibition will result in any long-term business increases.

More than 1¼ million Soviets passed through the Fair, many of them key figures in Soviet purchasing and planning organizations. Virtually all exhibitors sold goods they brought to Moscow, but observers say all major deals consummated at the Fair actually were negotiated earlier.

According to some estimates, almost 20 percent of the equipment exhibited was produced in the United Kingdom either under license from U. S. or by English affiliates of U. S. firms.

Flat-on-Back Paraboloid For Ionosphere Tests

PARABOLOID laid flat on its back will be used atop Millstone Hill, Westford, Mass., to continue MIT Lincoln Laboratory's ionosphere free electron backscatter experiments at uhf.

Structural profile will be similar to Arecibo Radio Observatory under construction in Puerto Rico (ELECTRONICS, p 20, Jan. 27), but antenna will be much smaller and will be parabola instead of a sphere. New dish will allow continued use of uhf radar equipment in operation since 1957 with 84-ft dish.

Frequency of original Millstone Hill facility is going to be raised, and new dish put up. Plan adds still another radar-communications tool to Millstone-West Ford-Haystack complex in Westford-Tyngsboro, Mass.

Studying Phased Radar For Nike-Zeus Program

ARMY introduced phased radar into Nike-Zeus antimissile program with award of a nearly $5-million contract to Western Electric for advanced radar design.

Meanwhile, General Telephone & Electronics received a multimillion dollar award from Bell Labs for development of advanced radar design for possible future incorporation into Nike-Zeus system. No money figure was given.

General Instrument Corp. got a $4-million Air Force contract to build transportable microwave radio communication sets.

See 10-1 Size Cut From Molecular Computer

TWENTY-SIX MOLECULAR BLOCKS do the work of 118 conventional parts and a 10 to 1 size and weight reduction is realized in its molecular computer now under development, reports Westinghouse's Air Arm division in Baltimore.

The new device, nicknamed "mole-com" for "molecular computer," will weigh less than 15 lb and occupy less than one-third of a cubic ft instead of the 175 lb and three cubic ft required by a similar conventional transistor computer, firm says. The molecular unit will be used in space devices.

Report Covers Solid Bragg-Gray Chamber

CONSTRUCTION of the solid analog of Bragg-Gray cavity ionization chamber has been attempted at USAF's Wright Air Development Division.

Thin layers of materials sensitive to radiation were placed between walls of C, Al, Cu, Sn or Pb. Two types of sensing agents were employed: thin layers of anthracene whose ultraviolet induced luminescence degrades upon irradiation, and 6 micron thick polyethylene terephthalate (Mylar) films whose optical density at 3,250 A increases upon irradiation.

Results with the anthracene disagreed sharply with theory, while the Mylar film yielded excellent agreement with theory, Air Force says. A preliminary attempt to discriminate between the fast neutron and gamma ray dose in a nuclear reactor was unsuccessful.

Just In . . .

IN TOKYO, Sony says commercial annual production of transistor tv receivers starts this month. Target: 40,000 units this year for both domestic and overseas markets.

TERRY INDUSTRIES, 100-year-old steel and heavy construction firm, forms subsidiary, Terry Microwave Electronics and Construction, Inc., and enters field of 3-D radar for prevention of air collisions.

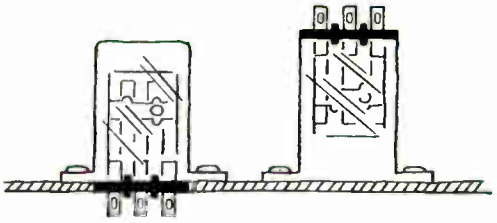
NATIONAL UNION ELECTRIC CORP. creates Advanced Science Division for its activities in missiles, electronics, aircraft and ordnance products; headquarters will be in Bloomington, Ill.

ELECTRONICS ASSOCIATES, INC., enters precision capacitor field by opening production facilities for polystyrene capacitors at its West Long Branch, N. J., plant.

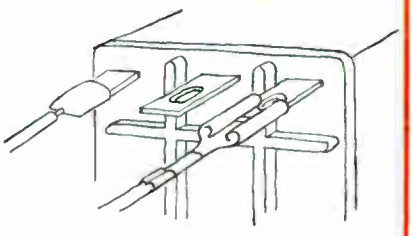
GE gives a $1-million initial contract to Kollsman Instrument Corp. to develop and build part of the attitude stabilization and control system for the United States' first Orbiting Astronomical Observatory (OAO) spacecraft.

SERVICE RECORDS of 200,000 airmen —and up to 50 facts on each— are stored on five reels of magnetic tape in National Cash Register data processing system installed at SAC headquarters, Offutt AFB, Neb.

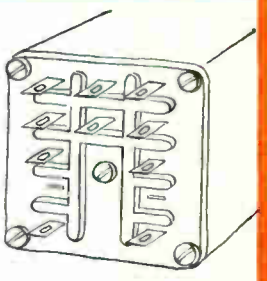
FRESH IDEAS IN RELAYS...



CHOICE of below-chassis or above-chassis connecting in plastic enclosures.



MULTI-USE terminals allow soldering, insertion in printed circuit board, and use of AMP Style 110 push-on terminals.



ALL TERMINALS on *one* panel . . . permits insertion in printed circuit board.

SPECIFICATIONS

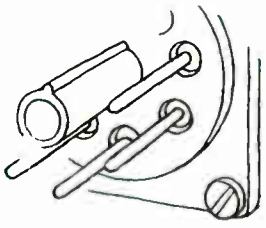
CONTACTS: *Integral with terminals;* up to 3PDT, 5 amp, 115 VAC or 32 VDC. Stationary contacts, fine silver inlay material; movable, solid fine silver.

COILS: Up to 230 VAC at 60 cps or 115 VDC.

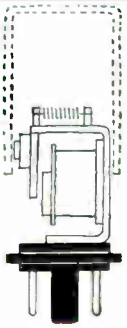
ENCLOSURES: Clear plastic.

TERMINAL PANELS: Barrier type or octal plug.

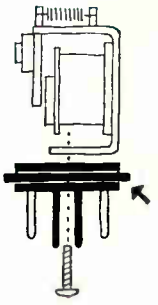
LATCHING RELAY: Available enclosed in clear plastic with plug-in mounting; or unenclosed.



OCTAL PLUG relays up to DPDT have recessed pin bases . . . meet UL spacing requirements to 150 V.



ALL ENCLOSED relays mount solidly on base . . . *not* on covers.



INTEGRAL plug-in base up to DPDT avoids wiring between contact terminals and pins.

OHMITE'S New "GR" Series

Stocked for Immediate Delivery From Distributors or Factory . . .

WRITE FOR BULLETIN 166

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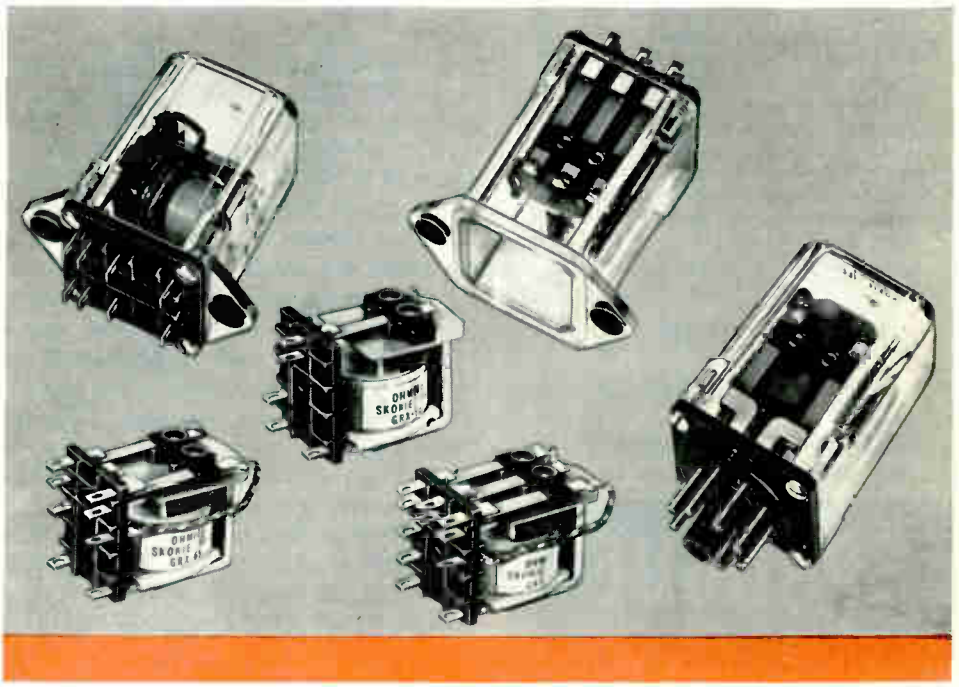


WASHINGTON OUTLOOK

FCC STILL FAVORS a joint venture of international communications common carrier firms to own and operate a commercial communications satellite system, but is willing to consider objections from electronics manufacturers and others. Communications Satellites, Inc., a company created by General Electric, has already filed a petition against FCC's proposed policy.

The agency presented its views last week at a closed meeting with industry. FCC Chairman Newton N. Minow listed three "minimum objectives" for a joint venture, however, which might cool the interest of the large common carriers:

First, that there be clearcut provisions for equitable access to the system under "fair and reasonable" terms.

Second, that there be no favoritism in hardware buying and that communications satellite equipment be purchased competitively.

Third, that a "truly global" system be established with "multiple access"—heavy and light traffic from many points—and that all interested foreign countries be allowed to participate. The federal government would pay some of the costs for the global capability by buying ownership in the system or through a direct subsidy.

FCC appeared to brush aside the possibility of a completely government-owned space communications system.

RALPH J. CORDINER, GE'S chairman and president, told the Senate Antitrust and Monopoly Subcommittee that the company is checking whether employees in its electronic tube division have violated the antitrust laws. This had been implied earlier during the subcommittee's inquiry into antitrust violations in the electric manufacturing industry. As of now, however, Cordiner said he is "satisfied" there has been no price-rigging in electronic tubes.

THE AIR FORCE has been given a green light to negotiate research contracts with Space Technology Laboratories, General Dynamics Corp., and the Hughes Aircraft Co. to study the feasibility of "Project Bambi" (Ballistic Missiles Boost Intercept). This is an antimissile system in which a stream of satellites would detect, track, and destroy oncoming ICBM's. Most Pentagon experts view such a system as vastly superior to the Army's Nike-Zeus. The Army, obviously, counters that Bambi is still in the study stage while Nike-Zeus hardware could be produced now.

THE ADMINISTRATION is seriously considering making a reality of an "automatic highway" in which driving control would be taken away from the motorist and cars would be propelled at fixed speeds and intervals through electronic apparatus. A special transportation study group has reported to the White House, Budget Bureau, and Commerce Dept. that an electronic highway is technologically feasible.

Among companies which have performed research in this field: Thompson Ramo Wooldridge, RCA, Bendix, General Motors, and Westinghouse. By the end of this month, the Administration will have in hand—and probably will approve—a specific recommendation that the government buy an automatic traffic control system to be developed on a competitive-bid basis by private industry and install it on a 100-mile stretch of a yet-to-be-built interstate highway. The experiment would be conducted on two lanes of a six-lane highway in about two years. Officials stress that competition would not be limited to the companies which have been most active in research up to now.

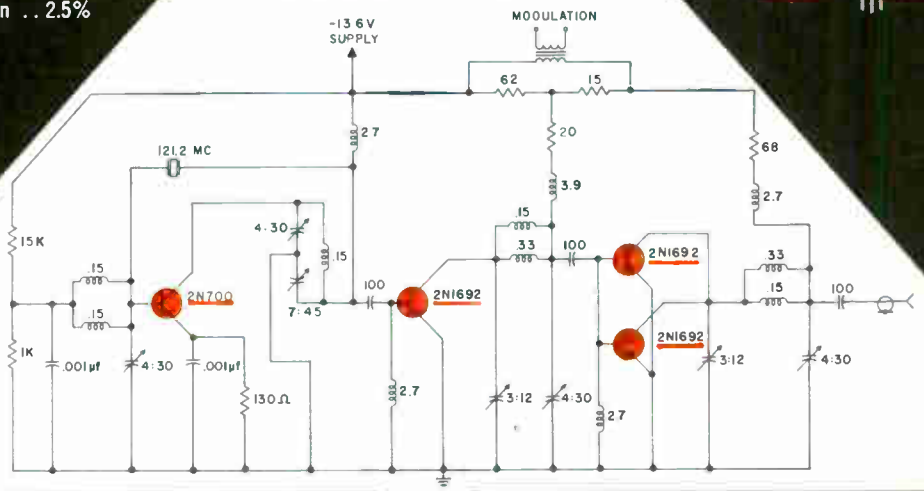
There is a strong feeling within the Administration that the latest technological advances should be incorporated in Washington's $37-billion interstate highway system investment. There is considerable confidence here that controlled traffic flow would sharply increase the road system's capacity and cut the rate of accidents.

A TRANSISTORIZED 120 MC AIRCRAFT AM TRANSMITTER

PERFORMANCE—

Supply Voltage .....13.6 V
Supply Current .....155 mA
Peak Power Output .....1.5 W
Average Power .....500 mW
Efficiency (overall) 26.5%
Envelope Distortion ..2.5%

MOTOROLA MESA CIRCUITRY CUTS SIZE...SAVES WEIGHT ...INCREASES RELIABILITY



The transmitter circuit shown above provides more effective coverage than most conventional tube transmitters with higher RF power. Designed for airborne communications, it demonstrates only one of the many possible UHF-VHF applications for Motorola Germanium Mesa transistors.

The remarkable achievement of Motorola Mesas in critical missile/space equipment proves their ability to contribute substantially to total circuit reliability. Designed for applications to 1000 mc, Motorola Mesas are ideal for a wide range of communications applications. And, they are available in quantity, for immediate use.

For Complete Data on the Transistorized Transmitter shown above request Special Report No. 34 from your Motorola District Office or write Technical Information Department, Motorola Semiconductor Products Inc., 5005 East McDowell Road, Phoenix 8, Arizona. If you desire technical Data Sheets on the devices listed above, please request by "type number".

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MOTOROLA GERMANIUM MESA AMPLIFIER TRANSISTORS

TYPE NO.	V_{cb} volts	V_{ce} volts	P_D mW	PG_e @ f typical	P_o @ f typical	Case
2N700	25	20	75	24 db @ 70 mc	50 mW @ 70 mc	TO-17
2N700A	25	25	75	26 db @ 70 mc	55 mW @ 70 mc	TO-17
2N700A(Sig C.)	25	25	75	26 db @ 70 mc	55 mW @ 70 mc	TO-17
2N741	15	15	300	22 db @ 30 mc	200 mW @ 30 mc	TO-18
2N741A	20	20	300	22 db @ 30 mc	250 mW @ 30 mc	TO-18
2N1561	25	25	3W	8 db @ 160 mc	.5 W @ 160 mc	—
2N1562	25	25	3W	7 db @ 160 mc	.4 W @ 160 mc	—
2N1692	25	25	3W	8 db @ 160 mc	.5 W @ 160 mc	stud
2N1693	25	25	3W	7 db @ 160 mc	.4 W @ 160 mc	stud

Immediate Availability — All Motorola Mesa amplifier transistors are available from your Motorola Semiconductor Distributor.

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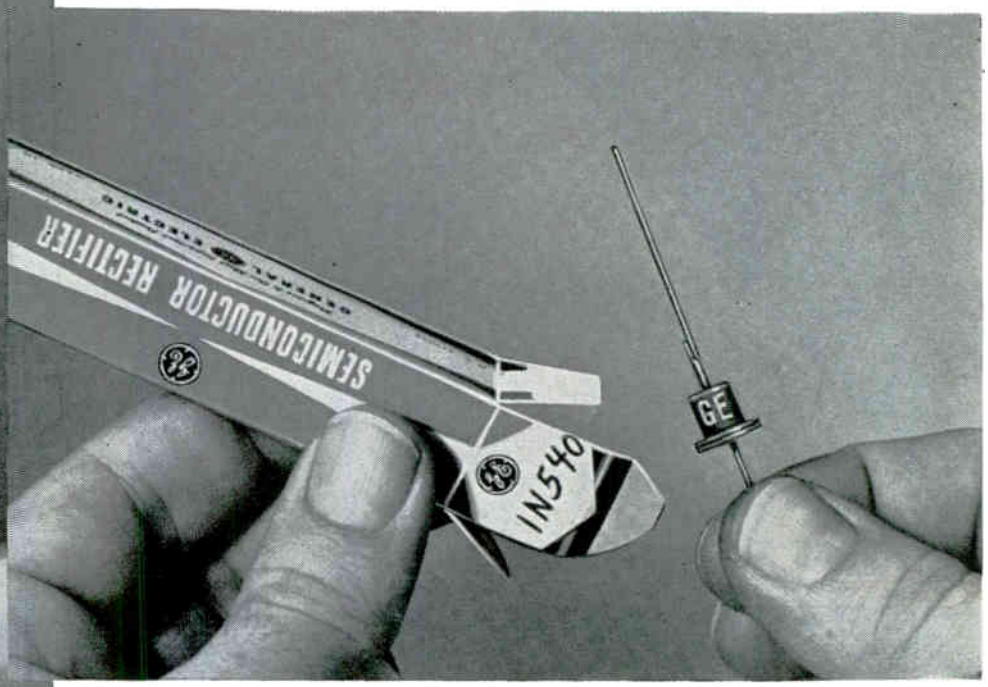
Minuteman can mean reliability in your rectifier circuits



The successful launching of the Minuteman missile dramatically demonstrates the importance of the super-reliability program that made it possible. General Electric low current 1N540, medium current 1N1204A, 1N2158 silicon rectifiers, and medium current 2N685 silicon controlled rectifier are a vital part of that program. They are used in some of the most critical circuits in the Minuteman.

But how does this mean Minuteman reliability for you? *Every* failure mode analyzed for Minuteman, *every* corrective action taken, *all* the high reliability work done for each of these rectifiers is applied to the entire line of that type of semiconductor.

For Minuteman type of reliability in your low current circuits, specify G-E 1N536-540, 1N547, 1N560-61, 1N1095-96 silicon rectifiers; for medium current circuits ask for 1N1199A-1206A, 1N1341-1348, 1N2154-2160 silicon rectifiers. For medium current silicon controlled rectifier applications, specify the G-E 2N681-689 series.

RECTIFIER COMPONENTS DEPARTMENT, SECTION 25F22, AUBURN, N.Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 17 ON READER SERVICE CARD→

How to select power transistors

by RICHARD F. MOREY, JR.

Manager, Applications Engineering, Clevite Transistor

Division of Clevite Corporation

A basic understanding of the interrelationship of transistor design parameters facilitates selection of the most advantageous unit for a given application.

Transistor characteristics depend upon each other. Consequently, a design change in the manufacture of a transistor directly affects a number of its electrical characteristics.

As a guide to users of power transistors, several of the important design elements and the electrical characteristics they influence have been summarized in chart form (fig. 1).

The curves (figs. 2-5), show typical characteristics for two power transistors of quite different design. Clevite's 2N1762, for example, is a 3 ampere unit having the following design parameters: Small junction area; high resistivity germanium; moderate germanium lifetime; average wafer thickness and no emitter doping.

In contrast, Clevite's 2N1146C is a 15 ampere power transistor which has several quite different parameters based upon a higher current and power requirement; large junction area several times the size of the 3 ampere unit; identical base width and resistivity but longer germanium lifetime and thicker wafer plus aluminum doping to increase emitter efficiency.

Working with the chart in figure 1 and the table, figure 6, we see that the comparative design elements of

Effect of Transistor Design on Characteristics

DESIGN PARAMETER	Addition of Emitter Doping	Increase in Wafer Thickness	Reduction in GE material lifetime	Increase in GE material resistivity	Reduction in Base Width	Increase in Junction Area
THERMAL RESISTANCE R_T	—	—	—	—	—	decrease
COLLECTOR LEAKAGE CURRENT I_{CBO}	—	decrease	increase	increase	—	increase
COLLECTOR BASE VOLTAGE V_{CB}	—	—	—	increase	—	decrease slightly
COLLECTOR EMITTER VOLTAGE V_{CE}	decrease	—	increase	increase	decrease	decrease slightly
D.C. CURRENT GAIN h_{FE}	increase	—	decrease	—	increase	—
LINEARITY OF h_{FE}	better	—	—	—	—	better
SATURATION VOLTAGE $V_{CE\ (SAT)}$	decrease	decrease	increase	increase	decrease	decrease
BETA CUTOFF FREQUENCY $f_{\alpha e}$	decrease	—	increase	—	increase	decrease
PUNCH THROUGH VOLTAGE V_{PT}	—	—	—	decrease	decrease	—
SECONDARY BREAKDOWN CURRENT I_m	increase	increase	—	decrease	—	increase

Figure 1.

the two transistors result in the 15 ampere unit exhibiting:

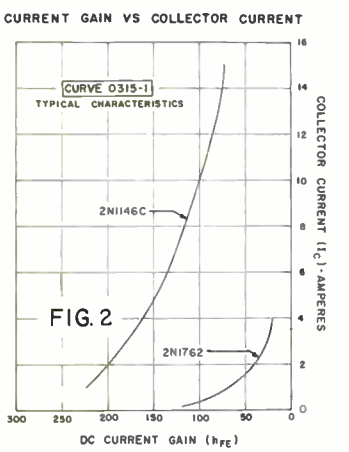
- — lower thermal resistance and higher leakage currents because of its large junction area.
- — slightly lower collector to base voltage.
- — higher gain because of the emitter doping and higher lifetime.
- — very linear current gain out to high currents because of its large area and special emitter doping.
- — lower collector to emitter breakdown voltages because of its higher gain and lower collector to base voltage.
- — much lower saturation voltage and base input voltage because of its high gain and thicker wafer and larger area.
- — low common emitter frequency response because of its high gain and large area.

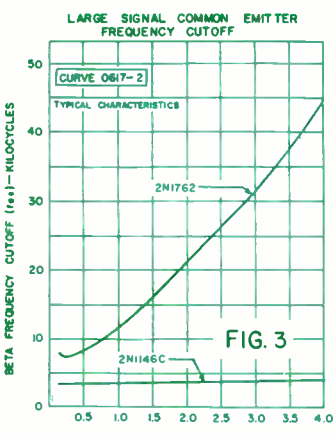
Comparison of Characteristics — Two different designs

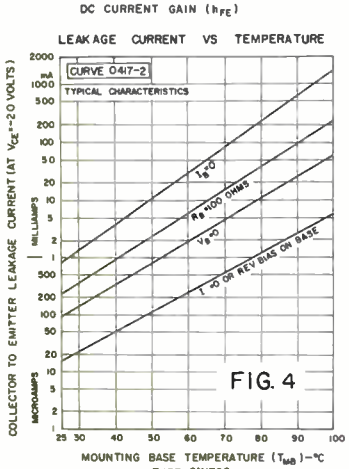
Characteristic	2N1762 Typical Value 3 Amp. Device	2N1146C Typical Value 15 Amp. Device	Units
Thermal Resistance	1.4	0.5	°C/watt
I_{CBO} at 100V at 85°C	3	15	mA
I_{CBO} at 100V at 25°C	1	4	mA
BV_{CBO}	130	120	Volts
$V_{CEO(sus)}$	70	50	Volts
Current Gain at I_C = 1 Amp.	60	220	
Current Gain at I_C = 5 Amps.	15	140	
Current Gain at I_C = 15 Amps.	—	75	
Saturation Voltage at 3 Amps.	0.3	0.2	Volts
Saturation Voltage at 15 Amps.	—	0.4	Volts
Saturation Resistance	100	26	Milliohms
Frequency Cutoff at 1 Amp.	18	4	kc.

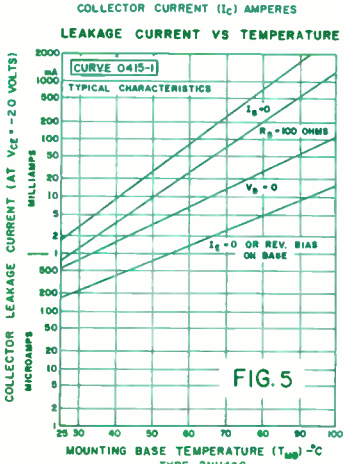
Figure 6

In order for circuit designers and users of power transistors to obtain the best combination of electrical characteristics, the requirements for the application must be well known and be matched to the transistors available on the market. Therefore, an elementary knowledge of the existing relationships between transistor characteristics is a useful design tool. A tabular summary of characteristics for Clevite's complete line of power transistors is available. Ask for Bulletin 61-A.

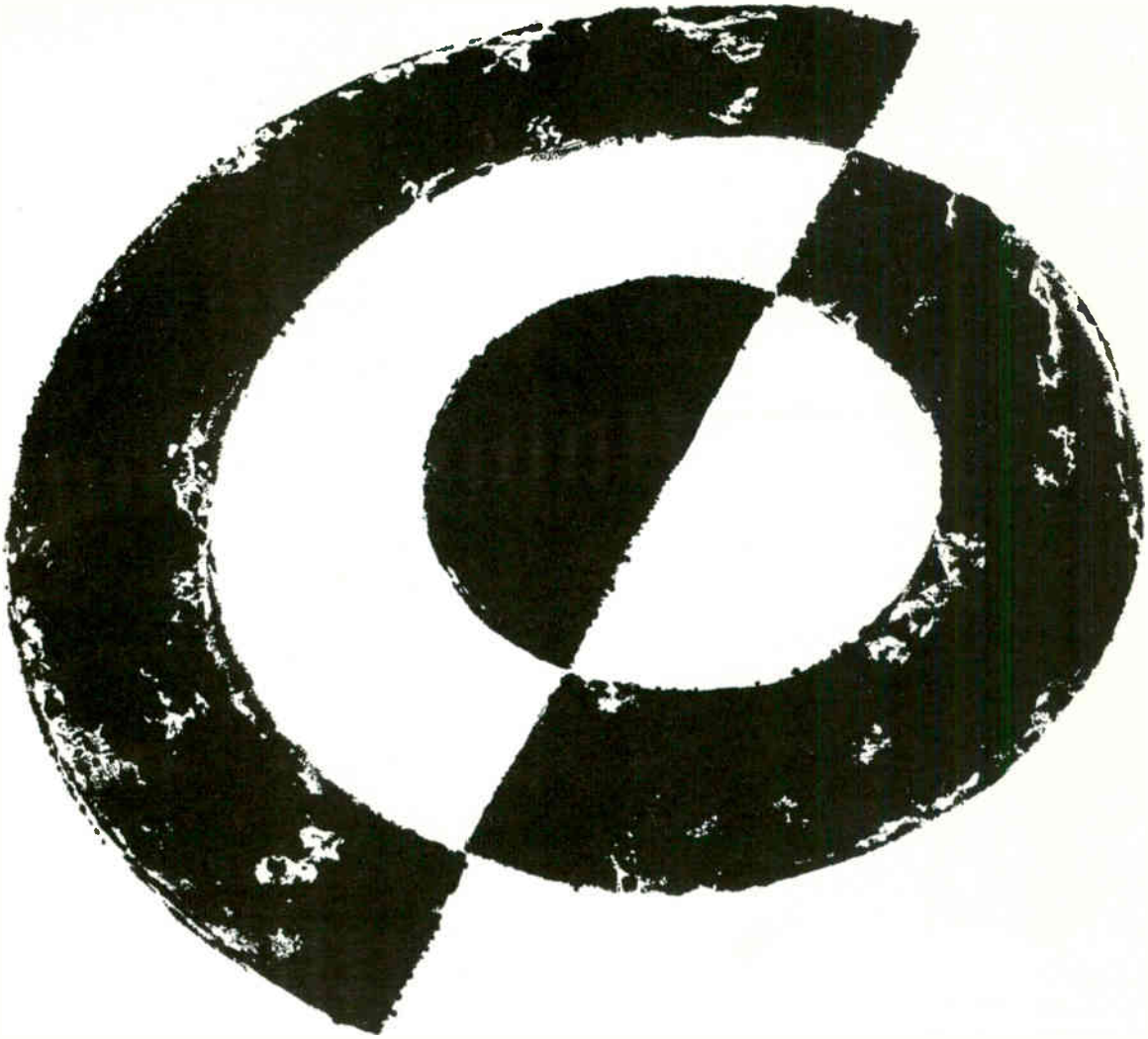








CLEVITE TRANSISTOR
Waltham, Massachusetts



Said J. Stefan and L. Boltzmann: *"The total radiation from a black body is proportional to the fourth power of the absolute temperature of the black body."*

Radiation is usually associated with high temperatures. Yet very cold bodies emit a radiation which can be highly significant in missile and space applications. The problem faced by infrared scientists, trying to detect variations in radiation from low temperature atmospheres, can be likened to detecting a one-foot cube of ice from a distance of five miles.

Lockheed Missiles and Space Division scientists are deeply engaged in studying the problems of infrared emission from the earth and its atmosphere, as seen from orbital altitudes. Although the earth resembles a black body at 300° Kelvin, the emission from its atmosphere, under some circumstances, is much colder. To make measurements under these circumstances, Lockheed has evolved radiometric equipment with one of the most sensitive detection systems yet conceived.

Scientists and engineers must also take careful measurements of a potential employer. Lockheed Missiles and Space Division in Sunnyvale and Palo Alto, California, on the beautiful San Francisco Peninsula, invites this close scrutiny. As Systems Manager for the DISCOVERER and MIDAS satellites and the POLARIS FBM, Lockheed preeminence in Missiles and Space creates positions in many disciplines for outstanding engineers and scientists.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-13A, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

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←CIRCLE 18 ON READER SERVICE CARD

Slow Payments Squeezing Firms: EIA

CREDIT COMMITTEE of the Electronic Industries Association, in a report available this week, said that 42 electronics manufacturers went into bankruptcy during the 12 months ended Mar. 31, 1961. This compares with 39 during the similar period a year previous.

An upturn in bankruptcies was also noted among electronics distributors. In twelve months ended Mar. 31, 1961, 20 distributors entered this category as against 15 in the previous twelve months.

This is not an alarming trend, according to committee chairman Herbert M. Evans of Tung-Sol Electric. He told ELECTRONICS that a considerably greater number of electronics manufacturers started in business this year than last.

The committee also noted increases among vendors who incurred liabilities as a result of bankruptcies. Vendor liabilities incurred through manufacturers totaled $19,229,000 in the year just ended as compared with $7,815,000 for the previous period. Liabilities incurred as a result of bankruptcies by distributors totaled $2,684,000 as against $2,009,000 the year before.

According to EIA, the chief cause of failures among both manufacturers and distributors was incompetent management. Other contributing factors included low sales volume or sales made under unprofitable conditions. Another reason cited for companies going into bankruptcy was difficulties with accounts receivable, often where excessive sums of money were owed by purchasers. Other companies failed because they stocked excessive inventories that they were unable to move.

Chairman Evans said that component manufacturers have the highest rate of financial failure. This has been true in past periods as well as in the period covered by this year's report. Producers of test equipment and instruments are next.

During the past year there was not one failure in the television production field. There were several failures, however, among manufacturers of small radio-phonographs. This latter group, said Evans, accounts primarily for the substantial increase in overall rate of failure.

According to the committee report, the rate of recovery of funds within the industry has been diminishing and is now at an all-time low. There has been an increased trend to slow payments. On the brighter side, many companies surveyed claim they are getting special terms from their principal suppliers. On the basis of such terms, the payments are not as slow as would be indicated by actual clearances. Extensions of time required for payment have enabled more companies to remove themselves from the late category. Despite this, there has been a sharp increase in the number of firms running 90 days or more behind in their financial obligations.

"There is no question in the committee's mind," says EIA, "but that much of the present unfavorable involvements of some electronics companies are due to the number of them that continue to operate on inadequate working capital and thus, to all intents and purposes are being financed to a considerable degree by the major vendors."

Another trend noted by the committee is seen as a favorable indication for companies in need of sounder financing, and this is the number of firms that have become publicly owned. Through public financing, many companies in the past year who had been chronically slow payers were able to liquidate their past-due obligations and get their accounting back on a current basis. A similar trend was noted among distributors.

During the past year, more than a dozen electronics distributors obtained public financing and raised on the average of $500,000 each. In the 1957-58 year, 14 electronics distributors went bankrupt incurring total liabilities of $1,500,000. In the 1958-59 period 16 went bank-

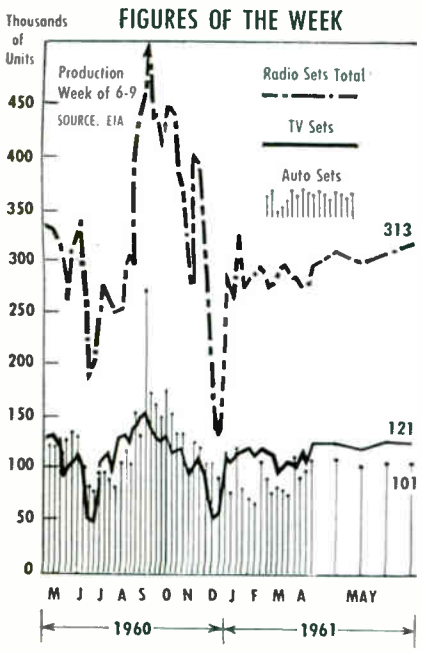
rupt at $667,000; and in the 1959-60 period, the number was 15 with liabilities of $2,009,000.

Manufacturers saw a similar increase in failure rates during the same time span. In the 1957-58 period there were 27 bankruptcies at $12,678,000 in liabilities, the next year the total was 31 manufacturers at $19,082,000. In the 1959-60 period, it was $7,815,000 in liabilities for 39 bankruptcies.

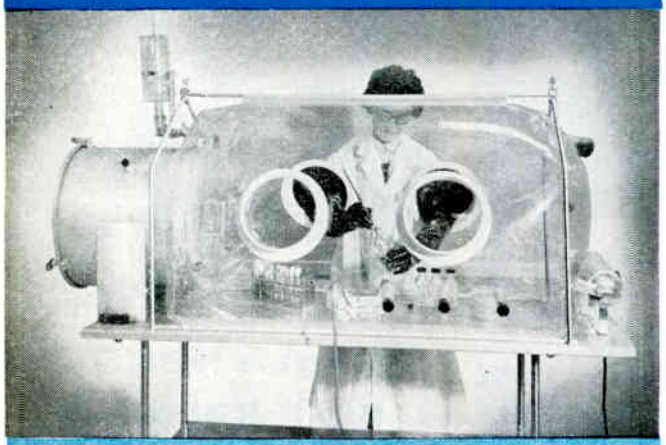
Also studied by the committee were patterns in growth of distributors in the U.S. during the past fiscal year. There were 58 new electronics distributor organizations established in the period. Average starting capital was $20,000. Of the total, California saw the start of 13 distributor companies; New York was second with eight. In Florida four started and in Texas, three. The remainder were scattered. Three of the 58 were continuations of companies that had previously been in financial difficulty.

In fiscal 1960, the number of new distributors was 63. In fiscal 1959 there were 30 starters. During the 1960 fiscal year, California led in new starts with a total of nine distributors. In Pennsylvania eight start-ups were noted and in Florida, five.

EIA added the comment that in all cases management was experienced, having been drawn from older concerns.



This is the PERFECT "Dust-free" Laboratory



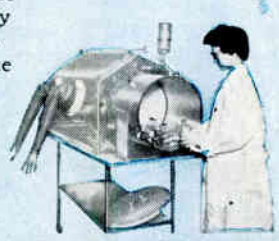
AMSCO Flexible Film Laboratory Dry Box

This low-cost, transparent "self-contained laboratory" is designed for laboratory or production procedures demanding a controlled, isolated atmosphere . . . whether it be dust-free, moisture-free, toxic compound confining, inert gas atmosphere . . . an almost endless list.

Amsco's disposable Flexible Film Dry Box is ideal for delicate transistor and diode assembly, experimental metallurgy, missile sub-assembly work, instrument assembly . . . even Alpha radiation studies. The clear plastic canopy enables technicians to work comfortably and swiftly with no eye strain.

When not in use the "envelope" may be collapsed into a compact package for convenient storage. Upon completion of certain studies, the canopy may be disposed of and replaced quickly and economically. The chamber size is 48" long x 26" wide x 28" high and is provided with four "working" ports, a large interchange lock for introducing parts and several tubular ducts for service lines. Complete air filtration system is optional.

Won't this low-cost, disposable Dry Box fit into your laboratory or production plans? An Amsco man will be happy to discuss the matter in detail . . . or write for bulletin IC-607.



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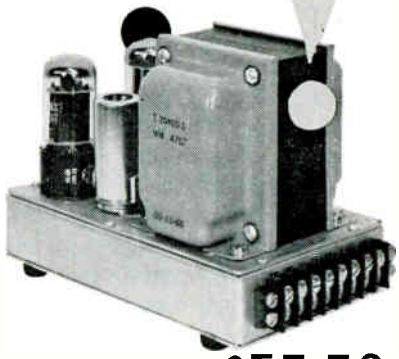
RS305A



@ $55.50

For original use . . . For incorporation into laboratory equipment . . . In 55- to 400-cycle systems. The Trans Electronics Model RS305A Power Supply provides voltage regulation of .05% load and .05% line over the entire 225- to 325-volt range. Operating current range 0-50 ma, continuous duty, with filament output of 6.3 volts CT AC @ 3 amps. Units feature low ripple and noise (5 mv peak to peak); fast recovery time (25 to 50 microseconds). Three versions of Model RS305A offer, respectively, modular construction in package 5 x 4⅛ x 6½ inches; rack-mounting; and rack-mounted models with 3¼-inch meters, in case with 3½-inch panel height. Input is 105-125 volts AC.

SPECIFICATIONS

model*	voltage range	current ma	filament volts/amps	price
RS-110				$108.00
RR-110	0-100	0-100	6.3/3	133.00
RM-110				169.00
RS-205				55.50
RR-205	150-225	0-50	6.3/3	80.00
RM-205				115.00
RS-217A				87.50
RR-217A	150-225	0-175	6.3/8	112.50
RM-217A				147.50
RS-305				55.50
RR-305	225-325	0-50	6.3/3	80.00
RM-305				115.00
RS-317				87.50
RR-317	225-325	0-175	6.3/8	112.50
RM-317				147.50
RR-450	+300-400		6.3/2	155.50
RM-450		0-50	6.3/1.5	196.00
DUAL TRACKING	—300-400		6.3/1.5	
RR-473	+300-400		6.3/2	140.00
RM-473		0-25	6.3/1.5	175.00
DUAL TRACKING	—300-400		6.3/1.5	
RS-505				81.50
RR-505	300-5002	0-50	6.3/3	106.50
RM-505				141.50
RR-303	0-300	0-500	6.3/15	320.00
RS-303	0-300	0-500	6.3/15	360.00
RR-550	300-500	0-500	6.3/15	310.00
RM-550	300-500	0-500	6.3/15	350.00

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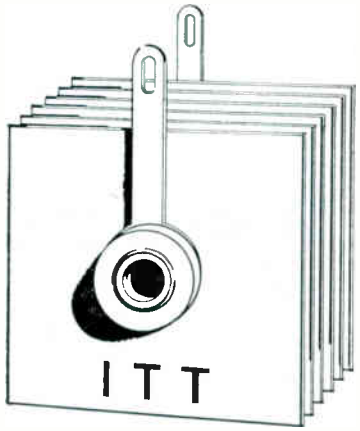

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Selenium Industrial Power Rectifiers
Selenium Miniature High Voltage Rectifiers
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What's Happening In Entertainment Tubes

ENTERTAINMENT TUBE manufacturers are reevaluating their market prospects this week following decisions by two companies to get out of the field (ELECTRONICS, p 9, June 9).

A number of manufacturers say the market for entertainment tubes is unquestionably declining. They cite several reasons:

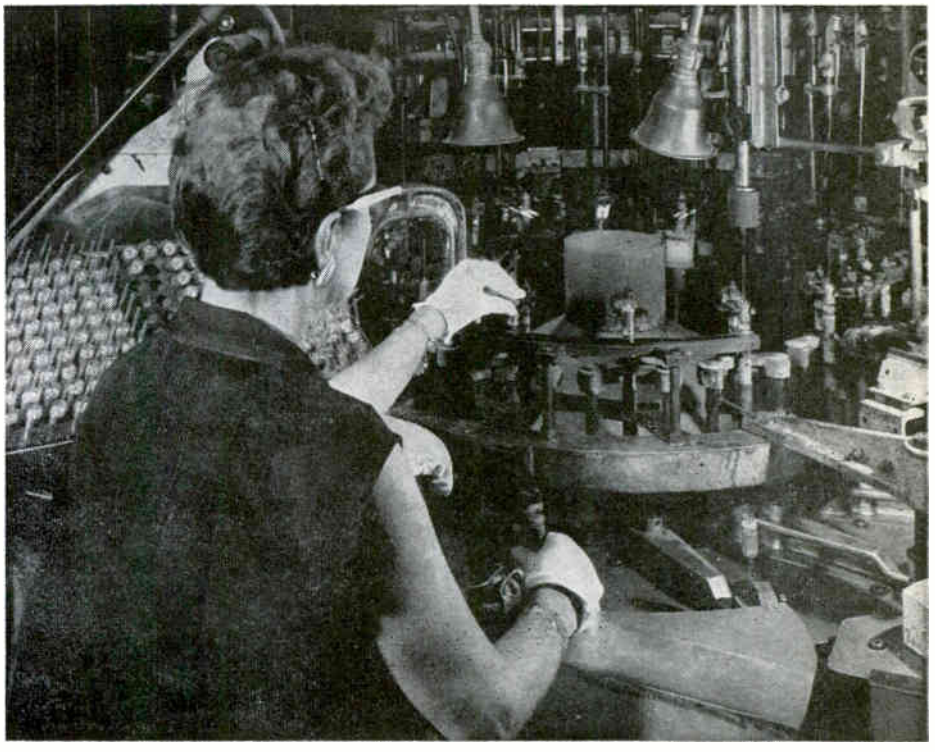
First is the upturn in imported entertainment tubes mostly from Japan. W. F. Greenwood, marketing manager for General Electric's receiving tube division tells ELECTRONICS that in 1955 there were 458 million receiving tubes sold in the U. S. of which 2 million were imported. In 1960 the market had contracted to 402 million tubes sold of which 30 million were imports.

GE predicts that in 1961 376 million tubes will be sold of which 40 million will have been imported. Sylvania's senior vice president of marketing, G. C. Connor predicts that in 1970 receiving tube sales will decline to about 271 million.

Another reason for the decline in entertainment tube sales is inherent in the improved quality of tubes themselves. Most manufacturers point out that multipurpose tubes reduced the number of sockets to be filled. In addition, improved operating life, greater reliability and better circuit design have reduced the replacement market.

A third factor is the large number of transistors used in consumer products. Although this was mentioned in announcements by CBS and Philco to discontinue entertainment-tube manufacturing, other manufacturers say it is not a major irritant.

John B. Farese, division vice president of RCA's entertainment-tube department comments, "Receiving tubes have and will continue to have an important place in the electronics industry for a long time to come in both entertainment and industrial areas. Looking ahead to the next five to ten years, we foresee a sizable volume of business." In discussing the RCA outlook, Farese points to the significant savings offered by lower cost components when used with tubes, and the greater design flexibility in tube circuits.



A tight but healthy market lies ahead for entertainment tubes. These are being manufactured at RCA's Cincinnati plant

Milton R. Schulte, president of Tung-Sol Electric says "Electron tubes have a real place in industry and will continue to be used in a host of applications in which semiconductors are not suitable." He also believes that the replacement market will continue to be important for many years to come.

Two bright spots on the entertainment tube makers' horizon are stereophonic radio and color television.

One tube marketing executive anticipates that color television will result in an annual increase of 20 million entertainment tubes by 1970. There will be additional demand due to wider use of phonographs, electronic organs and radios.

British Components Show Reveals Growth of U.S.-U.K. Licenses

LONDON—A bigger show, more U. S.-developed components and increased reliability were trends noted by visitors to Britain's Radio and Electronic Components show held here recently. The show has trebled in size over previous years. It is promoted by the Radio and Electronic Components Manufacturers Federation; 250 firms exhibited.

Output of components over the past 10 years has shown a steady 10-percent annual increase becom-

ing in 1960 a $360-million business. Around 10 percent is exported. Europe is Britain's biggest customer, while the U. S. purchases over $13-million worth.

Though production statistics portray a bullish industry, discerning visitors found little new and of what they did find most was being imported or made under license from U. S. companies.

Representative of new techniques appearing on the British market this way are the piezoelectric ceramic tuned circuits developed by Clevite Corp. and manufactured by the Brush Crystal Co. of Hythe, England; die-stamped printed circuits under license from Refac; and miniature one-inch-cube blower motors from Sanders Associates.

Among the British-developed components was a solid-dielectric variable capacitor for portable radios developed by Mullard Ltd. This double-range 0 to 180-pf and 0 to 80-pf capacitor in a synthetic resin housing measures only 0.787 inch by 0.59 inch.

Magnetic-core memories are shrinking. Two British companies, Plessey Ltd. and Mullard, now are developing 32 by 32 matrix planes using 0.03-inch-diameter cores with an 800-per-sq-in packing density.

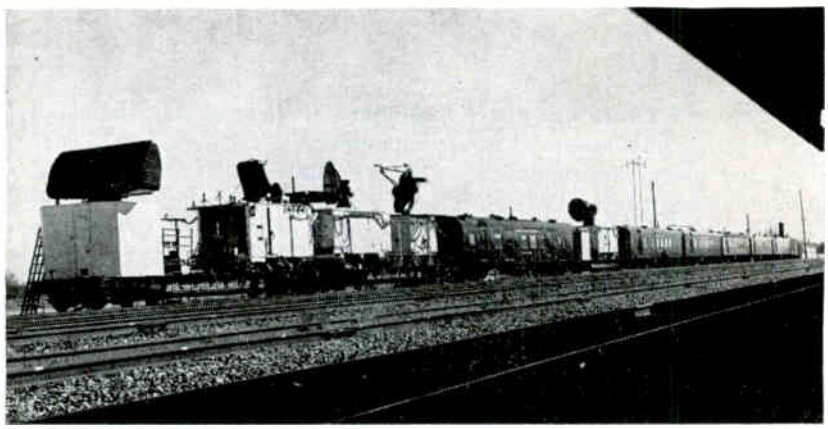
Switching currents are down to 656 ma. Next development envisaged is use of the 0.03-inch cores in a two-core-per-bit configuration.

Government research laboratories and several commercial firms displayed experimental microminiaturization techniques, some being used in Britain's missiles. One technique uses 1¼ by ¾-inch glass plates as substrate with silicon monoxide and nichrome evaporation for capacitors and resistors. Packing densities achieved by the Royal Radar Establishment is 260 components a cubic inch.

The range of semiconductors available in the United Kingdom increases. Mullard showed a new avalanche transistor producing 60-ma short-duration pulses with rise times of one nanosecond; also 50-Mc switching speed computer logic transistors using an alloy-diffused germanium junction.

Another show keynote was increased emphasis on reliability. In a recent installation at Mullard's semiconductor plant over 10,000 transistors are put on permanent test. Automatic test gear interrogates each transistor every day, test results being printed on punched cards and fed to a computer for quality analysis.

The system enables Mullard to record 40 million operating hours a year. By 1963 Mullard plans to record over 120 million hours a year. The same philosophy is being applied by switch manufacturer Henry Thomas Ltd. of London in test equipment where switches undergo one million operations as resistance meters automatically check for changes in contact resistance.



Electronic-laden train near bomber "target" calculates where bomb "hit"

Radar Bomb-Scoring Train Aids SAC

RADAR BOMB-SCORING (RBS) system, mounted on 10 railroad cars that shuttle about the country to a new location every 45 days, is improving the efficiency of the Strategic Air Command's practice bombing.

Composed of six 85-ft hospital cars used for command, administration, supply, maintenance and power, three 50-ft flatbeds with vans housing radar and ecm gear, and a 50-ft boxcar for storage, the RBS train is manned by a crew of 65.

B-47's and B-52's make bomb runs on a designated spot near the train—often devoid of natural or manmade objects to simulate bombing underground missile sites. The RBS crew detects and tracks the bomber using three radar systems and tries to jam its radar with ecm gear.

From the moment the aircraft opens its bomb bay doors until the bomb drops, data from a computer in the aircraft's radar system are automatically telemetered to the RBS crew. A computer in the train calculates where the bomb "hit".

RBS train equipment includes: automatic ground tracking radar (AN/MSQ-39) to acquire and track the bomber; ecm radar simulator (AN/GPQ-TIA) to evaluate and train aircraft ecm operators; and AN/TLQ-11 and AN/MPS-9 gear to train aircrews in jamming.

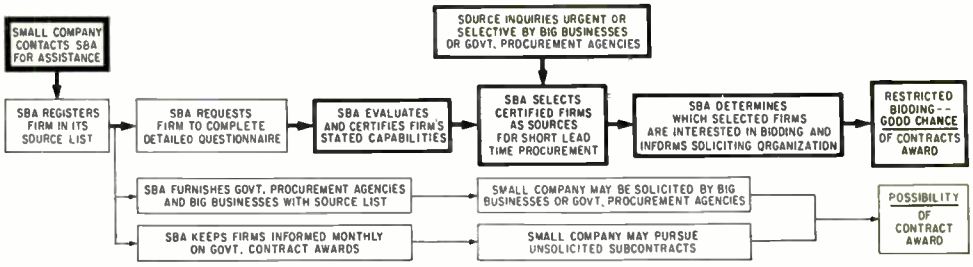
SAC will have three of these RBS trains operating around the country by September.

Army Missile Agency To Build Computer Lab

ARMY Ballistic Missile Agency hopes to start construction this summer on a $1-million laboratory to house computation facilities at Redstone Arsenal.

The lab is meant to replace the multimillion computation facility that was transferred to the George C. Marshall Space Fight Center when that civilian facility was set up last July at Redstone. The $1 million does not include the cost of computing equipment, which has not yet been specified.

How Small Business Administration funnels business to small companies



SBA Offers Help In Getting Contracts

SMALL ELECTRONICS FIRMS are generally not taking advantage of a convenient and promising business channel in obtaining contracts from government agencies and subcontracts from big business. Services offered by the government's Small Business Administration go abegging often because small companies (less than 500 people) do not know they exist.

Furthermore, SBA is prevented by law from approaching firms. Contact must be initiated by the companies themselves.

Only some 530 small electronic companies having research and development or production capabilities are included in the last registration list published by SBA.

The list is almost a year old, but an up-dated list to be published next July shows an increase of only 25 percent.

Many government agencies and prime contractors turn to SBA for help in making quick but qualified selection of small firm sources. They include the Fort Monmouth Signal Corps R&D installations; Rome Air Development Center, Arma Division of American Bosch Arma, ITT, IBM, Perkin-Elmer and many others.

Frequently, SBA is given only a ten-day lead before the sources have to be submitted. During this time, SBA must select qualified bidders, contact these firms to find if they are interested in the job and if they are able to carry the additional work and inform the soliciting organization of interested and available firms.

This effort is often done nationwide. One regional SBA office maintains direct liaison with the soliciting organization and with other regional offices contacting the small companies.

There have been instances of firms stating an interest in bidding and then declining to follow through when solicited. If this happens twice in succession the firm may no longer be considered for such preferential treatment on quick inquiries until the SBA has had time to reevaluate the firm.

Within one recent month, Rome Air Development Center asked the R&D section of SBA's New York Regional Office to help with 93 different jobs. A lead time of 30 days was given SBA to evaluate and contact sources.

Another recent operation by this SBA group was finding nationwide small business sources to handle a problem in microminiaturization connected with an Arma flight recorder system slated for completion in 1965.

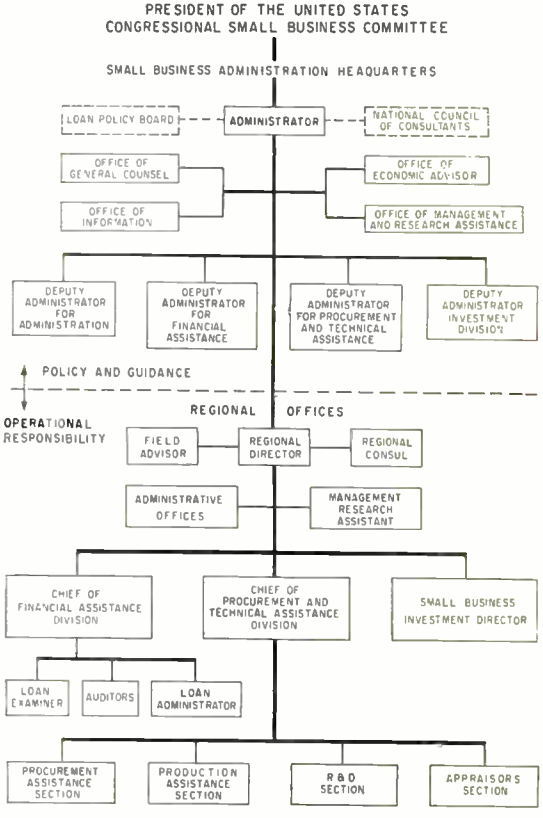
New York's R&D section is helping ITT Communications Systems division of ITT to find sources for work on an Air Force Aircom 480 L contract.

The SBA follows the procedures shown in the flow diagram. But, nothing happens until the firm approaches SBA. An exception to this rule occurs when SBA is looking for firms qualified in greatly needed and highly specialized technologies such as thin-films and mesa transistors. Then, they may try to find firms through trade shows and ask them to register with SBA.

Initially, SBA requires firms to register their overall capabilities such as annual sales, total floor area, number of employees, types of products developed by firm and manufacturing processes used When this information is received, SBA adds the firm to its source list, and sends a more detailed questionnaire.

This requests such information as: sales breakdown by manufacturing, R&D, engineering services and consulting services; number of scientists and engineers; description of specific past and current work in specialized areas such as magnetohydrodynamics; description of laboratory and testing equipment; and a listing of principal products or product lines in order of importance.

As soon as its schedule permits, SBA will send a representative to



Organization reflects policy uniformity, regional offices' freedom to act

visit the firm to verify its capabilities and its potentialities; SBA requires that the firm designate a technically qualified individual who can discuss engineering problems.

If satisfied by the representative's report SBA will certify the firm's ability to do work. A certified firm subsequently receives preferential treatment when quickie or selective inquiries are received from government agencies or business.

A firm not following through on the detailed questionnaire, remains on SBA's list and is referred to government agencies and big business for multiple-source bidding. However, these small firms lose out on many short-lead time contracts prevalent today.

All listed firms are informed by SBA once a month of government prime contract awards so that they can compete for subcontracts.

Sometimes, a government agency or a business will rule-out a small firm because of past financial difficulties. But SBA keeps up-to-date by visiting facilities once a year and up-dating capabilities accordingly. This help's SBA to set the record straight for firms making new headway.

In one instance, a company that had been in financial trouble a year ago, floated a successful stock issue within the past two months. Government agencies were still eliminating the firm from consideration until SBA made them aware of the present situation.

A watchful eye is kept on issuance of government contracts to see to it that the legal provision for small-firm awards if fulfilled by the individual agencies when possible. Since SBA reports direct to the President and the Congress, it can exert pressure if this provision is not followed.

Regional offices of the SBA located in highly developed electronic areas—New York, New England, Florida and the West Coast—are more adequately staffed than those in the less electronically developed regions. However, even there, more manpower is needed to do the job.

In the New York regional area, there are 600 R&D firms, majority of them in electronics. The single field man of the R&D section would have to visit three firms a day in order to reach all of them at least once a year.

Scientists Discuss Spark Chambers At International Parley In Belgrade

BELGRADE, YUGOSLAVIA—Radiation detectors, fast pulse circuits and monitoring systems were among topics covered at the Conference on Nuclear Electronics held here recently. The meeting was sponsored by the International Atomic Energy Agency (IAEA) and arranged by the Yugoslav Nuclear Energy Commission.

The second such conference on development of nuclear energy for peaceful purposes will cover plasma physics and controlled nuclear fusion research. It will be held at Salsburg, Austria, Sept. 4 to 8. The third, on use of radioisotopes in animal biology and the medical sciences, will take place Nov. 21 to Dec. 1 at Mexico City.

Exhibits included electronic equipment for detection and measurement of nuclear radiation. Ten countries exhibited: Austria, Czechoslovakia, Denmark, France, Poland, Rumania, Japan, Italy, Israel and Yugoslavia.

The Conference was attended by 352 scientists from 29 countries and five organizations. Large delegations came from France with 51 scientists, Italy 34, United States 29, United Kingdom and West Germany with 20 each. Yugoslavia was represented by 90 paritcipants and observers.

The USSR sent five delegates, three Russians and two Ukranians. Including these and four men from the USSR Joint Institute of Nuclear Research of Bubrovo and 14 from the other East European Communist bloc countries, a total of 23 scientists participated from behind the Iron Curtain.

Five organizations represented were CERE, European Center for Nuclear Research in Geneva; EURATOM; OKEC, European Economic Cooperation Organization in Paris; the Joint Institute of Nuclear Research at Dubrove, USSR; and the World Health Organization.

A total of 146 papers were presented, about 85 of them orally.

Several papers dealt with recent developments in semiconductor detectors, new materials used as scintillators for radiation detection and spark chambers or devices based on the production of electrical sparks as result of ionization caused by radiation.

In contrast to Geiger-Muller tubes, semiconductor detectors and spark chambers not only add visual effect such as flashes of light or sparks audible warning, but also can discriminate to a fine point the source, strength and type of radiation.

There was an unofficial consensus of opinion that U. S. delegates contributed most. Singled out for individual contributions were J. Keller of Poland, E. Gatti of Italy, K. Kandish of Britain and R. A. Mack and C. J. Borowski of U. S.

P. Desneiges of France described a range of portable instruments for keeping a permanent check of the radioactive contamination of surfaces, air and liquids and able to carry out checks at any amount at a great number of points.

Three Yugoslav scientists, B. J. Kovac, S. D. Mushdaka and M. V. Sobajic, described an instrument for radiation control by telephone. The instrument, connected to a telephone set, gives information on the radiation level in an area by dialing a number and lifting the receiver. A scientist can thus check from his own home what goes on in his laboratory.

S. Kobayashi and three other Japanese scientists described a survey meter that can not only detect the presence of a radioisotope, but can also determine its exact location.

C. J. Borkowski and R. H. Dilworth described a personal radiation monitor developed by the Oak Ridge National Laboratory. The device is the size of a fountain pen and weighs 3½ oz. It provides immediate audible and visual indication of gamma dose rate. The instrument operates continually for one month from a 4-volt mercury battery.

'Pencil' Tubes for Space

Coaxial pencil-type vacuum tubes by RCA are assembled with aid of microscope. Two were used in American astronaut's spacecraft for communication purposes

Airline Ticket System Uses Three Computers

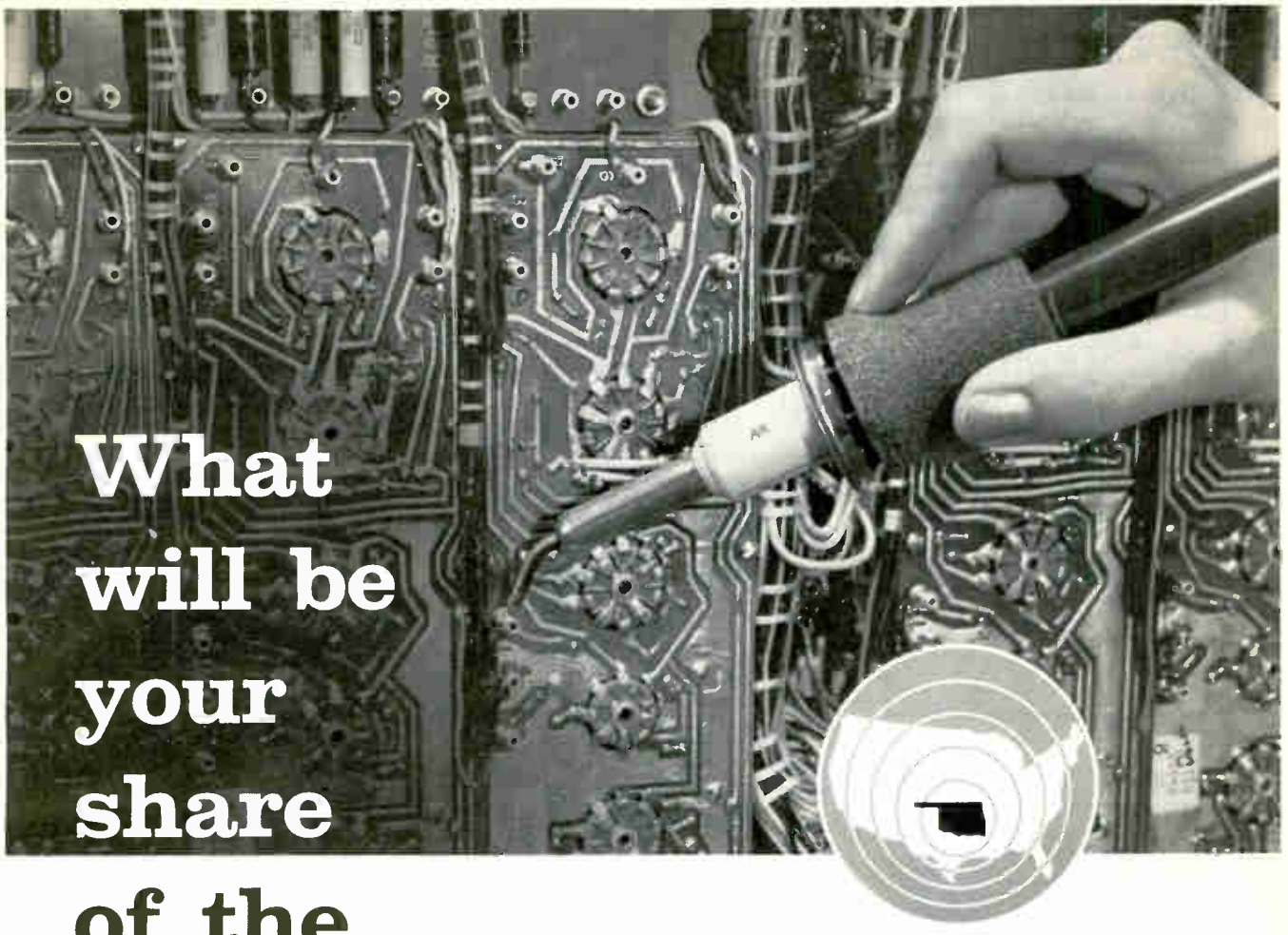
TWELVE THOUSAND miles of communications circuits, 1,000 keyboard sets, three years of engineering and manufacturing. These are all descriptive of United Airline's ticket reservations system recently put into operation. Fifteen thousand messages per second can be cleared through the system's data processing center in Denver, Colorado.

A three-year study by Stamford Research Institute and Teleregister Corporation resulted in the system design. Produced by Teleregister, the data processing communications system cost approximately $16,000,000. The system is expected eventually to be able to handle 540,000 reservations a day.

The first phase of the project is now in effect. It provides nationwide information on availability of space for 3,000 sales agents in 100 locations. The second phase will provide inventory of space records and flight information.

Called Instamatic, the system includes three solid state general purpose data processors, 827 keyboard units (counter-top sales agent sets) and 150 tons of communications equipment.

Approximately 500,000 transistors, 40,000 printed circuits, and 2,000,000 ferrite cores are used in the transmission and switching systems designed and built by North American Philips.



What will be your share of the electronics market in 1970?

In 1970 the sales of electronic components and equipment will total $21-billion. Your share of this gigantic, mushrooming market depends on your *right now* ambition . . . decisions . . . interest and research into future plant locations.

If you're looking ahead to 1970, we'd like to help by showing you:

- why Oklahoma is ideally suited to electronics by existing markets, resources and facilities
- why this energetic state produces and attracts bright, young, adaptable men and women so essential to your industry
- our great educational institutions with expanding facilities to aid company research, and opportunities to pursue advanced degrees during leisure hours
- Oklahoma's important central location, with strong lines of distribution radiating to the east, west, north and south — and jet service (passenger and freight) to either coast
- new industry services ranging from impartial site location studies to a proven 100% financing plan.

If you have this *right now* feeling about 1970, let's correspond confidentially. Contact Max Genet, Jr., Director, Oklahoma Department of Commerce and Industry, Box 3327-EA, Capitol Station, Oklahoma City, Oklahoma.

OKLAHOMA!

. . . where the future is just beginning

Plan New Gear for Nuclear Detection

THE U.S. COAST AND GEODETIC SURVEY'S worldwide network of seismological stations is getting beefed up with new, sensitive and standardized equipment.

The program, sponsored and financed by the Advanced Research Projects Agency, is the Vela-Uniform part of the three-part Vela program for detection of nuclear explosions.

Vela-Uniform's function is basic research in natural earth disturbances. The other two parts of Vela—called Vela-Sierra and Vela-Hotel—are, respectively, to develop ground-based instruments for possible detection of nuclear explosions in near space; and to develop satellite-based instruments and systems to detect nuclear explosions in space.

Since kiloton-size bombs produce waves equivalent to, and under most circumstances indistinguishable from small and numerous earthquakes, improved knowledge of natural earth noises will aid in identifying the nature of all noises —natural and manmade.

Vela-Uniform will develop improved knowledge of the world's crust and mantle, particularly with regard to the number, thickness and nature of the major layers. It will also study wave propagation characteristics through the earth, including regional travel time anomalies and a comparison of all types of seismic waves from earthquakes.

Results of these studies with the new gear should improve techniques for achieving an efficient worldwide system for monitoring nuclear explosions.

The requisites for such a system include better detectors, improved understanding of earth-noise signatures, better methods for separating normal noise from signatures, use of electronic computers and additional stations.

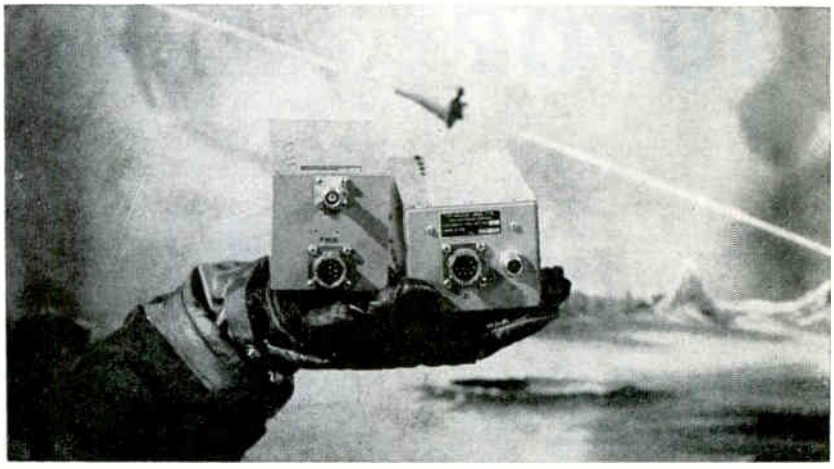
The present network in Vela-Uniform for detecting natural earthquakes consists of 125 stations at universities and scientific institutions in 65 countries and islands, on six continents.

The new equipment will not only be more sensitive but will be standardized. Efficiency of the existing net is impaired by the various equipments with different calibrations now in use.

Each station will be equipped with three-component short-period and long-period electromagnetic seismographs capable of recording seismic waves with durations of from 0.1 to 100 seconds. These will be built by Geotechnical Corp. for $20,000 each.

Time control—one big advantage to be obtained from standardized equipment—is furnished by crystal controlled oscillators accurate to one second in 40 days. These clocks also regulate the power supply to

Voice Transceivers Used by Astronaut



Alan Shepard communicated by voice with ground stations by using Collins uhf 618H-1 transceiver (left) and h-f 618V-2 transceiver

the recorders, thereby providing a uniform rate of rotation of the recording drum. Radio time signals are also automatically impressed on the records.

Present equipment can pinpoint an earthquake within 0.5 degree of latitude and longitude. The new gear is expected to reduce this area to 0.1 degree.

Another feature of the new equipment is improved depth determination—a big factor in distinguishing between earthquakes and nuclear explosions. Earthquakes occur anywhere from 15 Km to 700 Km below the earth's surface—usually consistent to the region—while underground nuclear explosions would be just below the surface.

Present gear can determine within ± 25 Km the level of the disturbance by feeding the measurements from a number of stations into a computer in Washington, D. C. The new gear is expected to improve these measurements.

Recent activity in Vela-Sierra is a $233,339 contract awarded by USAF to the Tempo component of General Electric. Tempo will develop recommendations for an optimum world-wide system of control posts using ground-based instrumentation for detecting nuclear explosions in the upper atmosphere and in space. Techniques to be considered will include, as well as go beyond, those set forth at the Geneva technical conferences.

Japan Refuses to Drop Transistor-Radio Quotas

JAPAN'S Ministry of International Trade & Industry has replied with a flat "No" to the request from Japan Electronic Industries Association that transistor-radio exports be completely freed.

New quotas for the U.S. and Canada are currently being calculated on the basis of exports in the last six months of last year. Quotas were put into effect on July 1 '60, renewed on Jan. 1. New quotas will go into effect this July 1, will not cover f-m radios, car radios, clock radios or camera radios. Only standard-broadcast a-m receivers of three or more transistors will fall under the quota.

Ocean Liner Has Dual-Duty Tv System

AT SEA THIS WEEK on her maiden voyage around the world, the British luxury liner *Canberra* is carrying some unusual electronic gear.

Among the electronic equipment aboard the 45,000-ton Cunard vessel is a television system that can operate as a closed-circuit shipboard network or from off-the-air pickup; a high-powered single-sideband transmitter for making long-distance phone calls anywhere in the world; a new depth-sounding system and several other unique systems. Marconi's supplied most of the equipment.

The television system on the *Canberra* follows a pattern used aboard another British liner, *Oriana*. Tests on the older vessel showed adequate tv reception when the ship was as much as 150 miles off shore. The *Canberra* system provides for reception of the 625-line and 525-line systems, as well as the British 405-line system. Viewers are able to tune in channels in any part of the world. In off-the-air use, programs are processed through receiving equipment located next to the *Canberra's* radio shack.

The ship is carrying about 40 tv sets to which program fare is routed from the central receiver. Set sizes include 17, 21 and 24-in units. The sets are in the ship's public rooms and first-class cabins, but a spokesman for Marconi's says provisions have been made to put a maximum of 350 tv sets.

In closed-circuit operation, the ship uses two vidicon cameras and 16-mm film chains including projectors for slides, motion pictures and live pickup. When the ship is out of range of tv transmitters, the liner's electronics men will provide filmed entertainment from the ship's library. The studio gear can also be used for televising plays and events staged aboard. Plans include passenger tours of the bridge and engine rooms by tv.

The single-sideband transmitter features speech inverters for scrambling conversations to insure privacy. Additional telephone facilities are built into transmitters intended primarily for use in telegraph traffic.

Among the *Canberra's* radio navigation equipment is Marconi's Lodestar direction finder. This device, once tuned to a radio beacon frequency automatically maintains its pointer at the true bearing thus derived with no further manual adjustments.

A new depth finder provides a pointer indication of the depth of water beneath the ship at any second. Using a dry-recording display, the system incorporates a simple computer that differentiates between true bottom echo, spurious reechoes and interference.

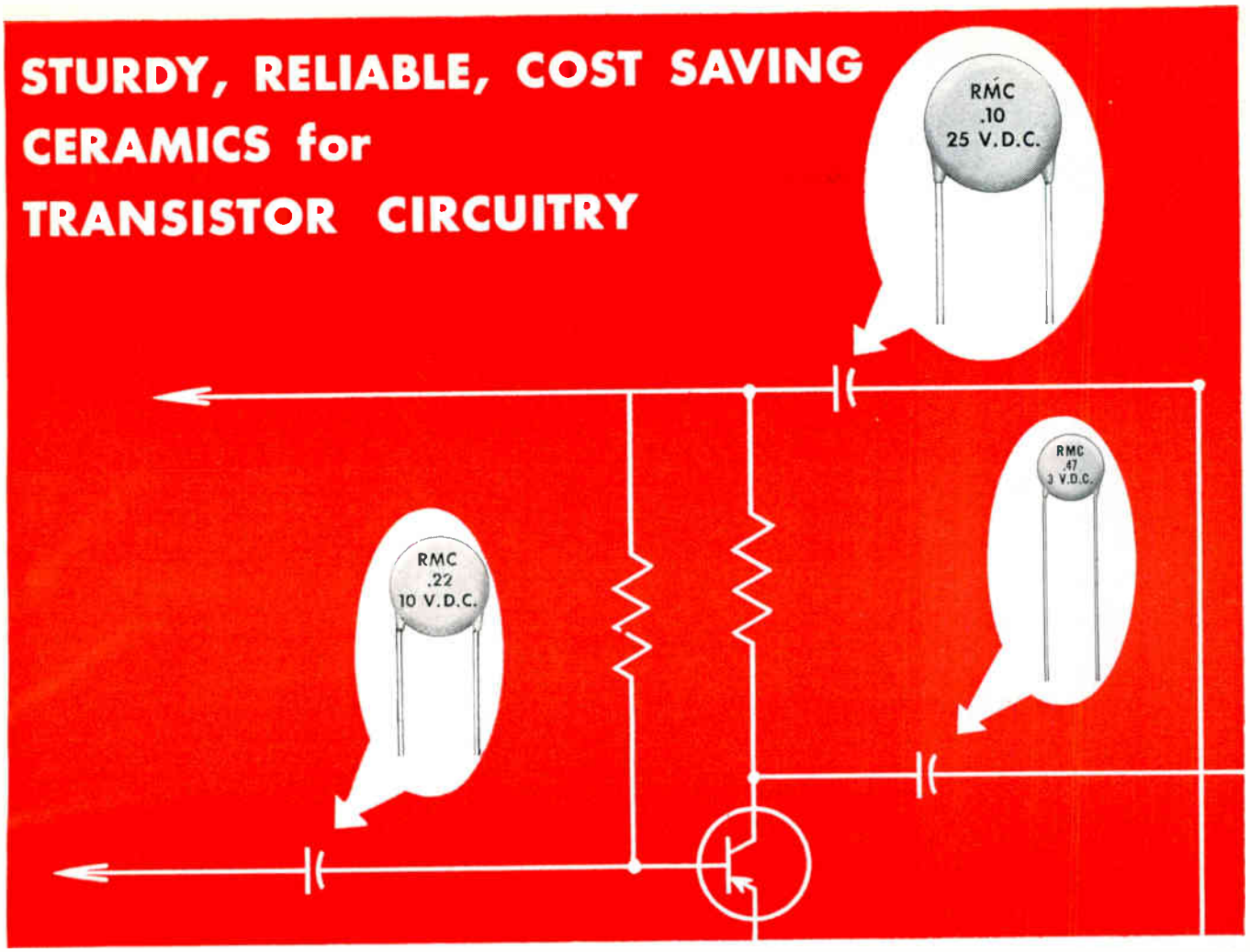
Zeus Countermissile Radar Passes Test

TARGET-TRACKING RADAR for the Nike Zeus countermissile system was successfully tested recently against a fast-moving intercontinental ballistic missile. Radar, installed on Ascension Island at the end of the Atlantic Missile Range, tracked an Atlas fired from Canaveral. Production work on the Zeus countermissile will not be authorized until the system has been completely tested.

Infrared Viewer

Transistorized infrared viewing device for military use was made by Varo Inc.

STURDY, RELIABLE, COST SAVING CERAMICS for TRANSISTOR CIRCUITRY



RMC Magnacaps®

3 VOLTS D. C.

μF.	Diameter
.05	.265
.10	.265
.22	.265
.47	.345
1.0	.565
2.2	.710

10 VOLTS D. C.

μF.	Diameter
.05	.265
.10	.350
.22	.555
.47	.725
1.0	.835
2.2	1.00

25 VOLTS D. C.

μF.	Diameter
.02	.410
.05	.600
.10	.785

RMC's Ceramic Research Laboratories have designed these new Magnacaps for application in low voltage circuits requiring capacitors with ultra high values and low power factors. RMC Magnacaps combine these desirable features with the miniature size, reliability and lower costs associated with ceramic capacitors.

Magnacaps exhibit a minimum capacity change between −55°C to +85°C and feature the mechanical construction necessary to effect additional production line economies.

If you have applications where space is critical and performance and economy are prime considerations, it will pay to investigate all the advantages offered by RMC Magnacaps.

U.S. Patent No. 2,529,719

DISCAP CERAMIC CAPACITORS

RMC

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

MEETINGS AHEAD

June 18-23: Summer General Meeting, AIEE; Willard Straight Hall, Cornell Univ., Ithaca, N. Y.

June 19-20: Broadcast & Tv Receivers, B&TVR of IRE; O'Hare Inn; Des Plaines, Ill.

June 22-23: Computers & Data Processing, Univ. of Denver; Elkhorn Lodge, Estes Park, Colo.

June 22-23: Air Lines Communications Administrative Council, AEEC; Saxony Hotel, Miami Beach, Fla.

June 26-27: Vacuum Metallurgy Conf., American Vacuum Society; New York Univ. Heights Campus, New York City.

June 26-28: Military Electronics, National Convention, PGME of IRE; Shoreham Hotel, Wash., D. C.

June 26-30: Aero-Space Technical Conf., Concepts & Design, AIEE; Ben Franklin Hotel, Philadelphia.

June 26-July 1: International Measurement Conf. and Instrument Show, IMEKO, IMIS; Engineering Societies Bldg., Budapest.

June 28-30: Joint Automatic Control Conf., AICHE, AIEE, ASME, IRE, ISA; Univ. of Colorado, Boulder, Colo.

July 5-9: Radio Techniques and Space Research, British IRE; Univ. of Oxford, England.

July 16-21: Conf. on Medical Electronics & Conf. on Elec. Tech. in Med. & Bio., IFME, JECMB, PGBME of IRE; Waldorf-Astoria Hotel, New York City.

Aug. 22-25: WESCON, L. A. & S. F. Sections of IRE, WCEMA; Cow Palace, San Francisco.

Sept. 11-15: Instrument-Automation Conf. and Exhibit, ISA; Sports Arena, Los Angeles.

Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Int. Amphitheatre, Chicago.

Nov. 14-16: Northeast Research & Engineering Meeting, NEREM; Commonwealth Armory and Somerset Hotel, Boston.

NEW CALIBRATED FIELD INTENSITY RECEIVER

POLARAD

Now, in a single unit, the new Polarad Model FIM indicates the absolute power level of a radiated or conducted input signal by comparing it against an internally generated signal.

- Model FIM accurately measures frequency and absolute power level of microwave energy.
- Only microwave Field Intensity Receiver with self-contained signal generator which calibrates entire system under test at any level.
- First single microwave test system to determine r-f interference and susceptibility to interference.
- Front-panel meter indicates average, peak, slide-back peak or quasi-peak value of r-f signals. Outputs for video, audio and recorder.
- Four interchangeable tuning heads cover 1,000 to 10,000 mc.
- Direct-indicating peak VTVM for ease of frequency location of impulse noise.
- Single UNI-DIAL tuning control tunes both the receiver and signal generator.
- Calibrated antenna system includes an omni-directional broad band antenna and a separate directional antenna to match each tuning unit.

COMBINES SIGNAL GENERATOR AND RECEIVER IN SINGLE UNIT

1,000 to 10,000 mc*

Two compatible tuning units under development will extenc frequency to 20 kmc.

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes On Microwave Measurements."

12345678

POLARAD ELECTRONICS CORPORATION:

Please send me information and specif cations on:

- ☐ Model FIM Calibrated Microwave Field Intensity Meter

My application is

- ☐ Model R Receiver (see reverse side of this page)

My application is

Name

Title Dept.

Company

Address

City Zone State

POLARAD
ELECTRONICS CORPORATION

FREE LIFETIME SERVICE

43-20 34th Street,
Long Island City 1, N. Y.

MICROWAVE RECEIVER

MODEL R 400 to 84,200 mc

A MULTI-PURPOSE PRECISION TEST INSTRUMENT

DETECTS AND MEASURES:

- Antenna patterns
- Field intensity
- R-F power
- R-F noise figure
- Leakage and interference
- Filter characteristics
- Bandwidth of microwave cavities
- Attenuation
- Insertion gain and loss
- Relative power differences between fundamental signal and harmonics

Now — one basic instrument serves for general communications as well as for detection and complete quantitative analysis of microwave energy.

Polarad Model R Receiver accepts all microwave signals: AM, FM, CW, MCW and pulse. Power and frequency are read directly on front panel indicators.

It permits all standard forms of signal monitoring: special output jacks for audio and video; trigger output to reproduce pulse width and repetition rate; recorder output to transcribe signals through commercial recording equipment.

Model R is simple to operate, extremely sensitive, highly accurate, and is designed for quick, easy inspection and servicing. It provides AFC, AGC, and continuous UNI-DIAL tuning. Nine interchangeable tuning units cover the entire frequency range. A tenth tuning unit is available for antenna pattern measurements from 2000 to 75,000 mc.

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements"

POLARAD ELECTRONICS CORPORATION

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Representatives in principal cities

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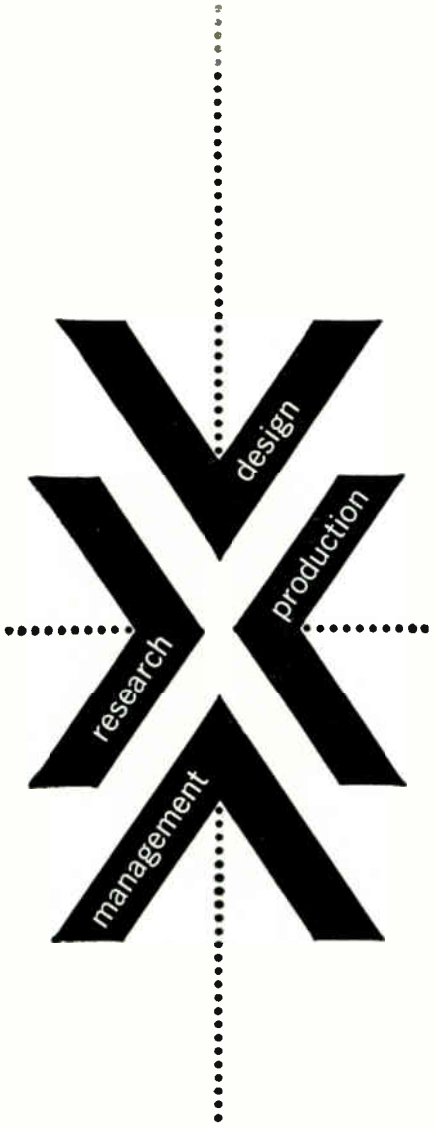

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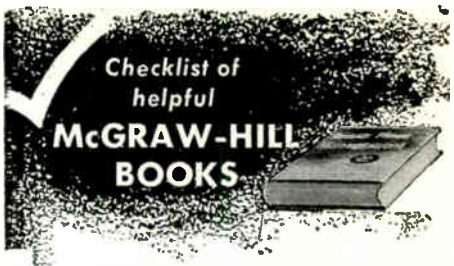

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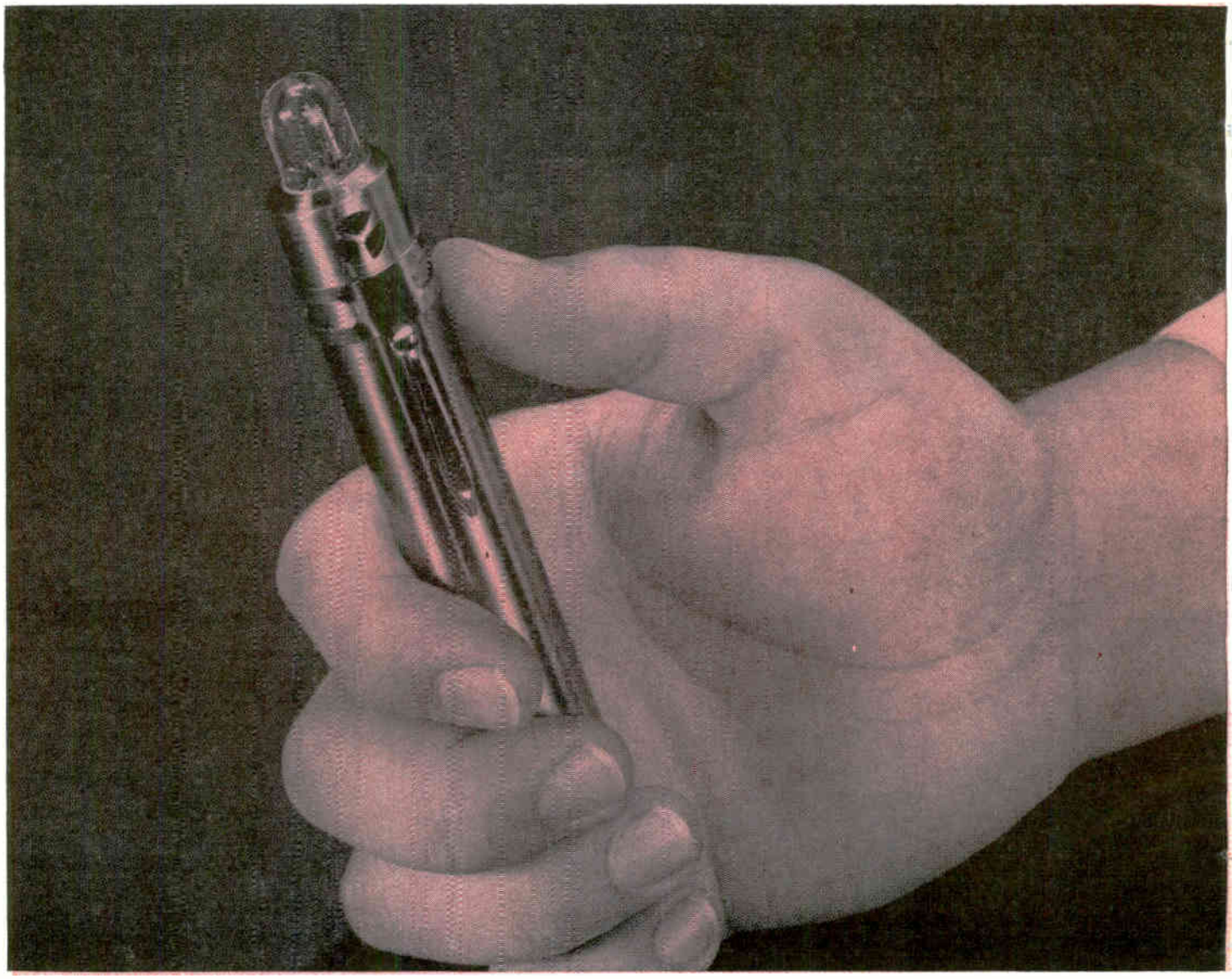
MALLORY MERCURY BATTERIES
for new sales appeal
in your products

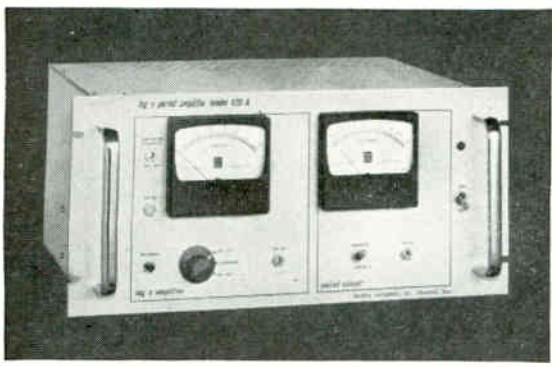


PERSONAL RADIATION MONITOR, developed at Oak Ridge National Laboratory, warns of radiation levels by flashing a neon lamp and sounding a tone in a hearing aid earphone. The transistorized circuit operates 24 hours a day for 30 days at a time, from power by a single Mallory TR-133R mercury battery.

Photo courtesy Oak Ridge National Laboratory
Operated by Union Carbide Corporation
For the U. S. Atomic Energy Commission

PORTABLE TRANSISTOR TEST SET is made by Metronix, Inc., a subsidiary of Assembly Products, Inc. Used as the DC power source, Mallory Mercury Batteries assure stable voltage over long periods of time, are undamaged by momentary short circuits, and provide long shelf life.

MICROMINIATURE TRANSMITTER, used for monitoring tooth wear and pressures and for other biomedical applications, is made by Varo, Inc. Small enough to be fitted into a dental bridge, it transmits information over short distances to a pickup/preamp, utilizing an RM-312 Mallory Mercury Battery smaller than an aspirin tablet.



A DUAL INSTRUMENT FOR REACTOR MONITORING, the log n Period Amplifier made by Keithley Instruments, Inc. gives extremely accurate low-level DC measurements. The constant voltage source used for calibrating this sensitive instrument is a Mallory Mercury Battery . . . chosen for its steady voltage and an accuracy within $\pm \frac{1}{2}\%$. Stable, long-lived Mallory Mercury Batteries are used as the power supply for several other Keithley instruments.

Miniaturize your new product . . . make it more portable . . . give it extra long service between battery changes . . . with Mallory Mercury Batteries. Pioneered by Mallory, these unusual batteries last 3 to 7 times longer than conventional batteries, depending on drain. They provide the highest watt-hours per pound of any commercially available primary battery. Sizes smaller than an aspirin tablet deliver ample energy for many miniature circuits.

Mallory Mercury Batteries have the unique characteristic of staying at constant voltage throughout their long life. This property is ideal for transistor circuitry . . . also proves useful in applying these cells as a highly stable source of voltage for reference or calibration. Voltage of cells coming from production varies no more than a few millivolts.

As for shelf life, we've tested mercury batteries held in storage for over six years: capacity loss was minimum. Steel case construction with molded grommet seal makes them free from leakage.

Choose from a broad line of standard single or multiple voltage cells . . . or let us develop a custom power pack for you. Write us for consultation and engineering data.

Mallory Battery Co., North Tarrytown, N. Y.
a division of P. R. Mallory & Co. Inc.

P. R. MALLORY & CO. Inc.
MALLORY

In Canada: Mallory Battery Company of Canada Limited, Toronto 4, Ontario
In Europe: Mallory Batteries, Ltd., Dagenham England

SHOCKING NEWS FROM EIMAC: there's now a 250-watt tetrode that can withstand shock of 90G for 11 milliseconds and vibration from 20-750 cps at 10G, with maximum rated voltages applied! It's Eimac's 4CX250R (shown 1½ times actual size). This new tube in the 4CX250B family is electrically equivalent to Eimac's 7580. The difference: the 4CX250R is ruggedized for extreme environments—as are other members of the family. And what a difference! Call your Eimac representative or write: Power Grid Tube Marketing, Eitel-McCullough, Inc., San Carlos, Calif.

Eimac

The Untouchables (Part 4)

Specify Crucible Charges of Deposited Hyper-Pure Silicon

Pre-packaged single piece crucible charges . . . in sizes and weights to meet the exact requirements of your Czochralski crystal growing equipment . . . are now available from Dow Corning.

Accurately Pre-weighed, these single piece crucible charges assure easy handling . . . smallest surface area . . . highest purity . . . an exceptionally clean melt and a savings in crucible costs.

High Quality is inherent in Dow Corning crucible charges. The *deposited* polycrystalline silicon in these charges has never touched a mold. Result — highest purity.

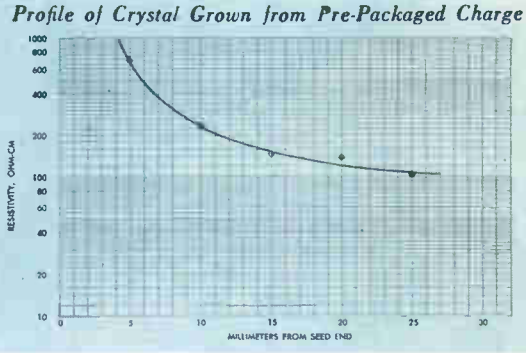
This High Purity means consistently higher quality crystals — simplifies doping procedures — increases device yield. Typical resistivity of N-type crystals grown from Dow Corning prepackaged crucible charges is greater than 100-ohms centimeter for 80% of the crystal; maximum boron content, 0.3 parts per billion atoms; maximum donor impurity, 2.0 parts per billion.

Now You Specify the Weight and Diameter, up to 38 mm (about 1½″), best suited for each crucible of your Czochralski crystal growing machines. Your crucible charges will be supplied in the appropriate length to provide the exact weight you require in just one piece.

Protective Packaging guards initial *deposited* purity right through crucible charging. Charges are individually wrapped in special cellophane, and sealed in airtight polyethylene envelopes to assure untouchable purity.

Whatever your need — deposited silicon crucible charges; polycrystalline rod or chunk; high resistivity P-type single crystal rod; single crystal rod doped to your specifications — Dow Corning should lead your list of sources.

Profile of Crystal Grown from Pre-Packaged Charge



Free brochure — "Hyper-Pure Silicon for Semiconductor Devices." Write Dept. 4218.

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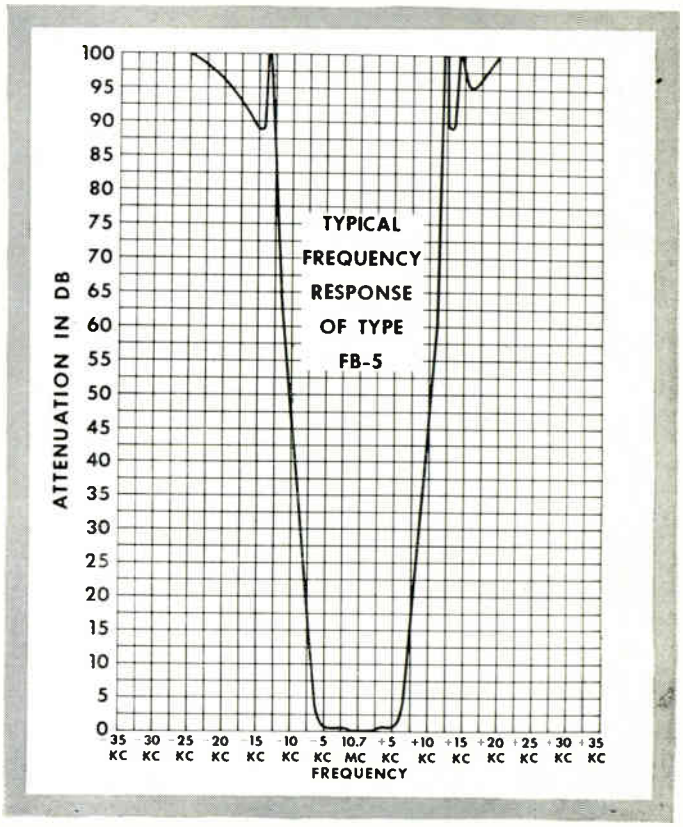
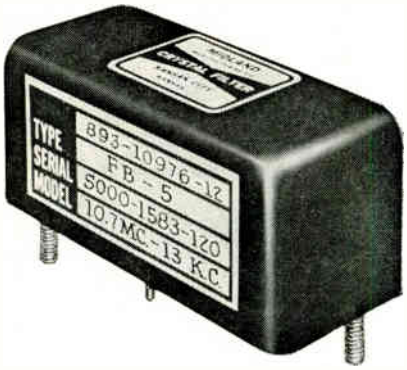
Dow Corning CORPORATION
MIDLAND, MICHIGAN
ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

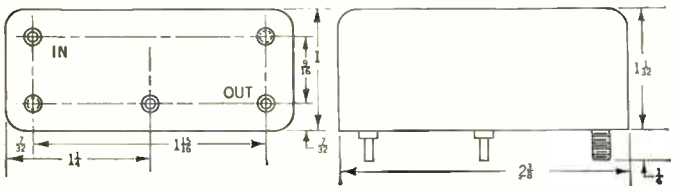
HAVE NARROW-BAND FILTER PROBLEMS?

A Midland "off the shelf" miniature crystal filter may be your answer to conserving space and reducing material and manufacturing costs

The Type FB Series is a group of hermetically sealed, eight-crystal, narrow-band filters that provide bandwidths in the range of 2 KC to 30 KC @ 6db, with a center frequency of 10.7 MC. Miniature in size, they are designed to operate in the environmental temperature range of −55°C to +90°C, with an insertion loss of 4db max. and an inband ripple of .8db max. Their specified ultimate rejection is 105db min. The type FB narrow-band crystal filter is ideally suited for design in two-way communication systems, telemetry systems, electronic instrumentation equipment and other applications where small fractional bandwidth filtering plus a high degree of selectivity and temperature stability is required. For further application information, write for ENGINEERING BULLETIN NO. NBS-102.







Specifications

	FB-2	FB-3	FB-5	FB-6	FB-8	FB-10
Center Freq.*	10.7±200 CPS	10.7±225 CPS	10.7±375 CPS	10.7±425 CPS	10.7±750 CPS	10.7±1 KC
BW @ 6 db Min.	2 KC	5 KC	13 KC	15 KC	20 KC	30 KC
BW @ 60 db Max.	3.6 KC	9 KC	23 KC	27 KC	36 KC	53 KC
60 db/6 db BWR Max.	1.8	1.8	1.8	1.8	1.8	1.8
BW @ 80 db Max.	4.5 KC	11.3 KC	26 KC	31 KC	41 KC	60 KC
Ultimate Rejection Min.	105 db	105 db	105 db	105 db	105 db	105 db
Req. Source/Load Resistance (R_o)	130 ohms	330 ohms	1 K ohms	1 K ohms	1.3 K ohms	2 K ohms
Inband Ripple Max.	.8 db	.8 db	.8 db	.8 db	**.8 db	***.8 db
Insertion Loss Max.	4 db	4 db	4 db	4 db	4 db	4 db
BW @ 1 db Min.	1.5 KC	3.8 KC	10 KC	11.5 KC	15 KC	21 KC

* Center freq. is the arithmetic mean of the frequencies at 6 db.
** 1.5 db max. ripple at the operating temperature extremes.
*** 1.8 db max. ripple at the operating temperature extremes.

Operating Temp. Range: −55°C to +90°C
Shock: 200 g
Vibration: 15 g to 2 KC
Max. Input Level: +10 dbm

Midland

MID 3-61

MANUFACTURING COMPANY, 3155 Fiberglas Rd., Kansas City 15, Kansas
WORLD'S LARGEST PRODUCERS OF QUARTZ CRYSTALS
DIVISION, PACIFIC INDUSTRIES, INCORPORATED

New Daystrom Series 319 Potentiometers Can Be Adjusted In Seconds After Ganging

It can be done. 24 cups of the Daystrom 319 Series potentiometers ganged within six inches. *Most important,* phasing of individual cups can be accomplished after installation, and with no interference to adjacent cups. Results: finite adjustments • many hours and dollars saved in installation costs • re-phasing in a matter of seconds!—■—The Daystrom 319 Series is ideal for multi-channel applications. Exclusive Daystrom design techniques result in unusual stability to shock, vibration, and other severe environmental influences. The 319 is rated at 2 watts in *still air,* operates over a range of −55°C, to 150°C, is available in resistances from 100 ohms to 200 kilohms, and meets or exceeds all applicable MIL Specs. Send for further data.

DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA

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CIRCLE 45 ON READER SERVICE CARD→

almost all major cities are defended with systems

that depend on Sperry electronic tubes

SPERRY

ELECTRONIC TUBE DIVISION

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GAINESVILLE, FLA.
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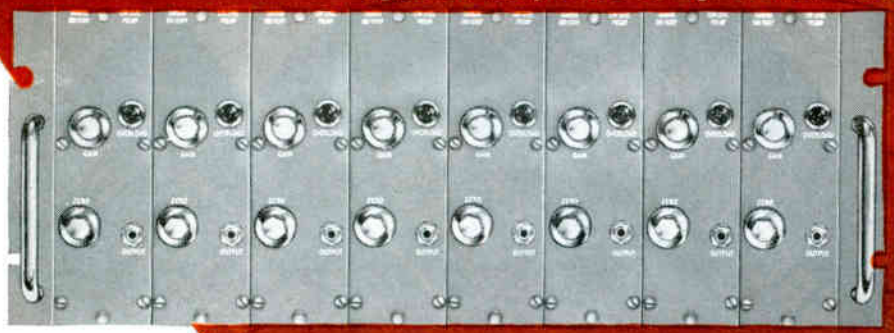
Model 860-1500P — handles low level DC data signals in the presence of high common mode



Model 658-3400 — drives high frequency optical galvanometers to 5 KC

COMPACT 7″ HIGH 8-CHANNEL UNITS ARE COMPLETELY TRANSISTORIZED, HAVE FLOATING INPUT ISOLATED FROM OUTPUT

Sanborn precision amplifiers

▼ Data Preamplifier — Model 860-1500P

Designed for precise, economical amplification of signals with source impedance of zero to 10,000 ohms, such as thermocouples, strain gage bridges, etc. in presence of severe ground loop noise, and for driving digital voltmeters, scopes, tape recorders and similar devices. Each plug-in unit is only 2″ x 7″ x 14½″ deep; 64 channels with blower require only 60″ of rack-panel space. Separate 868-500 Power Supply required for every 8 preamplifiers. Power consumption 2.5 watts per channel.

Noise	3 uv peak-to-peak
Gain	100 (10 mv in gives 1 v out) (Model 860-1500PA with gain of 1000 also available)
Output	± 1 v across 300 ohms, DC-70 cps; ± 1.5 v to 40 cps. Output impedance 100 ohms. (10 v across 10K available on special order.)
Linearity	± 0.1% of full scale output (2 v)
Common Mode Performance	120 db rejection at 60 cps, 160 db at DC, with 5000 ohms unbalance in source. Inphase tolerance 220VAC.
Input Impedance	Greater than 200,000 ohms
Gain Stability	± 0.1% for 24 hours
Drift	± 2 uv referred to input
Rise Time	to 99.9% less than 25 ms

▼ Optical Galvanometer Amplifier — Model 658-3400

Eight channels of amplification and common power supply. Each channel provides for sensitivity, compensation, damping and current limiting. Inputs floating and guarded, impedance 100,000 ohms on all ranges. All amplifier elements except output transistors are plug-in assemblies.

Sensitivity	± 10 mv input gives ± 400 ma output into 20 ohm load (max.). Eleven attenuator steps to X2000 in 1-2-5 ratio, smooth gain control.
Common Mode Performance	± 500 volts, max; rejection 140 db min at DC.
Gain Stability	Better than 1% to 50°C and for line voltage variation from 103-127 volts.
Frequency Response	0 to 5 KC within 3 db; can accomodate wide range of galvanometers.
Output	Output networks available for wide range of galvanometers.
Power Consumption	125 watts for 8 channels.

Your Sanborn Sales-Engineering Representative (offices throughout the U. S., Canada and overseas) will provide detailed information and application assistance. Call him or write plant in Waltham, Mass.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Massachusetts

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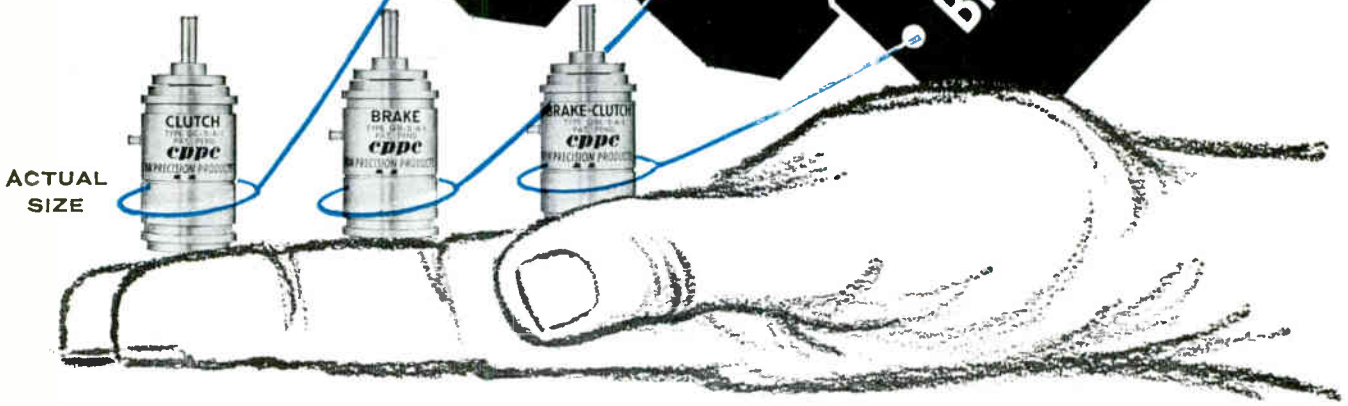
FROM CLIFTON PRECISION

SIZE 5 FREE CLUTCHES

SIZE 5 BRAKES

SIZE 5 BRAKE-CLUTCHES



- **GUARANTEED "NO-CREEP" DESIGN** (pat. pend.)
- **HIGHEST TORQUE PER WATT**
- **NO LOSS OF TORQUE DURING LIFE** (torque tends to increase)
- **NO TORQUE VARIATION WITH TEMP.**
- **OFF-SHELF DELIVERY**

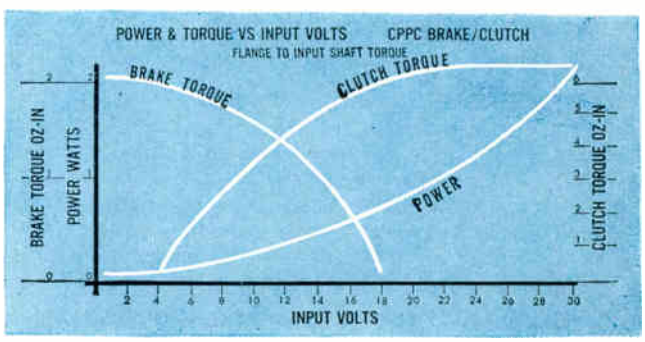
Well known as the quality manufacturer of highest accuracy and reliability synchros and rotary components, CPPC has now added to its line a series of optimum performance free clutches, brake-clutches and brakes.

These clutches were designed and fabricated for use in our Systems Division's Analog Navigation Computers as a suitable clutch could not be procured for sustained in-flight operation. They are designed to MIL-S-20708 and meet requirements of MIL-E-5400 and MIL-T-5422.

Write or call today for full information on these rugged size 5 components.

SPECIFICATIONS

Weight	0.97 Ounces
Minimum Engagement Voltage	6 Volts D.C.
Power Consumption	1.6 Watts at 28 Volts
Response Time at 28 Volts D.C.	2.8 Milliseconds
Inductance	0.33 Henries
Torque at 28 Volts D.C. Excitation	
Clutch	
Engaged (Minimum)	6.0 Ounce Inches
Disengaged (Maximum)	0.05 Ounce Inches
Brake	
Brake Torque (Minimum)	2.0 Ounce Inches
Polar Moment of Inertia	
Engaged	1.13 gm-cm²
Disengaged	0.78 gm-cm²
Backlash—Engaged	0 Minutes of Arc
Temperature Rise at 25° C	30° C



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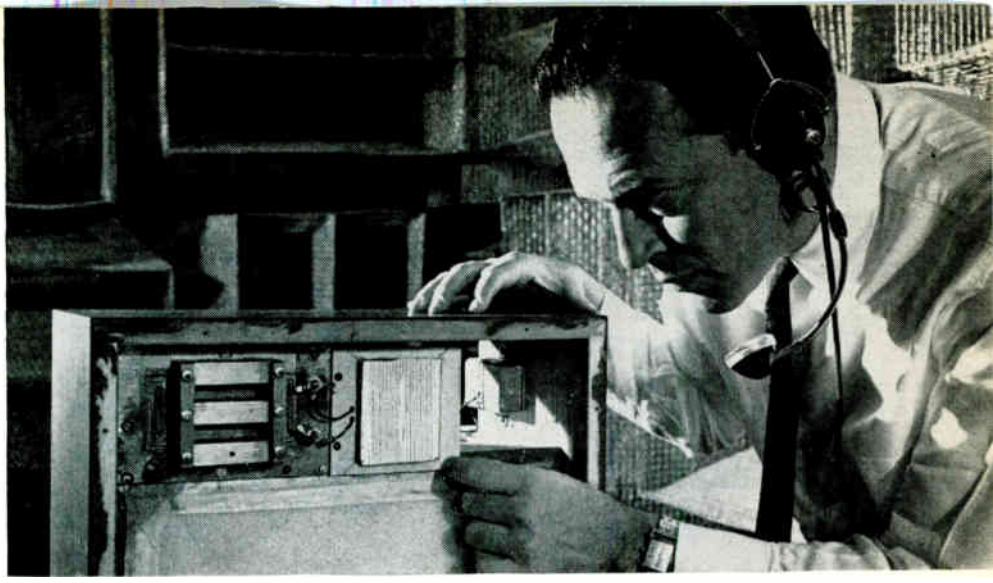
electronics
June 16, 1961



Speaker system showing treble unit at upper left, h-f unit at upper right and bass transducer below

Electrodynamic Loudspeaker Has Totally Active Surface

Nonresonant, pneumatically loaded bass unit and current-carrying sheet within a magnetic field for the higher frequencies give excellent frequency and transient response

By STANLEY R. RICH,
Vice President,
Bogen and Rich, Inc., Yonkers, N. Y.

THE SEARCH for a loudspeaker with a transient response as close to the ideal as possible, coupled with uniform frequency response free from resonance effects across the audio range, has occupied the talents of loudspeaker engineers for many years. Almost ideal transient and wide-range frequency response, free from excessive dips and peaks are produced by this new loudspeaker in which the radiating surfaces are true pistons. A 20-watt amplifier will provide ample sound volume for most home installations and the 8-ohm speaker system impedance requires no special matching transformers or networks.

When a pulse of current representing a signal from an audio amplifier is introduced into the voice coil of a conventional loudspeaker, mechanical forces are generated and coupled into the loudspeaker cone. In most good loudspeakers, the mechanical waveform follows the applied current and a pulse of elastic wave energy travels into the cone. The immediate result is an acoustical pulse having approximately the same waveform as the current pulse applied to the voice coil. The elastic wave energy can reflect back and forth between the inner and outer cone supports giving rise to a train of waves that may not have any harmonic relation to the initial current waveform, resulting in smeared or unclean sound.

One answer to this problem was the electrostatic loudspeaker that consists of a thin diaphragm active over its entire surface. A short voltage pulse applied to this loudspeaker causes movement over its entire surface. There are no parasitic or passive portions of the radiating surface that can store energy to continue to radiate unwanted and harmonically unrelated acoustic energy. Electrostatic loudspeakers are used where clean transient reproduction is required.

However the electrostatic loudspeaker requires a high polarization voltage and ionization may result in aging and possible breakdown of the transducer.

The treble transducer used in this new system concentrates its magnetic flux in a uniform sheet and uses a totally active diaphragm as shown in Fig. 1B. There is no inactive portion of the radiating surface and the acoustic output almost exactly follows the current introduced into the voice coil. The membrane supporting the aluminum wire voice coil is made from airtight, very-thin treated paper having an accordion pleat (for mounting) on all four sides. Six bar magnets are arranged in a soft-

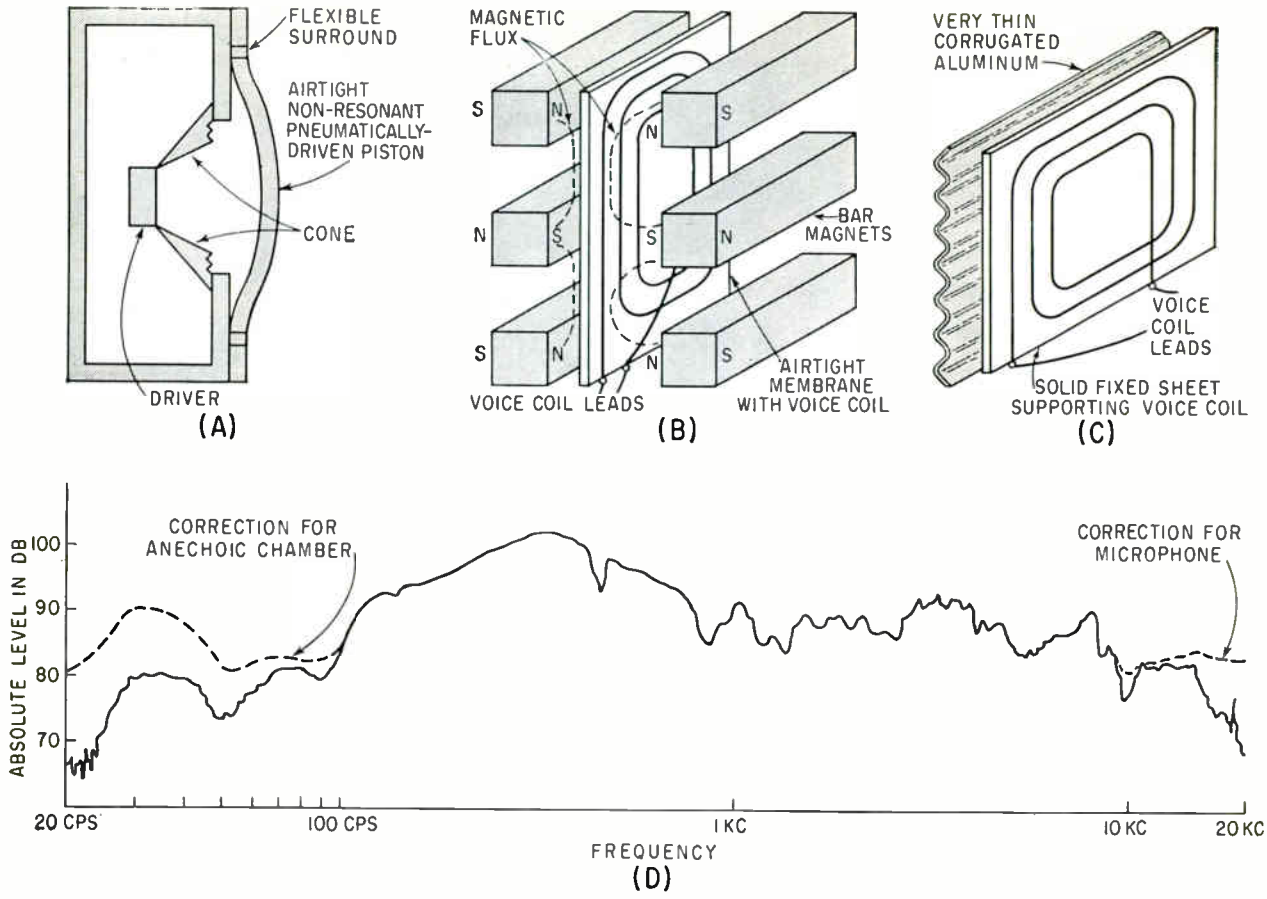


FIG. 1—Configurations of bass unit (A), treble unit (B) and h-f unit (C) result in response curve (D)

steel yoke so that like poles face each other. As the membrane is magnetically transparent, the magnetic fields mushroom to form a uniform sheet.

Transient response was tested by the circuit shown in Fig. 2A. The sawtooth waveform, generated within the oscilloscope, is differentiated then passed through a high-quality audio amplifier and into the transducer under test. The microphone was placed a few inches from the loudspeaker and its output displayed on the oscilloscope vertical axis. This produces perfect synchronization of the viewed pulses. Figure 2B shows the new loudspeaker response to a pulse with a 250 μsec duration and a repetition rate of 250 pps. Secondary energy, shown just to the right of the main lobe, is approximately 20 db down and represents a relatively small amount of unwanted signal energy. A conventional cone-type loudspeaker that included a dome structure for improvement of the higher frequencies produced the waveform shown in Fig. 2C. Another cone loudspeaker in which damping material had been introduced both on the cone surround rim and on the spider support, produced the waveform shown in Fig. 2D.

In low-frequency transducers, problems to do with long wavelength at low frequencies and the small size of conventional radiators must be solved. Varieties of solutions have been made and the two most successful are the sealed cabinet air stiffness loudspeaker and the corner horn. To be totally effective, the corner horn must be large and it is further limited by room placement. The sealed cabinet air stiffness units have been widely accepted although the small radiator size results in extremely large cone excursions. In many cases, a pronounced resonance peak occurs at the frequency at which the cone mass resonates with the sum of its own support stiffness and the stiffness of the enclosed air. The new bass transducer uses a relatively small cone excursion and reduces resonances to a minimum.

The loudspeaker radiation resistance falls off sharply with frequency below that frequency at which the circumference of the radiating surface (ideally a piston) is comparable with a wavelength of sound at the particular frequency. It is desirable to have as large a radiating surface as possible so that actual air displacement, and therefore distortion, will be minimized. Various types of horns attain this objective and are able to couple relatively small diameter driver units to large areas of driven air. However, the horn is physically large and usually requires corner placement.

The new bass unit uses pneumatic coupling of a conventional low-frequency loudspeaker to a nonresonant piston in a closed-cell, foam-polystyrene dome as shown in Fig. 1A. An eight inch driver is adequate to produce piston or plane-wave motion of the secondary radiator from below audibility to approximately 1 Kc. By choosing a secondary radiator of approximately 12 × 18 inches, excursion requirements for a given power output are cut considerably when compared to an ordinary cone-type

low-frequency loudspeaker. The overall audio result is extremely smooth from the lowest frequencies up to and through the crossover region.

At all frequencies within the range of this transducer, the distance from the driver to the secondary radiator is small enough so that the entrapped air can be considered nearly incompressible. Thus, in the same manner as a hydraulic lifting jack, or hydraulic ram, the driving unit is coupled by a substantially incompressible fluid to each area of the polystyrene piston. Consequently, a relatively small diameter drive unit is linked to a nonresonant radiating surface of much larger area. While the area of a 12 × 18 inch radiating surface is the same area as that of the radiating surface of an 18-inch diameter cone (21-inch speaker), the radiating piston is driven and controlled uniformly over its entire surface by the incompressible pneumatic connection between the driver and the radiating piston.

Unlike other attempts to couple a driver to a flat radiating surface, the polyfoam radiator is treated to render it nonresonant so that it will not introduce coloring of its own to change the tonal characteristics of the audio signal. The polyfoam radiator piston is supported by extremely flexible mounting material to prevent resonances. If the piston were clamped or restricted at any point, flexural resonances would appear to seriously distort and modify transducer response. Actual excursion of the low-frequency piston, when driven to maximum output, is as much as ½ inch at the lowest frequencies to be reproduced. Substantial amounts of sound are radiated at the low frequency end of the spectrum with almost no visible movement of the large radiating surface.

In the bass reproducer the acoustic loading of the large radiator by radiation is greater than the magnitude of the combined mass reactance per unit area of both the radiating piston and the driver cone. The eight-inch driver cone mass is distributed over the surface of the radiating piston by the mechanical advantage in the design. Over most of the range, this mass is controlled by the outside air tending to damp vibrations and minimize after images once the transient has died.

To complete the loudspeaker system, a third element uses the magnetic field generated by the distributed driver coil of the treble unit above 7 Kc. As in all coils, the reactance is finite and becomes equal (in this case) to the resistance of the wire itself at approximately 6 Kc. Above this frequency, the inductive reactance becomes appreciable and limits the current that can flow into the distributed driver coil when driven by a constant-voltage source. This tends to reduce high-frequency performance. By mounting a thin corrugated aluminum diaphragm near the driver coil, or as a separate entity as shown in Fig. 1C, current induced in this secondary radiator results in acoustic output to well beyond 20 Kc. The crossover is automatic and occurs only at the frequency where the induction field can induce substantial current in the thin aluminum sheet. The secondary radiator is self damping as any motion of its own results in a counter electromotive force being generated within the aluminum. This eddy current braking results in excellent transient response even at extremely high audio frequencies. This is implicit in Fig. 2E which shows the performance of the loudspeaker system with an input of 125 μsecs unidirectional pulses at a 2 Kc repetition rate. There is only the slightest trace of overshoot and after image.

This type of self-correcting performance is not available in electrostatic reproducers and this self damping or eddy current braking characteristics is unique and inherent in this loudspeaker.

The overall response is shown in Fig. 1D and a photograph of the 31 cps acoustic output waveform is shown in Fig. 3, both taken at 5.5 w input. This overall response is a complete system curve and includes the effects of all elements including transducers and crossovers.

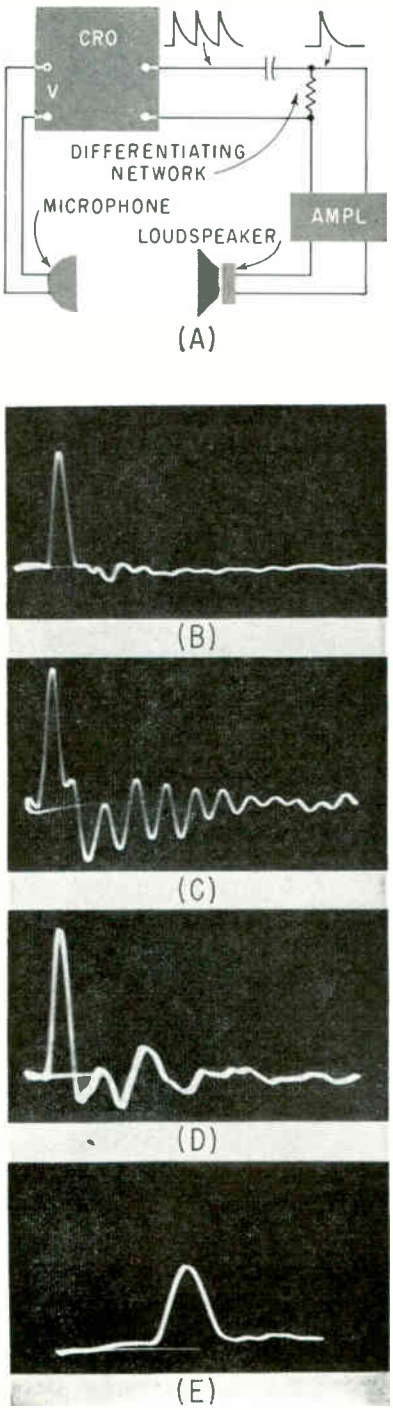


FIG. 2—Transient response testing circuit (A) with loudspeaker response to 250-usec, 250-pps pulse (B), conventional loudspeaker (C) and damped loudspeaker (D). New loudspeaker response to 125-μsec, 2-Kc pulse at (E)

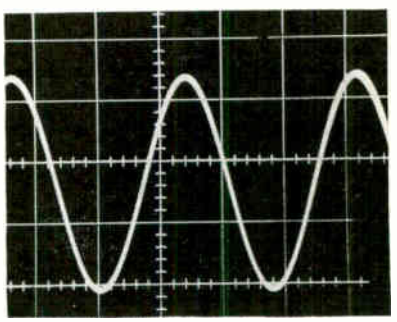
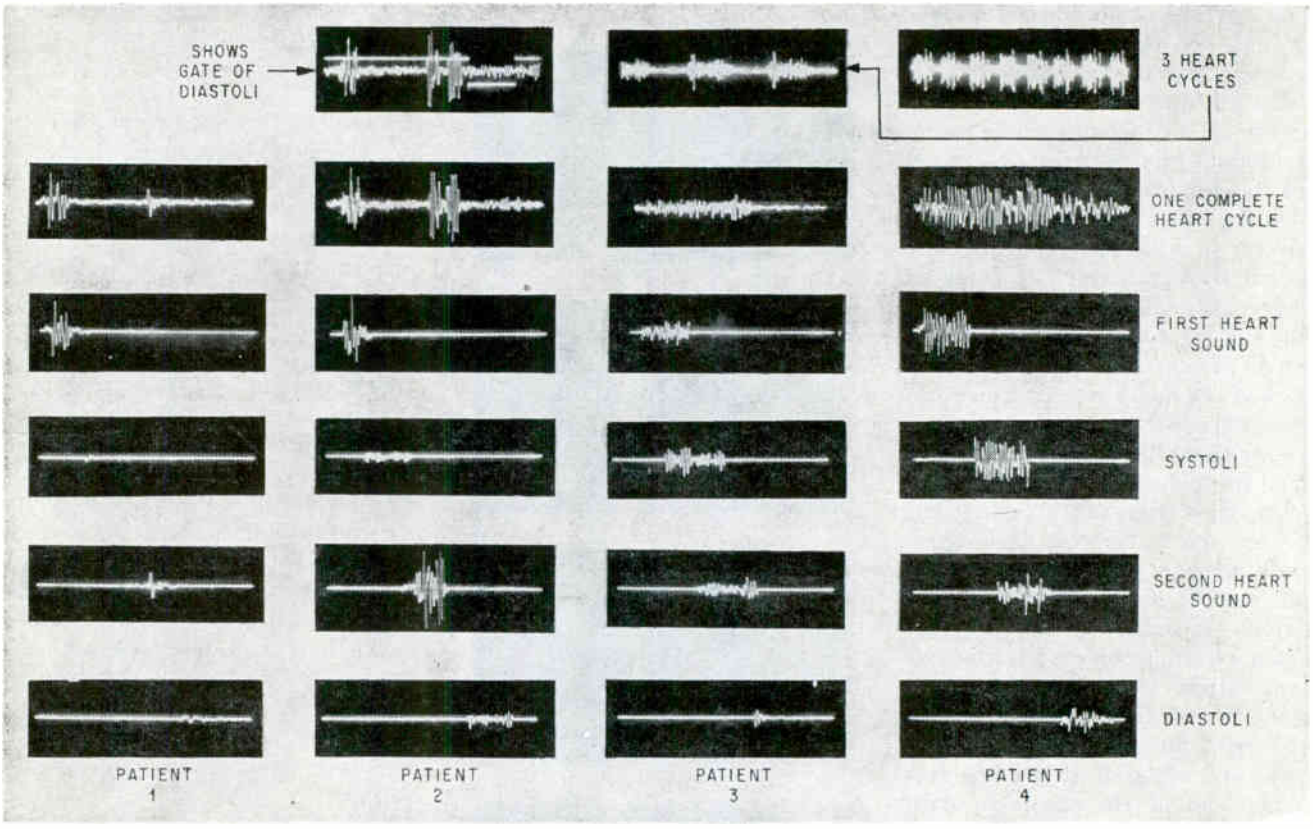


FIG. 3—Unretouched 31-cps acoustic output waveform

Heart-Sound Discriminator Simplifies Medical Diagnosis

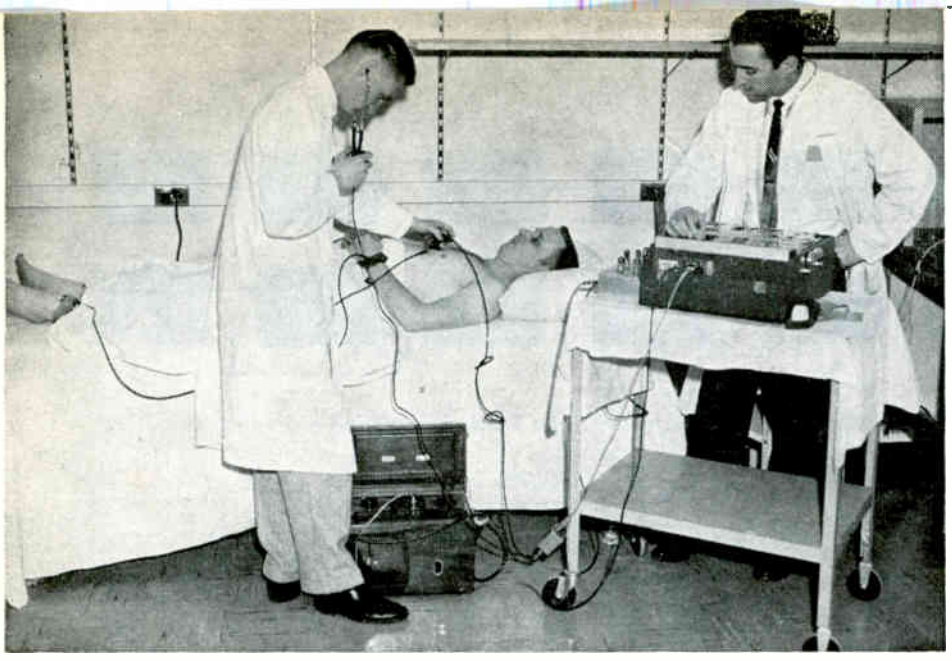
Electronic stethoscope, using sliding gate, permits physicians to listen only to those portions of a heart sound that are of interest. Circuit can be adapted for other areas where a large-amplitude signal masks an immediately following low-level one



Patient 1 is normal, others have different types of heart disease. To the untrained ear, sound from all are similar

By RICHARD WEISS,
Dept. of Electrical Engineering,
Seattle University,
Seattle, Washington

SELECTIVE ATTENTION to specific heart sounds has been used by the medical profession with great success for the past 50 years. Developing an educated ear requires about 3 years of practice and drill and is comparable with training the ear of a musician or piano tuner. This article describes the design, development and use of an electronic heart-sound analyzer that performs the same selection of specific heart sound intervals a physician in cardiology requires about three years to learn. It sidesteps the process of learning to selectively focus attention to certain low-frequency heart sounds while ignoring others. The physician learns to listen to these (lub-dub lub-dub) sounds (Fig. 1) and choose a portion of them for his attention.



Patient's heart sounds and electrical timing signals are recorded on tape

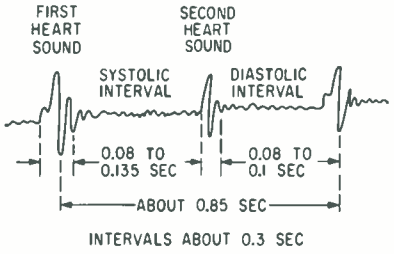


FIG. 1—Normal heart sounds

Heart trouble first appears as variations in the first and second sounds and rumbling or whirring noises in the systolic or diastolic interval, generally described as murmurs.

Since the human ear is relatively insensitive to low audio frequencies, large amounts of low-frequency power (such as heard through a stethoscope) are required for perception. The ear is also insensitive during a short recovery period immediately after such large-amplitude sounds. This makes it difficult to detect low-level sounds (such as made by murmurs) immediately after the large-amplitude, low-frequency sound. A long training period is required before the physician learns to selectively differentiate between them.

A self-synchronizing electronic gate, similar to the sliding gate used in radar range-finding systems, has been developed for selectively listening to heart sounds. The electronic circuit automatically discriminates chosen heart sounds with respect to a time reference. An overall block diagram is shown in Fig. 2. The heart sounds are picked up from the patient's chest wall by a contact microphone. These signals are recorded on one track of a two-track tape. Time reference signals are recorded on the other track. The tape is played back through the electronic analyzer that can be preset to gate the desired sound into the audio channel.

For time-reference heart-sound discrimination, the electronic circuit must have three properties: it must be able to synchronize with the heart sound within 100 μsec or less and therefore requires an event in the heart cycle that is constant and unique for a trigger; it should not operate for some predetermined length of time after the trigger and then should pass the chosen heart sound undistorted for another predetermined time, after which it shuts itself off until the next trigger pulse arrives; it should not introduce spurious signals within the heart sounds. The last requirement presents a problem as the energy content in the low-frequency heart sound resembles the energy content in the gating waveform.

The most constant and unique event in the heart cycle is the electrical discharge that activates the heart muscle. This does not originate in the brain but in an area of the heart tissue known as the sinus-node. The electrical discharge is propagated through the tissue, which is a resistive medium, at a relatively low velocity compared with the velocity of light. Two electrodes, placed anywhere on the skin, will generate a 1 to 2 mv potential difference because of the time difference of the passage of the electrical wave. This waveform is commonly used as a diagnostic tool in electrocardiograms (ekg's).

The electrical signal is picked up by the two electrodes and amplified in a high-gain differential amplifier. Noise common to both electrodes will be rejected at approximately 20,000 to 1 and only the potential difference will be amplified. This way, a pulse of 1 to 2 mv can be detected in noise in the order of volts. The signal is amplified and shaped to drive a trigger multivibrator as shown in Fig. 2. The trigger multivibrator level and sensitivity controls are adjusted to select the points on the input waveform at which the multivibrator will trigger to produce a single, sharp waveform. The overall result is a unique and constant trigger from the heart cycle, accurate to better than 100 μsec.

Many conventional time base circuits can be used to generate the gate-driving waveform. The arrangement shown in Fig. 3 was used. Two variables affect delay multivibrator V_1 cycle time—the grid bias of V_{1A} and the time constant in the grid circuit of V_{1B}. The grid bias is determined by a voltage-divider network and the one-shot cycle time is determined by potentiometer R_1 and capacitor C_1. The signal at the plate of V_{1B} is differentiated and then clipped at V_2. This pulse is used to start gate multivibrator V_3 through its one-shot cycle. The output from V_3 overdrives V_4 thus squaring the top of the rectangular waveform.

Extraneous noise emulating heart sounds arises from the gating waveform, which has an energy spectrum resembling the lower-fre-

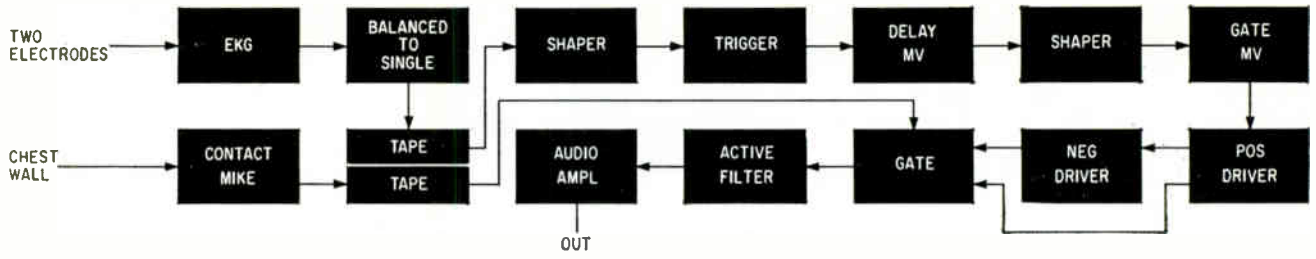


FIG. 2—Heart sounds from a contact microphone are recorded on one tape track ekg timing pulses on the other

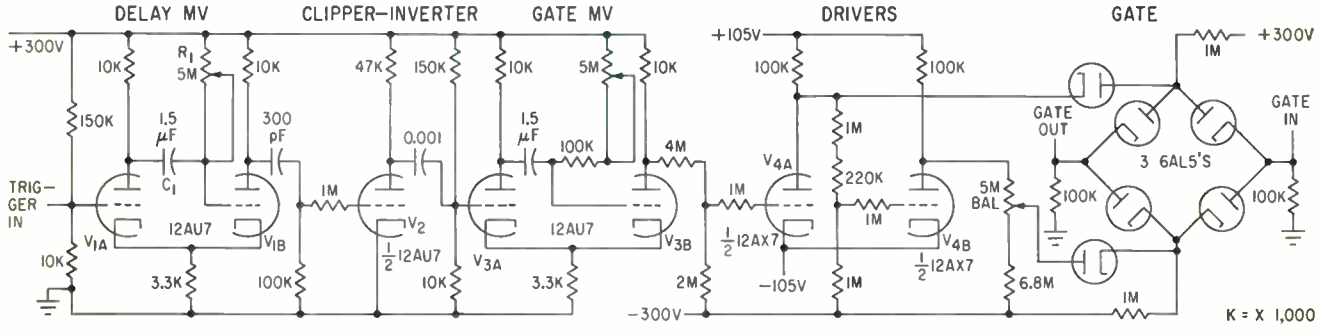


FIG. 3—Delay multivibrator determines time position of gated interval to pick up desired heart sound

quency heart sounds. The gate must be of the pedestal-free type; otherwise the pedestal would contribute measurably to the heart sounds. The gate must open and close as the heart sound is crossing zero because at any other point a transient would be introduced with an energy content close enough to that of the heart sound, thus causing an extraneous signal.

Design of pedestal-free gates is handled thoroughly in references 1 and 3. A six-diode gate, such as shown in Fig. 3 gives the best performance in this application. The unusual part of the design is the balanced push-pull driving system V_{4A} and V_{4B}. Both sections are overdriven, grid-current-limited stages leveled symmetrically at ground.

A residual spike in the gate output opening and closing will remain no matter how carefully the outputs are balanced. Analysis shows that this is due to variation in diode characteristics and may be minimized by selecting pairs of matched diodes. Figure 4A illustrates the spike-producing mechanism inherent in the gate. This effect may be reduced by operating the gate at a high level. The noise due to different diode characteristics is a constant, independent of operating level, and is always only a few hundred millivolts. The gate may be operated at a 20-volt level without distortion. The signal is attenuated again in passing through the filter and this results in some reduction in the signal-to-noise ratio but it has little effect on the overall response. The overall signal-to-noise ratio is in excess of 100. The gate acts as a nearly perfect device. The major problem is noise introduced by the sharp rising waveform if the gate opens during a time other than a zero crossing of the heart sound. This is shown in Fig. 4B and 4C.

To prevent this, the system must be designed so that gate opening will occur only when the signal is passing through zero. This instrument uses a filter with a sharp cutoff just above the highest-frequency heart sound (about 600 cycles for the patients studied). Active filter sections were designed and tested so as to produce no distortion in the heart sound while effectively causing zero-crossing gate opening. This method had the disadvantage of introducing some extraneous voltage variation in the transmitted signal at the instant of gate opening and closing, but this was imperceptible to the human ear. See Fig. 4D.

The complete active filter circuit is shown in Fig. 5. It is a two-section low-pass filter, buffered with a feedback loop to give the optimum cutoff characteristics.

Two variables determine the specific transfer function: the ratio of R_1/R_2 and gain G in the feedback loop. For optimum flatness of response a gain of 0.92 in the feedback loop and a ratio of R_a/R_b of 1 to 10 are required. The response is adequate to give a zero-crossing gate opening effect. The heart sound may be passed through this filter and the effect of the filter cannot be detected either by the human ear or on an oscilloscope.

Records of patients' heart sounds with trigger pulses were stored permanently on two channels of stereo-type tape. Ordinarily levels of channel isolation were more than adequate to keep the triggers out of the heart sounds. This also facilitated recording since only the tape recorder and a circuit capable of generating synchronous pulses with the ekg need be transported to the bedside. Some typical recordings and their gated responses are shown in the photographs. Each vertical column represents a patient with a different type of heart condition. Each horizontal row, except the uppermost row of 3 photos, represents the same gated interval. The first row having 4 photos is the sound from a complete heart cycle. Note the difference in waveform from left to right. The left hand column represents a patient with a normal heart while the other three

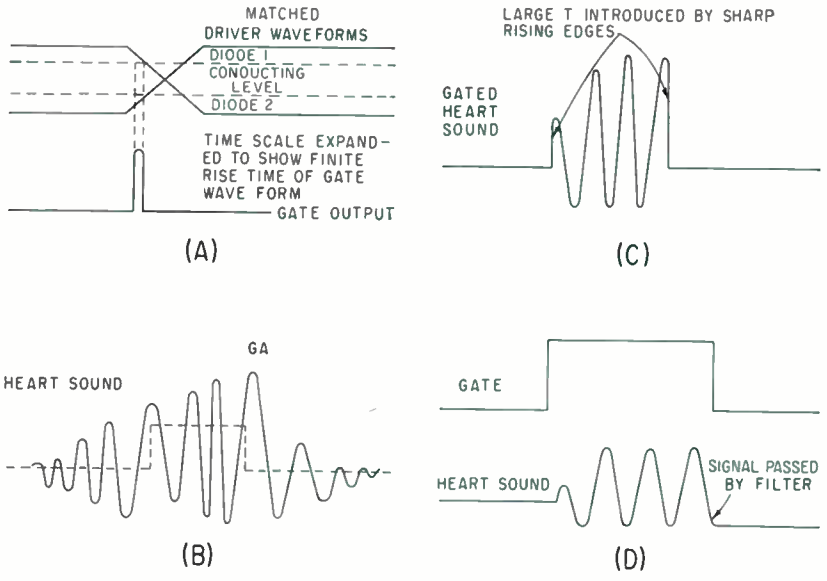


FIG. 4—Noise pulse resulting from one diode switching earlier than other (A). Heart sound and gate (B) showing resultant heart sound (C). Heart sound passed by filter (D)

columns represent individuals with serious heart conditions. To the untrained ear the complete sounds of all four patients are similar. Row 2 shows the gate adjusted to select only the first sound from each patient. The normal-patient sound is a sharp rap. Note the variations in the diseased conditions. Row 3 shows the gated systolic interval (the ejection period). This period is relatively quiet in the normal heart. Murmurs exist in the diseased condition and they appear as whirring or blowing noises in this interval. They are of low amplitude relative to the first and second sound and are difficult to recognize in context. Row 4 is the gated second sound. Patient 2 has a split second sound. This is perceptible only using the gate. Patients 3 and 4 have so much regurgitation of blood during diastole (filling period of the heart) that location of the second sound becomes difficult. Row 5 is the gated disastole. The major murmur occurs in patient 2. The audible characteristics of this sound may be isolated and studied out of context.

The error in gated intervals due to the patient's arrhythmia is inherent in the device and must be compromised. The delay and gate width remain fixed as the patient's heart rate changes so that although the system retains perfect cyclic synchronization, different intervals are gated producing a confusing effect as the gate slides from heart sound to interval and back to heart sound. This is apparent only for narrow gate widths and when trying to select a sharply defined point in the heart cycle. The best countermeasure is to keep the patient as quiet as possible to avoid arrhythmia but with certain types of heart disease this is impossible.

The design developed to assure zero crossing gate opening introduces a certain amount of error in the signal. To date, this is not a serious limitation in the patients thus far studied but conceivably it could become important with certain types of heart sounds.

The possibilities of this device have only begun to be exploited. Some of its users are: training of student and resident medical personnel, clinical diagnosis and mass examination of school children.

It is possible that other applications will develop as the information gained from gating time samples of heart sounds becomes available in larger quantities.

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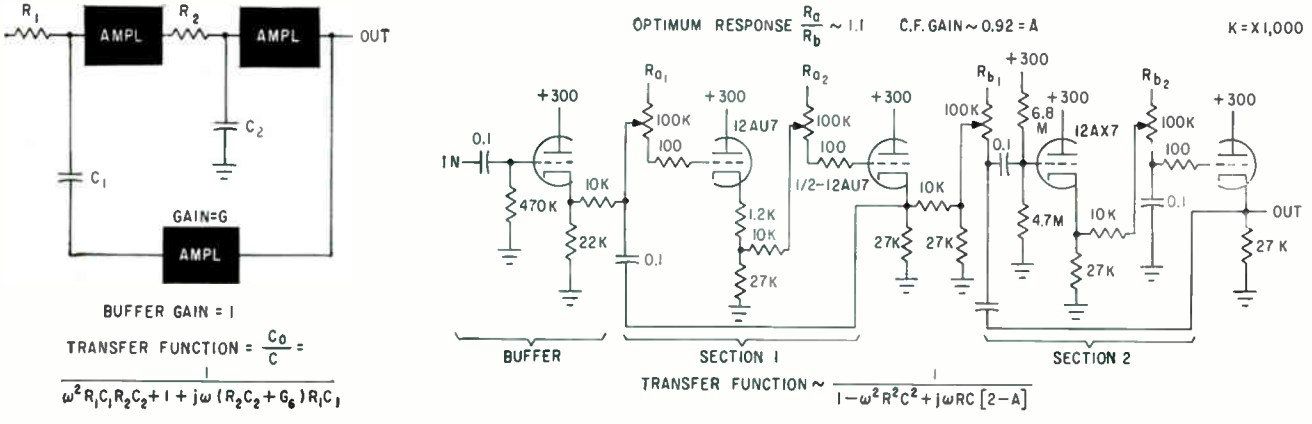
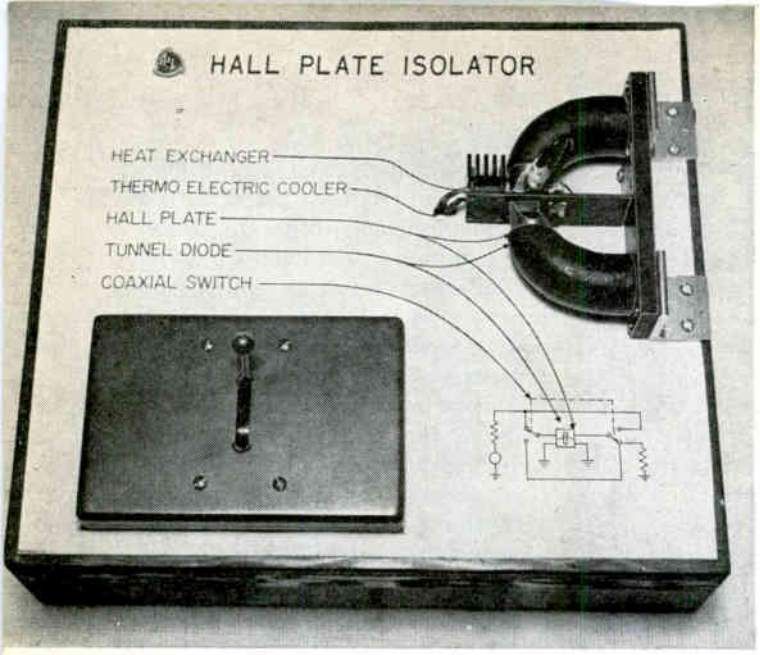


FIG. 5—Active filter is composed of two sections and has a rolloff of 12 db per octave above approximately 900 cps



Demonstration of the Hall plate isolator shows thermo-electric cooler. Coaxial switch is at lower left

Microwave Isolator Combines Hall Effect and Tunnel Diodes

By C. H. HUBBARD,
L. A. LoSASSO and E. ROUSSO,

Airborne Instruments Laboratory,
Deer Park, New York

SOLID-STATE HALL PLATES, immersed in static magnetic fields, can be combined with shunt resistors to yield unidirectional circuit elements[1] or isolators. If negative shunt resistors are used, the isolator can be made lossless or even provide forward amplification.

Since the Hall effect is a majority-carrier phenomenon, unlike the action in a transistor, the bandwidth of the Hall plate is restricted only by the dielectric relaxation time of the material, which is of the order of 10^{10} cps. Because tunnel diodes provide negative resistance and extremely large bandwidths are possible, the combination should yield an isolator or unidirectional amplifier with bandwidth hitherto unattainable with solid-state devices. However, problems have prevented the realization of useful gain-bandwidth products and have limited untuned devices to near the audio range[2].

The nonreciprocity of a Hall plate, determined by the Hall angle, is a function of the product of mobility in the semiconductor and the applied magnetic field, assuming one type of carrier. This dimensionless product must be substantially greater than unity; for a field of 5,000 gauss a mobility in excess of 20,000 sq cm per volt-second is required. This can be achieved with certain compound semiconductors, for example, HgTe, InAs and InSb. The last has the highest known electron mobility, 65,000 cm^2/v-sec at room temperature. Unfortunately, high-mobility materials have a low energy gap and therefore a high intrinsic carrier concentration at room temperature. This results in a high and temperature-dependent conductivity. It is difficult to make a Hall plate of these materials that has an impedance level as high as 1 ohm at room temperature.

The stability requirements on tunnel diodes, specifically the necessity of preventing oscillation due to the inductance of even the shortest leads, call for an impedance level of the order of ten ohms. Therefore, experimental arrangements with impedance transformers have been used[2, 3], with circuits resembling that in Fig. 1A.

In this circuit the functions of isolation and amplification are separate. Isolation occurs within the dashed rectangle, being provided by the Hall plate and associated positive resistances[1]. A minimum insertion loss of 6 db will be encountered that is more than overcome by the tunnel diode or diodes.

Problems associated with impedance transformers severely limit the bandwidths that can be obtained with this configuration (10 Kc at AIL). It is difficult to build a transformer with leakage reactance much below the 1-ohm level of the Hall plate over any bandwidth; a 10-nanohenry leakage inductance will limit the bandwidth to 20 Mc. Therefore impedance transformation, tuned or untuned, is undesirable. It is thus necessary to fabricate Hall plates with higher impedance levels.

In semiconductors with a large electron/hole mobility rate, such as InSb, the conductivity at a given temperature can be substantially reduced by acceptor doping, without affecting the Hall angle. If at the same time the plate can be cooled, further reduction in conductivity can be achieved. Using InSb doped with zinc having carrier concentrations of 10^{16} and 5×10^{15} per cu cm, and small commercially available thermoelectric coolers, Hall plates have been fabricated with impedance levels of 25 ohms, a convenient value for use with tunnel diodes. The thermoelectric cooler also provides an additional adjustment of circuit parameters, necessary because of the inflexibility of tunnel diodes and permanent magnets.

Another difficulty with the isolator of Fig. 1 is that ground reference is lost on passage through the device. This prevents the building of a single-ended amplifier without the reintroduction of transformers, and necessitates separate and isolated bias supplies for each tunnel diode. To avoid this a three-terminal Hall plate was used in the configuration in Fig. 1B.

The three-terminal Hall plate can be described by the impedance matrix[4]

$$\begin{bmatrix} R_c & R_c(\frac{1}{2}+\alpha) \\ R_c(\frac{1}{2}-\alpha) & R_c \end{bmatrix}$$

where R_c is the resistance between

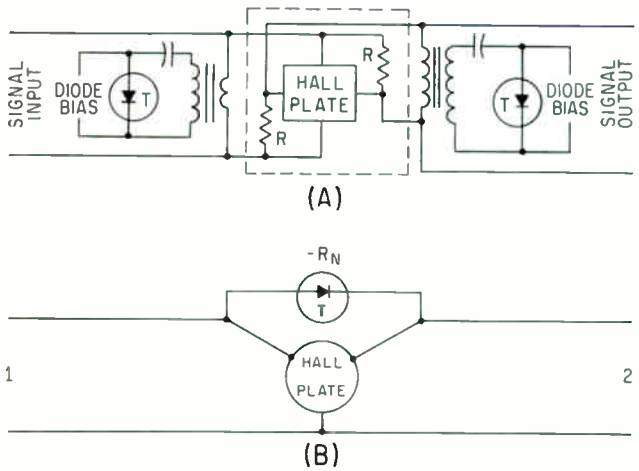


FIG. 1—Experimental isolator circuit involving impedance transformers (A); the three-terminal Hall plate with tunnel diode (B)

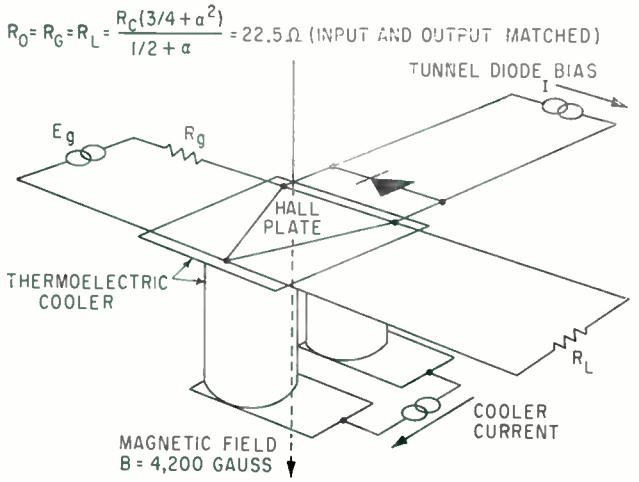


FIG. 2—Circuit arrangement used in experiments, showing the Hall plate and thermoelectric cooler. Type 1N2941 tunnel diodes were used

any two terminals, and α, a measure of the nonreciprocity, is a function only of the Hall angle. For each value of R_r and α, there are two possible values of the tunnel diode negative resistance that result in perfect isolation. The magnitudes of these will be denoted by R_{NG} and R_{NL}, and are given by $R_N = R_r\ (3/4 + \alpha^2)/(1/2 \pm \alpha)$. The plus sign is associated with R_{NG}, and results in isolation in the 2 → 1 direction. The available gain in the 1 → 2 direction is given by $G\ (1 \rightarrow 2) = [\alpha/(1/2 - \alpha)]^2$. For values of α greater than 1/4, the transmission from port 1 to port 2, $G\ (1 \rightarrow 2)$, is greater than unity, resulting in power gain in the forward direction (hence the subscript G on R_N). If a diode of value R_{NL} is used, isolation is obtained in the 1 → 2 direction, whereas transmission in the 2 → 1 direction, the power gain is $G\ (2 \rightarrow 1) = [\alpha/(1/2 + \alpha)]^2$. This is always less than unity, resulting in a net insertion loss and the subscript L on R_N. Both values of R_N are in excess of R_r, thus satisfying the d-c stability criterion on the tunnel diode. The Hall plate is also the stabilizing resistance of the bias supply, eliminating bypass and blocking components.

The input impedance of the isolator is given by $R_{in} = R_r\ (3/4 + \alpha^2)/(1/2 \pm \alpha)$, where the minus sign is associated with the low-loss, or gain, mode of operation. Additional interstage gain can be provided by placing tunnel diodes across the input and/or output impedance of the isolator. If three diodes are used, the configuration has been termed by Shockley and Mason[5] the dissected amplifier.

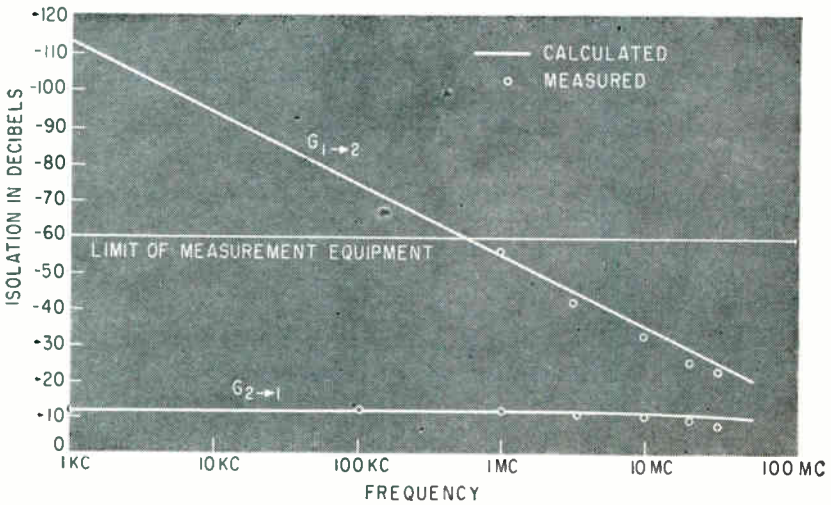


FIG. 3—Isolation achieved using type 1N2941 (solid lines) and type 1N3128 tunnel diodes plotted against frequency

Experimental results have been obtained using the three-terminal isolator configuration of Fig. 2, without the interstage diodes, in both the high and low-gain modes of operation, by varying the Hall plate temperature with the thermoelectric cooler. Even at the relatively high impedance levels, the lead inductance of the tunnel diode is a serious problem. Conventional diode packages and ultra-low inductance packages are both unacceptable; the required lead inductance is less than 10 nanohenries. The experimental arrangement is shown in Fig. 2. Typical gain-bandwidth products of 200 to 300 Mc could be obtained using available tunnel diodes.

Figure 3 summarizes results obtained with 1N2941 tunnel diodes.

The authors acknowledge the assistance of J. P. Madigan and J. Papas.

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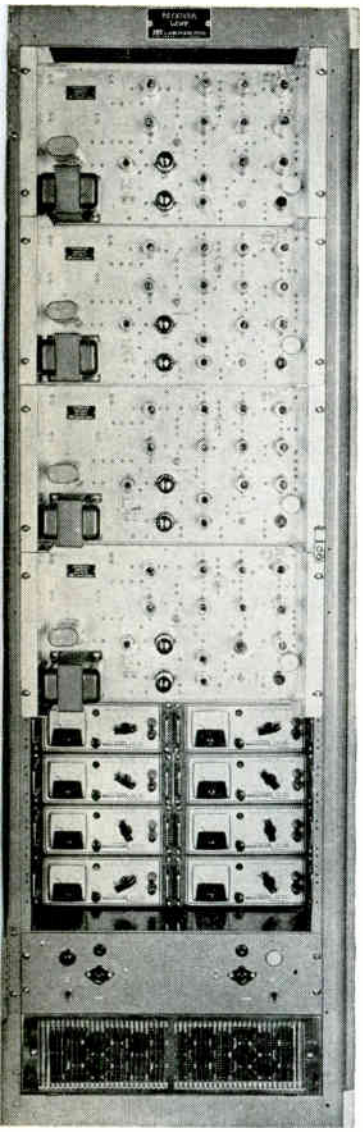
Video Distribution Amplifier

Automatic-gain-controlled amplifier handles comparatively high input and output levels over a large bandwidth

By HERBERT H. NAIDICH ITT Federal Laboratories, Nutley, New Jersey



Installation shows four distribution amplifiers and power supplies

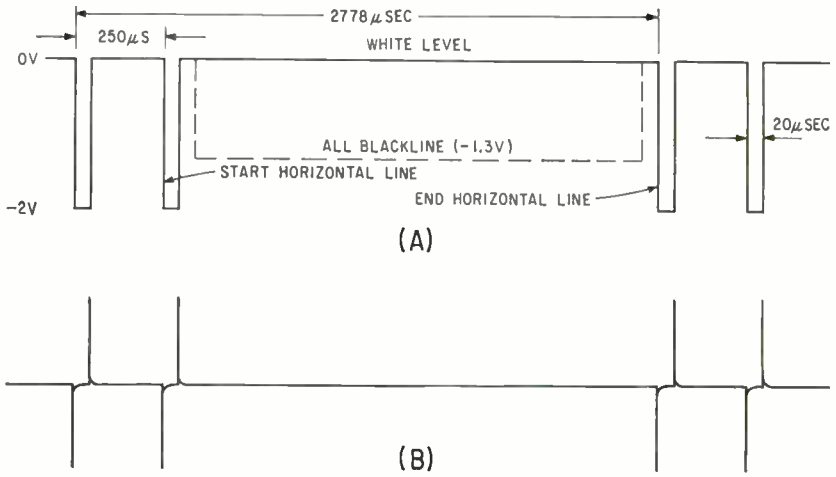


FIG. 1—Composite video (A) and differentiated sync pulses (B) for system

THIS VIDEO DISTRIBUTION amplifier was designed for a high-speed facsimile system. It was used both at the transmitting and receiving ends. The composite video signal is shown in Fig. 1. It is similar to tv video. The amplifier is suitable for tv work with only minor modifications to the sync circuits.

Although amplifiers with automatic gain control are common, in this amplifier: (1) Input and output signal levels are comparatively high, causing problems in linearity; (2) a 1.5 cps to 12-Mc bandwidth is needed; (3) the d-c component must be preserved; (4) a high degree of regulation must be maintained; and (5) d-c drift must be low. Amplifier specifications are shown in the table.

The block diagram of the amplifier is Fig. 2, the circuit is Fig. 3. Fixed input and output pads set the nominal operating levels, allowing the same amplifier to be used where different operating levels are required.

Paraphase amplifier V_1 converts the input signal to push-pull to drive control amplifier V_2 and V_3. Output of the control amplifier is converted to a single-ended signal by differential amplifier V_4 and V_5. Cathode follower V_6 isolates the differential amplifier from the succeeding keyed clamp V_7, V_8 and sync separator V_{11}. The keyed clamp establishes the d-c level which is direct coupled to the line by line driver V_9 and V_{10}. Peak detector V_{13} and agc amplifier V_{15} measure the output, compare it against a reference voltage and send the amplified error voltage to the control amplifier.

Where the signal level is small as in r-f or i-f receiver amplifiers, the gain is controlled by varying the voltage on one of the tube elements, usually the control grid. This varies the g_m of the tube and therefore the amplifier gain $g_m R_L$. Where the signal is large, however, variation of mutual conductance as a function of bias voltage distorts the signal waveshape. Attenuating the signal before insertion into the control amplifiers, and then reamplifying it is generally undesirable because of microphonics and hum.

Here the control amplifier is operated at a comparatively high level, but distortion is made negligible by operating the control amplifier in push-pull. The control amplifiers operate class A at all times, and average g_m of the tube is controlled by the bias voltage fed to it by the agc amplifier.

To get cancellation of second harmonic distortion in conventional push-pull amplifiers, an output transformer is needed for subtraction. Since a transformer is not practicable for an extended frequency range, a differential amplifier is used with the control ampli-

Eliminates Interstage Transformers

fier to obtain subtraction. When the output of differential amplifier V_4 and V_5 is taken push-pull or plate to plate, the second harmonic is cancelled. However, as the output must be taken single-ended or from plate to ground, cancellation depends on the common-mode rejection ratio, which is the ability of the amplifier to cancel frequency components that are in phase at the two grids of the differential amplifier.

The common-mode rejection ratio $A_d/A_c = g_m R_k$ is the quality factor for comparing the rejection capabilities of differential amplifiers, where A_d, the gain for the difference signal, equals $\mu R_L/(2r_p + R_L)$ and A_c, the gain for signals which are in phase, equals

$$\mu(R_L r_p)/R_k(2r_p + R_L)$$

Sufficiently high common-mode rejection ratio is obtained by using high g_m tubes (6AH6) and increasing R_K by returning it to -150 v instead of ground. This common-mode rejection ratio can be further improved by using a constant current tube in place of the cathode resistor.

It is desirable to clamp the composite video with a 10-μsec pulse immediately after the end-of-line sync pulse. This clamping gate is obtained by the sync separator blocking oscillator. Cathode follower V_{11A} drives sync stripper V_{11B}. The positive sync pulses establish grid leak bias, allowing only the peaks of the sync pulses to cause curent flow in V_{11B}. Differentiating network C_1 and R_1 (Fig. 3) develops positive pulses at the trailing edge of the sync pulses (Fig. 1B). These pulses trigger blocking oscillator V_{12} which in turn supplies a large push-pull 10-μsec low-impedance gate to the keyed clamper. The time constant of the blocking oscillator (C_2, R_2) is made sufficiently large so that the differentiated start of line sync pulse is ignored and the blocking oscillator fires only after the end-of-line sync pulse.

To insure maximum clamping and obtain minimum keying pulse feedthrough, the four-diode balanced switch (V_7, V_8) is used. As the grid of the line driver is periodically connected to -150 v, no grid resistor is required for this stage. This gives maximum back-to-forward resistance ratio to the clamp circuit. Optimum clamping performance of the diodes is obtained by lowering their filament voltage to approximately 5 v. Clamping is obtained by discharging coupling capacitor C_3 when the clamper is keyed after the end-of-line sync, forcing this point to -150 v.

Since the signal cannot be clamped at the low impedance level of the line, the line driver direct couples the clamped video voltage to the line. The nominal operating level of 5 v into a 75-ohm line terminated at both transmitting and sending ends requires a peak signal current of 5/37.5 = 133 ma. The series-connected, bridge-balanced drivers are well suited for this application.

Figure 4A is a simplified schematic of this circuit. The bridge balances the d-c currents and there is no current in the load resistor when there is no signal input. Figure 4B shows the equivalent circuit as seen by the power supplies. The equivalent circuit is based on the fact that the output impedance for a tube with unbypassed cathode resistor is $Z = r_p + (1 + \mu) R_K$. Zero voltage drift due to filament voltage changes and tube aging is reduced with this symmetrical arrangement. If the positive and negative supply voltages drift, there will be no net change if the magnitude and sign so the drifts

AMPLIFIER SPECIFICATIONS

Input level	2 v nominal
Output level	5 v adjustable ±1 v
Video rise time	0.08 μsec
Droop	2 percent for an all black line
Regulation	1 percent for input variation ±6 db
Load	75-ohm line terminated transmitting and receiving end
D-c drift	zero output (white) ±50 mv

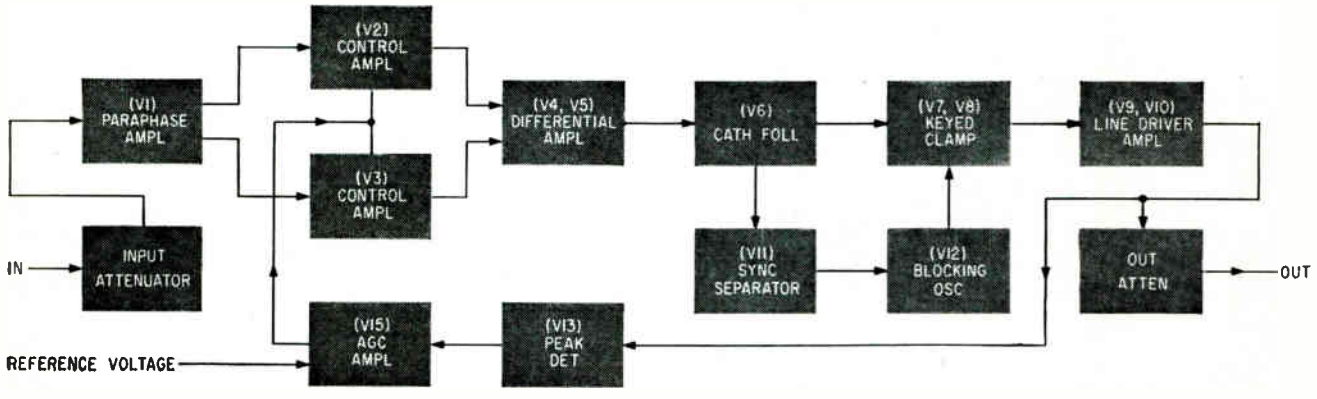


FIG. 2—Block diagram of distribution amplifier shows tube complement

are equal. As each leg of the bridge has an impedance $Z = (2 + \mu) R + r_p$, the output drift is

$$e_d = \frac{D}{2} \times \frac{R_L}{[(2 + \mu) R + r_p]/2 + R_L}$$

where D is the differential voltage drift of the power supplies. The drift is approximately 2 millivolts per 100 millivolts of differential power supply drift.

The driver stage has good linearity. It operates similar to push-pull even though the input and output signals are single ended. Output stages often have poor linearity, for to achieve reasonable efficiency they must be operated over a large portion of their total dynamic range. The push-pull characteristics can be understood by referring to Fig. 4A and 4C. When the input signal to V_1 is in a direction to increase the current in V_1 by an amount i_1, the voltage drop across the plate resistor or V_1 causes a decrease in the current of V_2 by an amount i_2. The polarity of these currents is in a direction to cause the output voltage to have the value $(i_1 + i_2) R_L$.

If R is of the correct value, i_2 can be made equal to i_1 and the equivalent circuit (Fig. 4C) is similar to that of push-pull circuits. Correct value of R is found by writing the equation for loop 2

$\mu i_1 R = i_2 (r_p + 2R + R_L) + i_1 R_L$

and if i_2 is equal to i_1

$$\mu R = r_p + 2R + 2R_L$$

and

$$R = (r_p + 2R_L)/(\mu - 2)$$

The voltage gain (A) when $i_1 = i_2$ is $2iR_L/e_i$ and can be found by writing the equation for loop 1

$\mu (e_1 - iR) = i (r_p + 2R + 2R_L)$

$i = \mu e_i/[r_p + (2 + \mu)R + 2R_L]$

and

$A = 2\mu R_L/[r_p + (2 + \mu)R + 2R_L]$

Results obtained experimentally indicate close compliance with these equations. The push-pull operation which would eliminate second harmonic distortion would be ideal if the equivalent generators in loop 1 and loop 2 were identical, as is the case in a conventional push-pull amplifier. In this circuit, the voltage induced in loop 2, $(\mu i_1 R)$, is not identical to that induced in loop 1 because of the harmonic distortion caused by i_1, and is not therefore exactly equal to the induced voltage in loop 1, $\mu (e_i - i_1 R)$.

The gain in the feedback amplifier is determined from Fig. 5, which shows variation of gain as a function of control voltage for the control amplifier. To avoid the nonlinearity consideration, this gain is measured by push-pull output over push-pull input.

Assume that the amplifier is working at a nominal input of 2 v and an output of 5 v and that the

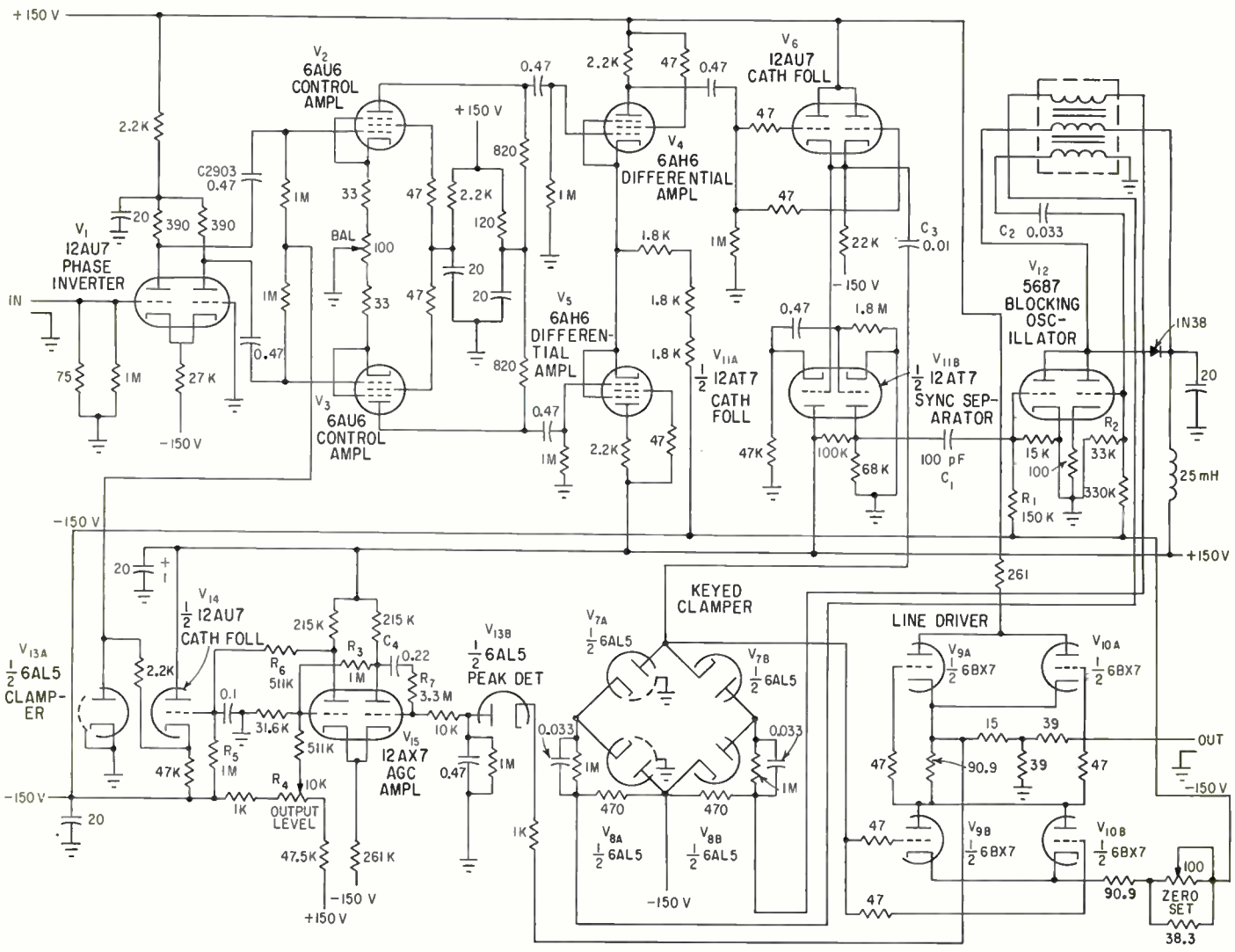


FIG. 3—Schematic of amplifier shows how differential amplifier eliminates second harmonic distortion

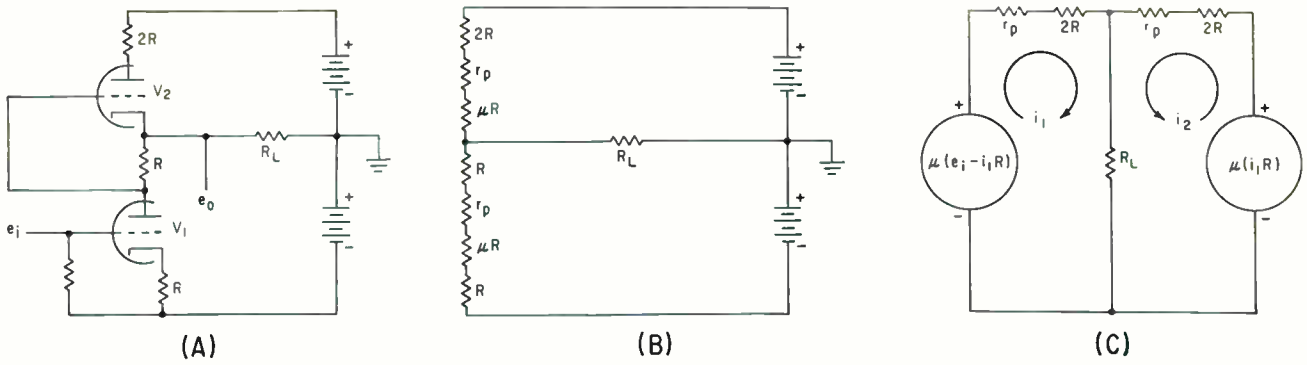


FIG. 4—Simplified schematic (A), and equivalent circuits (B) and (C) for bridge-balanced drivers

quiescent bias of the control amplifiers is at minus 3.8 v (unity gain). If the input drops one-half to 1 v, the gain of the control amplifier must double to hold the output constant. Figure 5 indicates that the bias must shift from −3.8 to −1.8 to double gain. The feedback gain to maintain output within one percent is

$$\frac{\text{req'd change in bias}}{\text{error}} = \frac{3.8-1.8}{0.01\times 5} = 40$$

Detected output is at −5 v d-c. After comparison with the reference voltage, the d-c level of the amplified error voltage must be shifted to the nominal bias level of the control amplifier. The simplest way to shift the level at the output of the feedback amplifier is by a voltage divider. This divider drops the gain by about one-half and the amplification requirements are therefore increased to about 80. A safety factor of two makes the total gain in the d-c amplifier 160. While this gain is available from a single pentode, a single stage cannot be used because the amplified error voltage would have the wrong polarity. Such an amplifier is highly subject to drift. A differential amplifier is highly desirable, but the gain requirements are too severe for even a high-mu tube like the 12AX7. Since cascaded stages are obviously undesirable, positive feedback is used to increase the gain of this differential amplifier. In Fig. 3, this feedback is obtained by R_3.

It is possible to reduce the error to zero by increasing the positive feedback until the agc amplifier has a gain of infinity. While it is usually undesirable to operate with infinite gain, since any increase in gain would cause instability in the agc amplifier, this condition would not make the entire amplifier unstable. When positive feedback within the agc amplifier is increased to the point of regeneration, it evolves into the Schmidt multivibrator. Operation of the agc amplifier in this manner merely reverses the polarity of the error voltage.

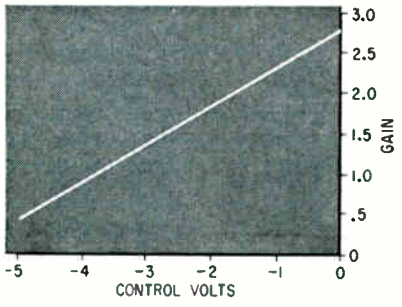


FIG. 5—Control amplifier gain varies with voltage

The level of the output signal is set by adjusting the output level control R_4, which establishes the reference voltage against which the output of the peak detector is compared. The d-c level of the amplified error voltage is established by voltage divider R_5, R_6. Cathode follower V_{1A} couples the amplified error signal to the grids of control amplifiers V_2, V_3. Diode V_{1B} limits the maximum positive excursion of the amplified error voltage to ground level. This prevents the saturation and blocking of the control amplifiers when no signal is present.

Negative feedback is introduced by means of C_4, R_7, thus controlling h-f characteristics and establishing the stability of the entire amplifier.

Regulation of the amplifier is achieved by holding the peak level of the sync pulses equal to a reference voltage. When the input sync pulses are held constant and the video is switched from all black to all white, the regulation of the amplifier should not be affected. However, the change in average value of the signal causes a change in the nominal operating point of the capacitor coupled amplifier stages. Sufficient nonlinearity exists in the individual stages to change the overall gain and therefore the amplitude of the sync pulses at the output. Time constant of this change in gain is related to the time constant of the first three R-C coupling networks in the video amplifier. The agc amplifier senses this change in sync pulse amplitude and corrects for it with considerable delay. Initial attempts to stabilize the operating points of the individual stages by diode clamping proved unsatisfactory as the operating levels were too low for adequate clamping, and deterioration of the l-f video response was difficult to avoid because of the back resistance of the diodes.

This problem of gain changes with shifts in average value of the signal is solved by improving the response time of the agc loop so that its response is faster than the time constant of the average value change. This is accomplished by limiting the h-f roll-off in the agc amplifier when its gain has been sufficiently attenuated principally by the inclusion of R_7 in series with C_4.

The author acknowledges the contributions of S. Eisenmesser, R. Hicka and J. Sur.

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Multiaperture-Core Counters Give

Use of these all-solid-state counters in the time-sequencing logic circuits of a

By W. R. JOHNSTON,
Sr. Staff Engineer,
Ampex Computer Products, Co.,
Culver City, Calif.

ACCURACY of control systems for missile guidance depends on the precise timing of functions with respect to the time of missile launching. Oscillator-driven counters are useful for timing. The multi aperture-core counter described in this article is combined with a time-logic matrix which stores command times. When the counter's time count reaches these times, commands are delivered to the guidance-control system.

This highly reliable counter withstands heavy shock and vibration along with wide temperature and power-supply variations. Its square-loop multiaperture ferrite cores facilitate its nondestructive readout capability, which allows the counter to function as a register.

Figure 1A shows a single stage of the counter. A similar preceding stage drives input windings N_1 and N_2 at points A-A. This stage drives input windings N_1 and N_2 of a succeeding counter stage connected to points B-B. Core 2 and its windings N_3, N_4 and N_6 and transistor Q_1 would constitute a blocking oscillator if there were a trigger winding on core 2. By adding core 1 with its windings and making the polarity of the winding N_2 on core 2 as shown, the blocking oscillator is converted into a single stage of a binary counter. Drive windings N_1 and N_2 are equal and connected in the same polarity. Winding N_3 is the reset winding of core 1. Winding N_5 provides the trigger for the blocking oscillator. Winding N_6 is the feedback winding fed by N_4 to provide the blocking-oscillator action. Windings N_6 and N_5 are connected in series but in opposing polarities, with N_6 having more turns than winding N_5.

TABLE—COUNTER CODE

No. of Count Pulses	Counter Stage State			
	2^3	2^2	2^1	2^0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	1	0
5	0	1	1	1
6	1	0	1	0
7	1	0	1	1
8	1	1	1	0
9	1	1	1	1

Assume that both cores are in the 0 or cleared state of flux remanence (Fig. 1B). Input current to windings N_1 and N_2 delivers the same driving magnetomotive force (mmf) to the cores and changes their flux state at the same rate, provided the cores are identical in magnetic characteristics and the core loads are equal. Since windings N_3 and N_4 are open-circuited at this time, the core loads are equal. The net output of windings N_5 and N_6 is negative because N_6 has more turns than N_5. This output back-biases Q_1 and no further action occurs. Windings N_1 and N_2 switch only half the flux of the cores. Core 2, which started with its flux state entirely in the 0 or cleared state now has half its flux in the opposite direction to provide a magnetic couple about each of the small holes in the core. Both cores are in the 1 state after the first count pulse.

The next pulse applied to the counter is the reset pulse to the N_3 winding that threads core 1 of each counter stage; this pulse resets core 1 to the 0 state. Since the pulse induced in N_5 is negative at the base of Q_1, it does not cause Q_1 to conduct.

When the second count pulse produced by the preceding stage of the counter appears, it will again switch core 1 to produce a positive pulse on winding N_5. Because core 2 was not reset, it does not now pro-

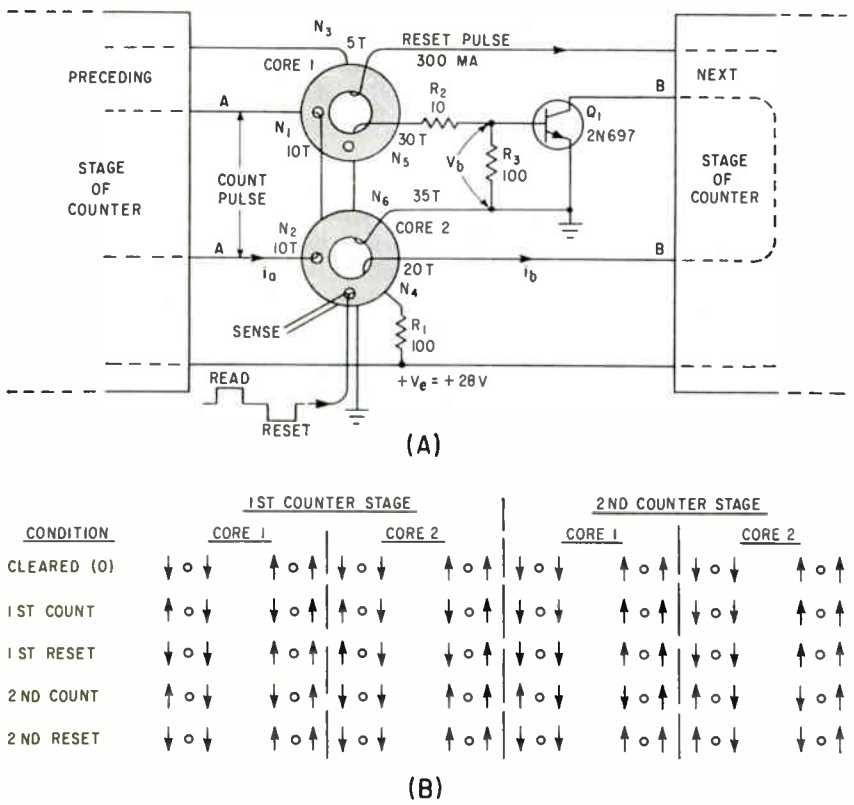

FIG. 1—Counter stage (A) is basic building block of counters. Flux conditions near small holes in cores of counter is shown in (B)

Nondestructive Storage Readout

missile guidance control system is typical of its possible applications

duce an output pulse on winding N_6. Thus, Q_1 receives a positive pulse that switches it into conduction. The output-current pulse through Q_1 drives the N_1-N_2 windings of the next stage to produce the same result as was produced by the first count pulse to this stage. The output current pulse through Q_1 also goes through N_4 of this stage, resetting core 2. This reset action produces a positive pulse on winding N_6 which takes over the drive duty from core 1. Due to this blocking-oscillator action, Q_1 continues to conduct, even though the input pulse may stop, until core 2 has been reset to the 0 flux state and there is no further flux change in the core to sustain the positive feedback.

The second reset pulse through core 1 resets it to the 0 state. Now this stage of the counter is the same as it was two count pulses before. However, it has delivered a count pulse to the following stage of the counter.

The current and number of turns used to drive the cores is set by the size and magnetic material of the core. Pulse width is determined by the speed at which the cores will switch, the required tolerances to temperature, and voltage fluctuations. About pulse width: the flux content of core 2(ϕ_2) and the number of turns of N_6 determines the volt-microseconds of transistor drive winding N_6. Since this is a constant for a given temperature, if drive voltage V_b of Q_1 is increased, the length of time that this voltage is at the base must decrease; that is, $\phi_2 N_6 = V_b$ (time) $= K$. This drive voltage is determined by the speed at which the core switches as $dV_b = d\phi/dt$.

Thus, if the supply voltage is increased to produce more current from the transistor, V_b is greater, the core switches faster, and the pulse becomes shorter. Similarly, a higher ambient temperature will reduce the mmf required to switch the core and the core will switch faster and thus produce a shorter pulse. The converse of both of these examples holds true.

The relative pulse widths of the counter stages are important although the actual width is not critical. For example, consider the action of core 2 being reset by Q_1. Since input current due to the second count pulse is still flowing in winding N_2, the drive in N_1 must be greater than the sum of the $i_a N_2$ input drive and the coercivity of the core. This is set up by making N_4 much larger than N_2, since the currents in the two windings may be considered equal when current limiting resistors R_1 of this stage and the preceding stage are matched. If the input current pulse on N_2 stops before the blocking-oscillator action is completed, core 2 will fully reset and the counter will operate correctly. However, should the blocking-oscillator action stop before the input current pulse ends, core 2 will have some of its flux switched to the 1 state by input $i_a N_2$. This will not only produce a high 0 when interrogated by a READ pulse to N_7, but when the next count pulse (the third) comes, there will not be enough flux in core 2 to counteract the output of core 1 in winding N_5 and Q_1 will be triggered to give a wrong count.

If germanium transistors are used, resistors R_2 and R_8 make the counter more stable by dampening any noise pulses that may appear on windings N_5 and N_6. Silicon transistors have a high enough threshold voltage to provide stability against noise. However, the emitter resistance of silicon transistors may vary 100 percent or more from one to another. Resistors R_2 and R_8 neutralize the effects of emitter-resistance variation and stabilize the pulse width. However, it is still necessary to select silicon transistors for proper emitter resistance.

A binary counter is built by connecting in series a number of stages such as the stage shown in Fig. 1A. However, for display, it is difficult to visually read more than a few stages of a binary code and decimal code is preferable. Using the counter stage of Fig. 1A, the extra components required to construct a decimal counter consist only of one core and one diode per decade (Fig. 2). Binary-to-decimal decoding is done by rearranging the resetting of core 2 of the 2^1 stage. The table shows the 4-2-2-1 decimal code used. To make the four stages count from all 0's to all 1's in 10 counts instead of the 16 counts required for binary, it is necessary to skip a count of two in the 2^1 stage at three different count times. Once set in the 1 state, the 2^1 stage does not reset until the count of ten, at which time the 2^3 stage resets the 2^1 stage as well as itself.

This counter connection also permits a trick to reduce trouble caused by changing pulse widths. The in-

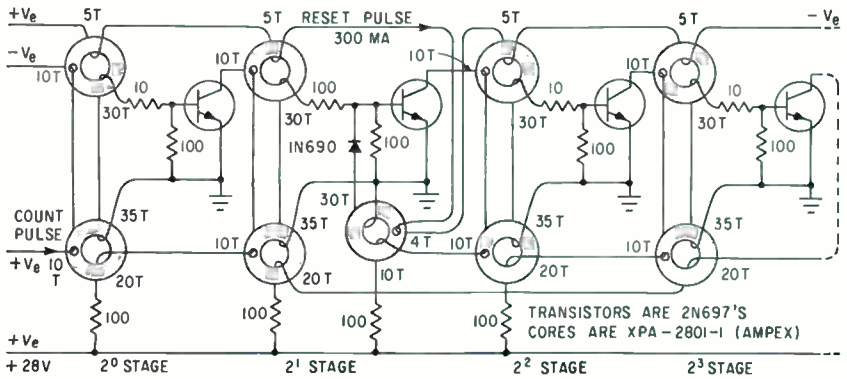

FIG. 2—Slight modification of four-stage straight-binary counter comprised of stage shown in Fig. 1A fashions this decimal-coded counter

put current must stop before, or at the same time, but never after the current pulse in N_4 which resets core 2. There is always some delay before this reset pulse becomes established although it cannot be made more than about 1 μsec. It can be regulated somewhat by changing the value of R_3. If there was a $\frac{1}{2}$-μsec delay between the start of an input pulse to a counter stage and the start of the output pulse of the same stage, the tolerance of the pulse widths would be ± 0.25 μsec. This is not enough. One method of guarding against varying pulse widths is to make each succeeding stage produce a longer pulse by increasing the number of turns in N_6. This would become cumbersome in a long counter.

Pulse widths can be standardized in the circuit of Fig. 2. The output pulse of the 2^1 stage does not need to be longer than that of the preceding stage, 2^0, as its core 2 is reset by the 2^3 stage. Thus, the 2^1 output pulse can be shortened considerably. The 2^2 output pulse is made longer than the pulse it receives from the 2^1 stage and the 2^3 output pulse is made longer than the pulse it receives from the 2^2 stage. If the propagation delay through the stages is made long enough, the 2^3 output pulse may be shorter than the 2^0 pulse and still reset core 2 of the 2^1 stage correctly. The 2^0 pulse of the next decade unit of the counter is then made the same as the 2^0 pulse of the first decade unit. Typical pulse widths for the 2^0, 2^1, 2^2 and 2^3 stages are 6, 3, 4 and 5 μsec, respectively. A propagation time of $\frac{1}{2}$-μsec per stage means that the reset pulse of core 2 of the 2^1 stage lasts $\frac{1}{2}$-μsec longer than the count pulse.

The maximum repetition rate of this counter depends upon the length of the counter, the propagation delay and pulse widths. Eight-stage (two decade) counters can be run at 100 Kc. The 22-stage counter has been run at 40 Kc. By breaking up the reset winding and driving it with sequential reset drivers, this can be improved to near the 100 Kc rate, but the circuits required detract from the desirable features of the counter.

Using only one power supply of nominal +28 volts, this counter can operate reliably in temperatures from −15 to +100 C. The power supply voltage may be varied from +23 to +38 volts while operating over this temperature range.

The counter could be made with ordinary, rather than multiaperture, ferrite memory cores, but it would not have the nondestructive readout feature for missile use. Consider only core 2 of Fig. 1A and 1B. Examine the flux state of the inner and outer legs about the small hole through which the interrogate (READ) and SENSE windings pass. In the 0 state, the flux in both legs is in the same direction. Therefore, if kept at a proper value, the interrogate pulse cannot change the flux in the outer leg. Hence, there will be no signal induced in the sense winding. However, a count pulse passing through winding N_2 is large enough to switch the outer leg with flux around the large hole of the core. Now, at each small hole, the flux in the outer leg is opposite to that in the inner leg. Thus, when an interrogate pulse is applied to winding N_7, the flux reverses its magnetic state around the small hole only. This induces a voltage into the sense winding which can be read as a 1. By applying a reset pulse on N_7 of the same magnitude but reversed polarity to the READ pulse, the flux around the small hole is changed to its initial state so it may be interrogated again. This procedure can be repeated indefinitely, and at a high repetition rate (500 Kc). This is the most useful feature of the counter, because it provides the counter with a register at no extra cost. The only limitation imposed is that the interrogating pulse must not occur during the count action.

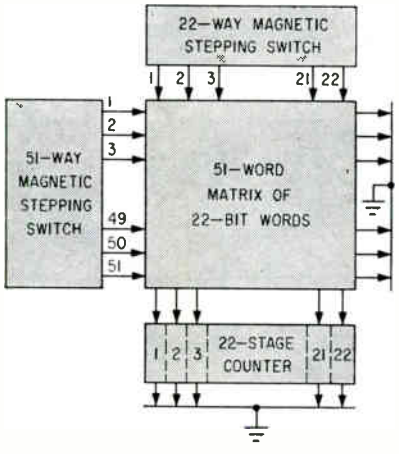

FIG. 3 — Simplified diagram of system's time-selection logic

Figure 3 shows how this counter is used in a missile. The matrix comprises the same type of multiaperture cores used in the counter. Matrix cores store preset time information. These cores are interrogated by using the coincidence of half-current pulses from the 51-way stepping switch in the word direction and from the 22-way stepping switch in the bit direction. The 22-way switch also interrogates the stages of the counter consecutively by using a 2-turn winding. As the matrix is scanned, a comparison circuit (not shown) compares bit 1 of every word in the matrix to the state of the count core in stage 1 of the counter, bit 2 of every word in the matrix to the state of the count core in stage 2 of the counter, and so on for each counter stage. Thus, when the counter reaches a time set into a matrix word, the comparison circuit produces a command pulse. After the matrix is completely scanned, the counter is stepped to the next count and the scanning process is repeated. Thus, by programming times into the words of the matrix, it is possible to cause an action to occur at a specified time.

This counter does not require several different power supplies nor does it require one that is rigorously regulated. It can be read either serially or in parallel and the nondestructive readout is not sensitive to either pulse width or rise time. It can be designed with most transistors having a gain-bandwidth figure of 10 Mc or greater and can operate over a wide temperature range with no compensation of any kind. Because circuit impedances are measured in ohms and fractions of ohms, it is almost impervious to extraneous noise which disturbs most electronic circuits, particularly flip-flops.

This counter may be used in many applications where the count rate is not too high. It is extremely reliable and can be made easily and cheaply.

Papers on multiaperture devices given by Hewitt Crane of Stanford Research Institute in the Jan. 1959 issue of the IRE Proceedings led to the development of this counter. Milton Rosenberg of Ampex Computer Products Co. conceived the counter and its use in the missile control system.

Crystal Biasing Improves Millimeter-Wave Detector

By KORYU ISHII
ADELARD L. BRAULT,
Marquette University,
Milwaukee, Wisconsin

BEFORE ELECTRON TUBES were invented, engineers often biased a crystal detector to increase gain. The technique was later abandoned, but has again come into use in the millimeter-wave region.

Since it is hard to generate millimeter waves with high power sensitive detectors are necessary. If a 20-db increase in gain is needed at 73 Gc for a conventional millimeter-wave detector, several solutions exist: a superheterodyne receiver with a reflex klystron amplifier,[1] traveling-wave tube amplifier, backward-wave amplifier, parametric amplifier or maser. All cost from several hundred to tens of thousands of dollars, and most are not available.

Tunnel diodes may provide an economical solution, but at present no amplification has been reported over 40 Gc.[2, 3]

Presently, the most economical solution is to d-c bias a crystal detector. The gain can be increased by 20 db at 73 Gc at low cost; also, d-c biasing of crystal detector reduces the system noise figure and increases sensitivity.

The receiver consists of a 1N53 crystal detector and a high-gain audio amplifier. Block diagram is shown in Fig. 1A.

The circuit of Fig. 1B supplies d-c bias to the 1N53 diode; capacitor C provides a path for the audio and eliminates any disturbance

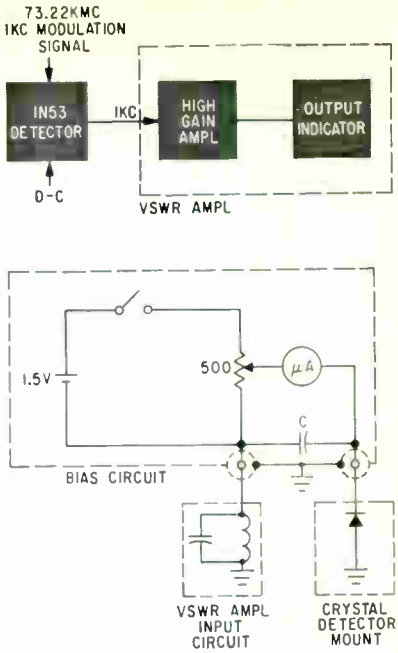

FIG. 1—Block diagram of experimental receiver, (A); circuit for biasing crystal detector unit, (B)

caused by the biasing circuit.

Figure 2A shows the effect on the detector gain, using output with zero bias as reference.

Biasing also increases the noise output of the crystal, as shown in Fig. 2B. Noise output $N_o = N_i F G$, where N_i is noise input, F is noise figure and G the gain.

The S/N ratio at the output increases as bias is applied keeping the input S/N ratio constant. Since noise figure F is the ratio of the input S/N to the output S/N, bias must decrease noise figure.

D-c biasing achieved a substantial improvement in sensitivity and noise figure.[4] The 14-db improvement in sensitivity shown in Fig. 2C corresponds to a 68-dbm minimum detectable signal. The small-signal method of measurement was used.[5] The results in Fig. 2D indicate a 14-db improvement.

The authors thank Raytheon for contributing the klystron tubes, and J. A. Stefancin, S. Krupnik and J. D. Horgan, for their assistance.[6]

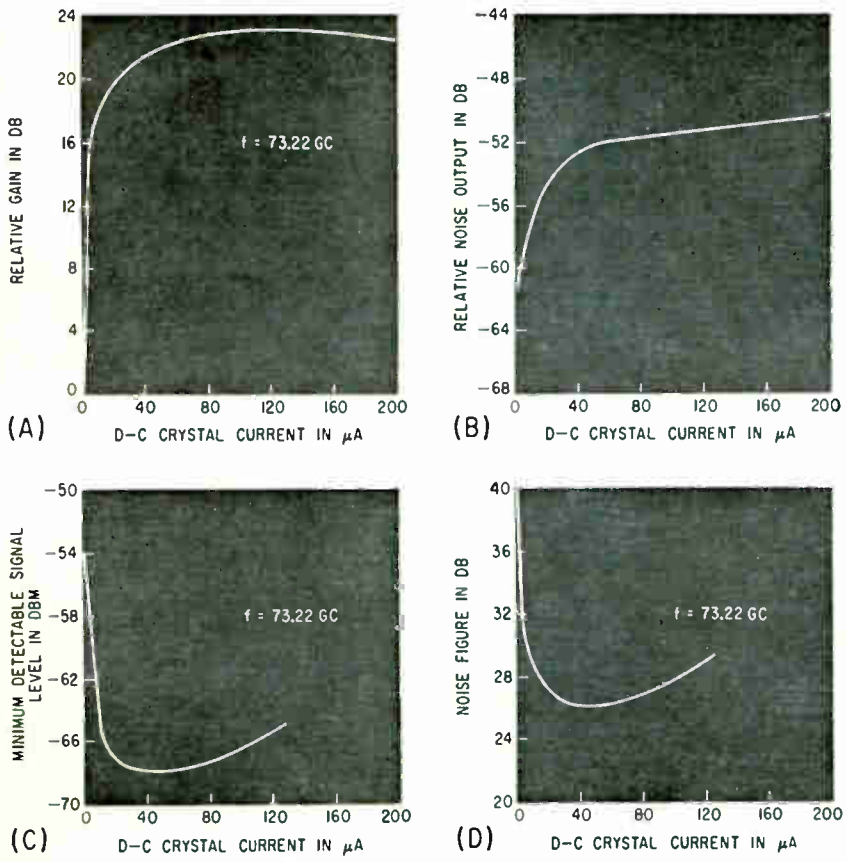

FIG. 2—Gain characteristic of biased detector, (A); noise output characteristic, (B); sensitivity characteristic, (C); overall noise figure characteristic, (D)

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(1) K. Ishii, Using Reflex Klystrons as Millimeter-Wave Amplifiers, ELECTRONICS, 33, p 71, March 18, 1960.
(2) R. F. Trambarulo, Esaki Diode Amplifier at 7, 11, and 26 Kmc *Proc IRE*, 48, p 2,022, Dec 1960.
(3) C. A. Burrus, Millimeter Wave Esaki Diode Oscillator *Proc IRE*, 48, p 2,024, Dec 1960.
(4) J. S. Hollis, Antenna Measurements Part II *Microwave Journal*, 3, p 85, March 1960.
(5) IRE Standard on Noise Measurement, 1952, *Proc IRE*, 41, p 891, 1953.
(6) This work was supported by a Frederick G. Cottrell grant to Marquette University.

D-C Voltage Comparator Circuit Uses Tube and Transistor

By RALPH D. VALENTINE,
Marine Electronics Office,
Avco Corp., New London, Conn.

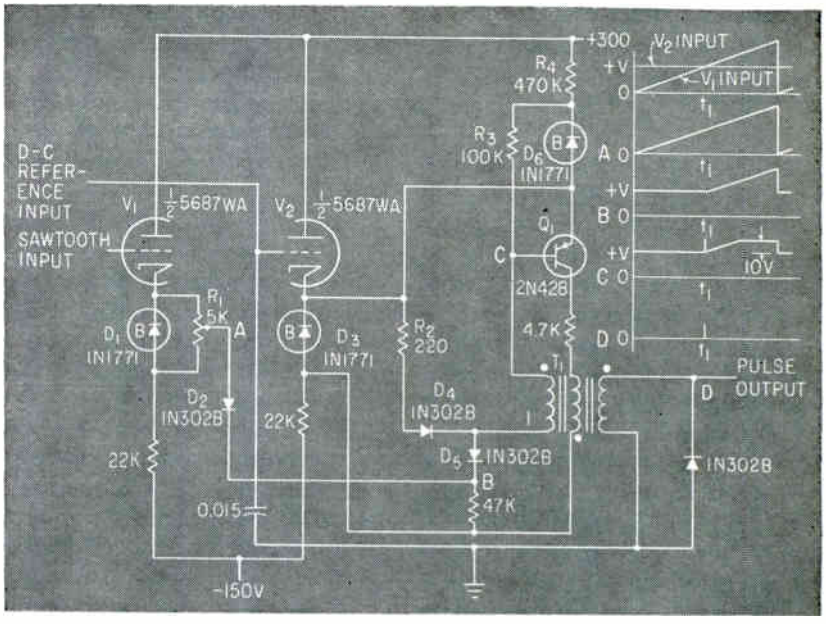
THE HYBRID d-c comparator circuit described compares a long-duration sawtooth input with a d-c reference and generates a pulse when the two inputs coincide.

Generation of a comparison pulse by comparing a d-c reference voltage and a short-duration sawtooth wave is a relatively simple task; however, when the duration of the sawtooth wave is extended it becomes increasingly difficult to maintain accuracy.

Junction transistors operated in saturation exhibit low resistance and, when cut off, extremely high resistance. This characteristic lends itself to using the junction transistor as a switch. When this switching characteristic is used in a regenerative circuit, such as a blocking oscillator or a multiar circuit, a sharp pulse is generated. The hybrid circuit described here incorporates the desirable properties of both the blocking oscillator and the multiar circuits.

At $t = 0$ the base of Q_1 (see figure) is saturated and the transistor is conducting. At $t = t_1$ the sawtooth voltage input is equal to the B^+ voltage and the base is driven to cut off; regenerative action occurs and a positive pulse appears across the output.

The d-c reference voltage is fed to cathode follower V_2. Ten-volt Zener diode D_3 in the cathode of V_2 establishes the voltage across transistor comparator Q_1, hence the transistor reference voltage follows the input reference voltage, while the voltage across the transistor remains constant. Since Q_1 is normally saturated, the emitter and base voltages are effectively equal. Assuming the d-c voltage drop across T_1 and D_5 to be negligible, the voltage at point B is equal to the reference voltage at the cathode of V_2. The sawtooth voltage is fed to cathode follower V_1. Ten-volt Zener diode D_1 establishes the voltage across resistor R_1. Control resistor R_1 balances out initial mismatch in the voltage levels between the sawtooth and the reference voltage. When the sawtooth voltage at A exceeds the reference voltage at B, D_2 conducts, thus reducing base drive, and Q_1 starts to desaturate. The base of Q_1 is driven to cutoff and regenerative action produces a pulse at D. During the regenerative period D_5 cuts off and D_4 conducts. Diode D_4 and resistor R_2 offer a low impedance path to lead 1 of transformer T_1 during the regenerative cycle.



Schematic of d-c voltage comparator, using a 2-μsec 1:1:1 pulse transformer, type PCA-111-2, which produces an output spike with a rise time of 0.1 μsec and permits comparing a positive sawtooth input with a d-c reference to an accuracy of 0.05 v

Because of the slow rate with which a long-duration sawtooth voltage passes through the critical voltage range, multiple triggering takes place until the voltage at R_1 has driven the base completely to cutoff. In dealing with sawtooth voltage amplitudes in the order of 100 v, it becomes necessary to use protective measures so as not to exceed the transistor voltage ratings. To keep from exceeding the base-to-emitter voltage rating, a protective network, consisting of R_3, R_4, D_5 and 10-v Zener diode D_6, is used. When the base of Q_1 becomes 10 v positive with respect to the emitter, D_5 stops conducting, and the base-to-emitter voltage remains constant at 10 v for the duration of the sawtooth.

In dealing with sawtooth voltages it is generally desirable to compare a positive sawtooth voltage to a d-c reference; therefore, a *pnp* transistor is used. A 2N428 computer transistor is operated in a saturated condition with about 200 μamp base current. For proper operation, the comparator transistor must normally be held in saturation, then cut off by the positive sawtooth.

The accuracy of this comparator is as good as the matched cathode-follower outputs. The ranges in sawtooth duration can be from a few microseconds to several minutes. The sawtooth voltage amplitude is limited only by the range of the vacuum tube.

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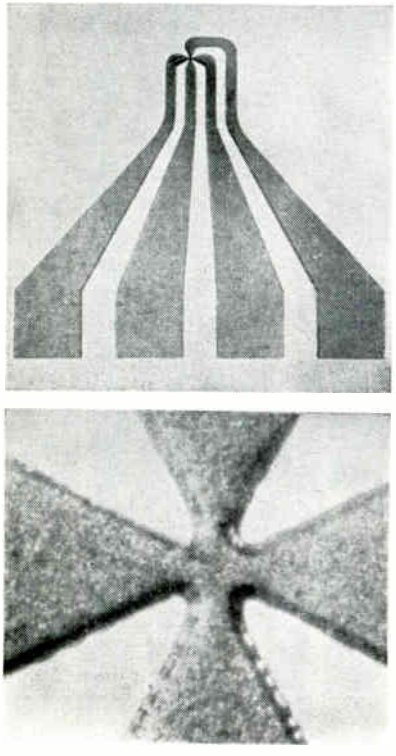
Miniature Hall Probe Maps Magnetic Fields

By D. D. ROSHON, JR.,
Endicott Development Lab.,
International Business Machines Corp.,
White Plains, N. Y.

MINIATURIZED Hall-effect probe enables magnetic mapping of small, sharply discontinuous structures. It can be used for fundamental field studies and for development of magnetic components. One of its most important present applications is measuring fields associated with magnetic data recording.

Theoretical descriptions of external magnetic fields on arbitrarily shaped ferromagnetic structures are quite difficult even using approximate methods. However, the physical size of available sensing elements makes most direct measurement techniques unsatisfactory for the fields encountered in magnetic data recording. The new sensor is small enough for this application, and its sensitivity is sufficient to measure magnetic fields having an intensity of less than 0.01 gauss.



Vacuum deposited bismuth forms two lines shown at top. In enlargement at bottom 100 microns is equal to about 0.6 inch in photo

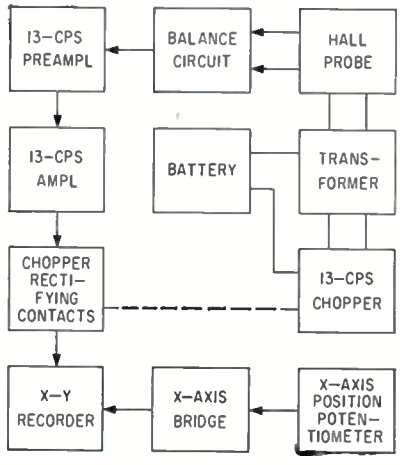


FIG. 1—Instrumentation enables Hall-effect probe to detect fields of 0.25 gauss with 400 microamperes probe current

The probe is made by vacuum depositing two microscopically thin lines of bismuth on a glass slide. One line carries current perpendicular to the magnetic field. Hall voltage proportional to field strength is developed in the other line, which is at right angles to both the first line and the field.

The metal is deposited through masks of special glass made by a photographic etching process that involves contact printing from a negative. Because of the small size, the mask is carefully cleaned before evaporation by detergent, nitric acid and chromic acid baths. Acetone is used for drying, and immediately before evaporation, the mask-substrate assembly is cleaned by ion bombardment for 15 minutes.

Bismuth of 99.998 percent purity is evaporated from a resistance heated tantalum boat located 10 cm from the substrate and deposited at a rate of 3,000 angstrom units per second.

The Hall coefficient is isotropic in the plane of the film, and measurements on this type probe yield a Hall coefficient of about +1.0 cm^3/amp-sec. This value was obtained for films from 2 to 20 microns thick and is considerably higher than that for annealed films. These films do not exhibit noise in excess of the thermal noise associated with their resistance. Noise from current or magnetic field was never observed. Output from the Hall-effect probe is linear within one percent over the range from 1 to 1,000 gauss.

Probe resistance was usually made about 10 ohms to match associated instrumentation, but most of the resistance was in the probe leads. In larger probes, only about 3 percent of total resistance is associated with the sensitive region. The smaller probes are better in this respect, having about 15 percent of their total resistance in the sensitive region.

Initially it was assumed that probe resolution was essentially equal to the dimensions of the intersections of the four leads, which proved to be so. Stated differently, the sensitive region can be considered a square with sides equal to lead width at the intersection. It was also verified that the sensitive region was uniform so that the magnetic field averaged throughout this region.

The instrumentation for field mapping in Fig. 1 was made up largely of commercially available units. A mechanical chopper provides 13 cps chopped d-c to the probe through an impedance-matching transformer. A 6-volt storage battery with low internal discharge provides the d-c.

The balancing circuit compensates initial probe voltages. Because no phase shifting was necessary at the low frequency, a variable resistor between one current and one voltage contact could be used for balancing. The 13-cps Hall signal is fed to an amplifier with a 10-ohm thermocouple preamplifier. The rectified signal is applied to the y axis of an x-y plotter.

Hall voltages as small as 1×10^{-9} volts can be measured with this

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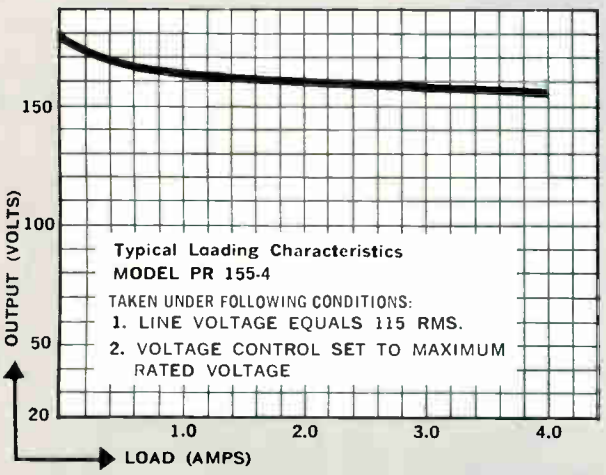
PR 38-5M	0-38	0-5	2	3½	19	13⅞	$325.00
PR 80-2.5M	0-80	0-2.5	1.5	3½	19	13⅞	$325.00
PR 155-1M	0-155	0-1	1	3½	19	13⅞	$325.00
PR 310-0.6M	0-310	0-0.6	0.5	3½	19	13⅞	$345.00
PR 15-30M	0-15	0-30	4	7	19	13⅞	$495.00
PR 38-15M	0-38	0-15	2	7	19	13⅞	$475.00
PR 80-8M	0-80	0-8	1.5	7	19	13⅞	$450.00
PR 155-4M	0-155	0-4	1	7	19	13⅞	$430.00
PR 310-2M	0-310	0-2	0.5	7	19	13⅞	$430.00

REGULATION:

LINE: ±1% for 115±10 v ac line change at any output voltage within specified range.
LOAD — *at maximum output voltage:*
Less than 2% output voltage change for 50-100% load change (3% for PR 15-10M and PR 15-30M).
Less than 4% output voltage change for 25-100% load change (6% for PR 15-10M and PR 15-30M).
(See Graph below for typical load characteristics)

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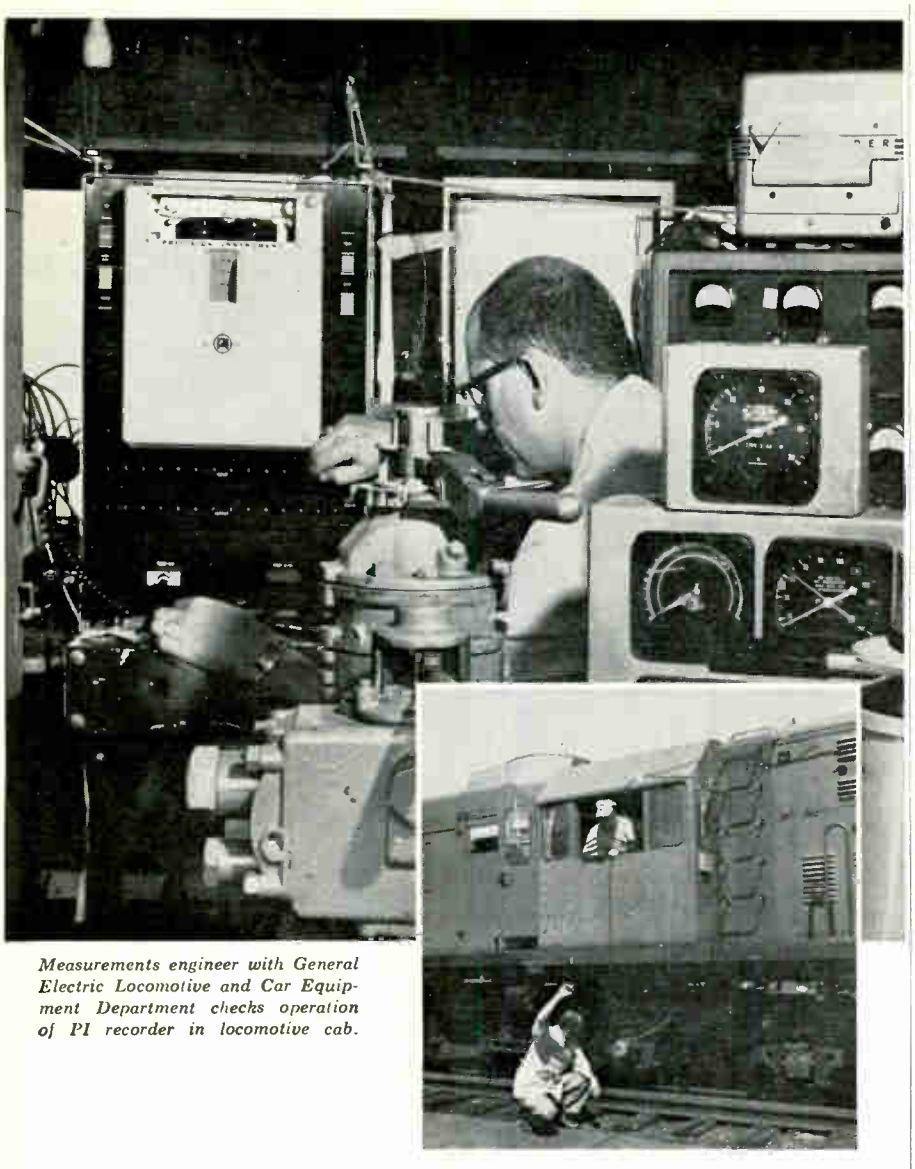


Measurements engineer with General Electric Locomotive and Car Equipment Department checks operation of PI recorder in locomotive cab.

system. Using 400 μa probe current, minimum detectable magnetic field is 0.25 gauss. Equivalent drift is less than 2 gauss in 24 hours. Fields down to 0.005 gauss can be measured with 20 μa probe current, but thermal drift is greater. During these measurements, ambient or probe temperature was not controlled and no heat sinks were added to the probe.

In another instrumentation system, the probe was supplied with 1,000 cps a-c. A high-gain, narrow-band, tuned amplifier was used, and total amplifier gain was 3.6×10^5. A phase-shifting network balanced initial voltages, and a phase-sensitive rectifier was used in the output to discern field direction. This system was designed to handle different probe resistances.

Fields of 0.1 gauss were detected

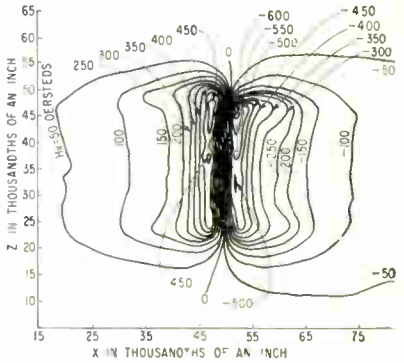


FIG. 2—Map shows distribution of normal component of magnetic field near recording head gap

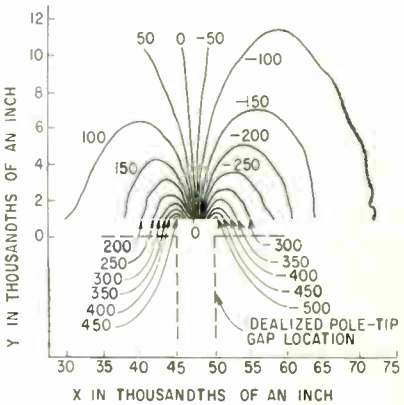


FIG. 3—Distribution is shown of normal field component in plane perpendicular to head gap

with this system. It can map at higher speeds, presumably because the harmonic content induced in the voltage at 1,000 cps was smaller than at 13 cps.

Two additional instrumentation systems were also devised for the

probe. A beat-frequency technique was used in one while the other was a pulsed-current system. The minimum detectable magnetic field was about one gauss using either of these systems. However, both of these methods suffered from coupling effects from the magnetic structure being mapped.

A typical application of the probe is in the study of external magnetic fields produced by domain boundaries in magnetic materials. Preliminary work has already been reported with cobalt films.

The probe has also been used in connection with magnetic components. Distribution of the normal component of the magnetic field in the vicinity of the 0.004-inch gap of a magnetic recording head is shown in Fig. 2. Since the core is constructed of etched laminations, there is roughness in the gap, causing irregularities in the field. Distribution of the normal field component in a plane perpendicular to the gap is shown in Fig. 3.

Rubidium Frequency Standard Is Developed

FREQUENCY standard has been developed with accuracy equivalent to one second in 300 years. Limited power is required to operate the small, light-weight frequency source.

The standard, which was developed by FMA, Inc., El Segundo, Calif., uses a virtually indestructible gas cell. The rubidium frequency standard weighs only 20 pounds and is about the size of a table model record player.

The signal is generated when a light beam is passed through the gas cell. The light changes the energy state of the rubidium causing the silvery white metallic element to release electromagnetic energy at a precise frequency. This microwave signal is the basic reference provided by the unit that enables it to be used as a frequency or time standard.

The rubidium standard is expected to be useful in a variety of equipment operating in the higher frequency regions of the electromagnetic spectrum. Anticipated applications include communications, navigation and computations systems for aircraft and missiles.

Improved Plastics for Space Hardware

PLASTIC FILMS having electronic applications beside their important packaging roles were introduced by Allied Chemical[1] at the Plastics Exposition show last week in New York. These are Aclar fluorohalocarbon films and Capran polyamide films.

Aclar offers high volume and surface resistivity, good power factor and high frequency, and low dielectric constant. These films show promise in the production of printed circuits, printed cables, electroluminescent panels, and insulation for capacitors. A plant for the commercial production of Aclar will be in operation at the end of this year.

Aclar has virtually zero moisture absorption, is transparent, and has good tear strength and abrasion resistance. Moisture vapor transmission for Aclar 33C is 0.015 gm/mil/100 in.^{2} at one atmosphere for a 24 hr period. A comparative figure for polyethylene is 6.3. These films are not attacked by inorganic acids, alkalies or oxidizing acids, and resist most organic compounds. This material has space applications approval for use in connection with liquid oxygen. Aclar can be vacuum formed, extrusion coated, metallized and laminated to other films or metals. At Allied Chemical, fluorohalocarbon powders, marketed under the trade name Halon, are being investigated for encapsulation of cable jacketing, wire, connectors, sockets, and other electronic components.

Capron films are based on resins derived from E-caprolactam and are under study for use as tapes or ribbons. Unoriented Capran strength approaches 10,000 psi. Oil and grease resistance is excellent. These films have low gas permeability and form a barrier to most organic odors, particularly the aromatic type; low permeability to oxygen, nitrogen, carbon dioxide, and especially fluorocarbon propellant and refrigerant gases. Capran films feature superior resistance to surface wear, excellent fold endurance, high burst and impact resistance, and good elongation. They are clear or hazy, depending on grade, and may be sealed by electronic and thermal methods.

Characteristics of Semiconductive Polyethylenes

Property	ASTM No.	DFDA-0520	DHDA-7800	DFDC-5275
Density, gms/cc	D1505	1.1	1.13	1.12
Flow index at 440 psi, 190 C., gms/10 min.	D1238	0.6	1.0	0.4
Tensile strength, psi	D412	1,900	2,000	1,900
Elongation, %	D412	100	275	250
Yield strength, psi	D412	1,900	2,000	1,900
Brittle. temp. 20% fail., deg C	D746	−30	−55	−55
Secant modulus, psi	WC-66K [a]	39,000	21,000	21,000
Environ. stress cracking resist. at 50 C. in Igepal CA-630. F_o-hrs.	BTL [b]	<1.0	>500	>500
Vol. resist at 23 C., ohm-cm	D257	0.5 to 1.5	25 to 50	3 to 10

[a]—Union Carbide Plastics Company test method; [b]—Standard Bell Telephone Laboratory test method

Three new semiconductive polyethylene compounds, developed by Union Carbide[2], are based on a polyethylene resin that permits the incorporation of large amounts of conductive materials, while retaining most of the desirable properties of polyethylene (See table). These materials were developed with missile applications in mind. Most conductive of the three is Bakelite DFDA-0520.

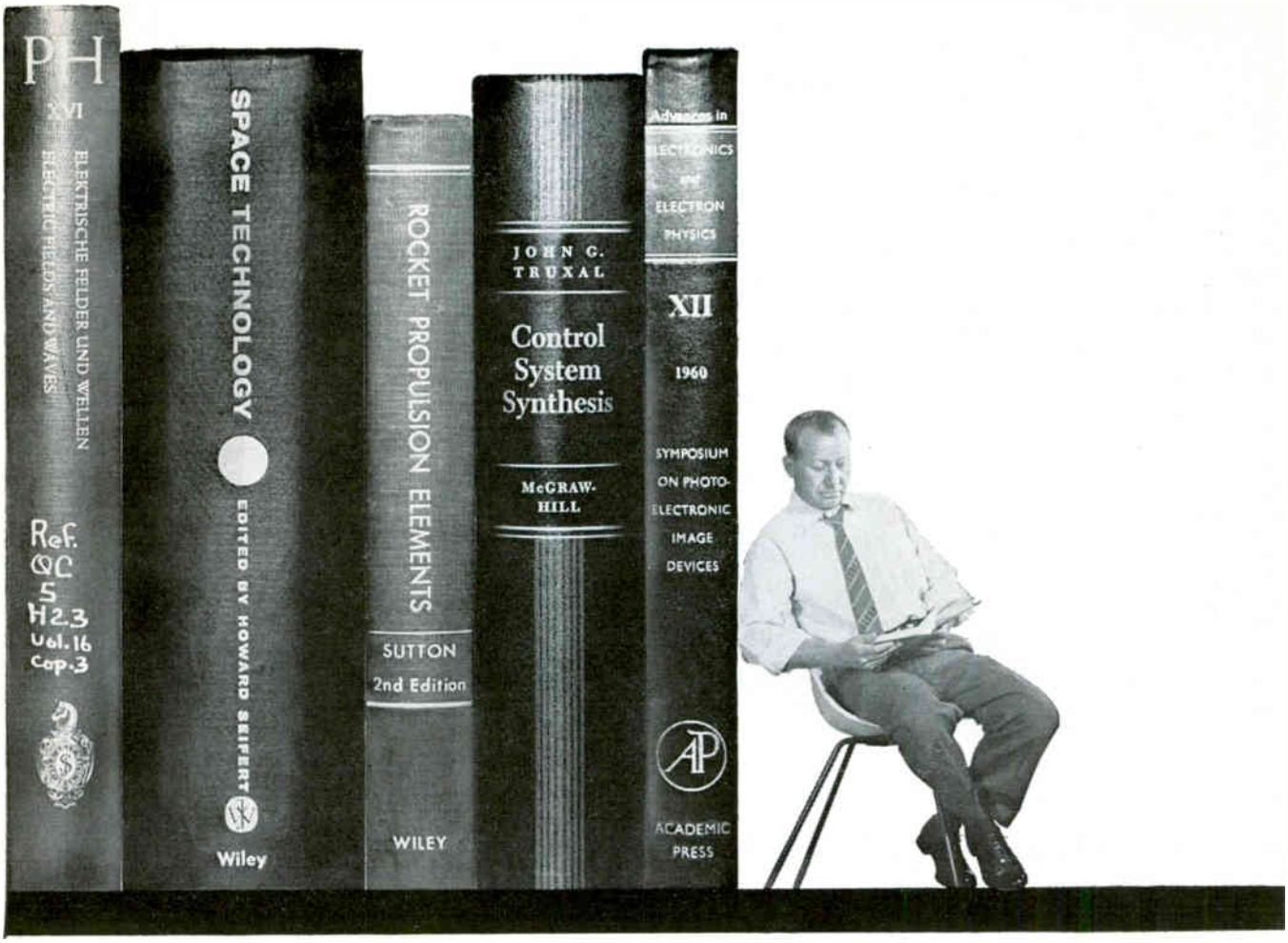
Designed only for internal use in cables, it is recommended as voltage stress relief shielding in high-voltage cables. This material can also replace copper braid as an electrical interference barrier or as a cable ground against lightning, the discharge being drained off before causing short circuits.

For external cable jacketing, DFDC-5275 is recommended as lightning protection on multiconductor cables such as underground communications cables for missile sites. Properties of this polyethylene include excellent stress cracking resistance, low temperature impact, flexibility and good elongation characteristics over a wide temperature range.

The third polyethylene, DHDA-7800, possess properties that recommend it for external jacketing where moderate conductivity is required. With volume resistivity less than 50 ohm-cm, it exhibits excellent stress cracking resistance and elongation, good impact strength, and low temperature properties. All three of the polyethylenes may be processed on standard wire and cable extrusion equipment.

An epoxy resin, especially developed to help meet problems encountered in the glass-filament winding process for missile structures, is now available in Bakelite epoxy ERL-0500[2].

This resin has a low viscosity, is easy to handle and, properly cured, exhibits excellent mechanical properties. This epoxy resin has a viscosity of 2000-4000 cps at room temperature. High cure temperatures have no detrimental effects on filament wound structural properties, but do increase the heat distortion point considerably. Girth stresses approaching 120,000 psi and interlaminate shear values of 4,000 psi have been developed with



electronic and electromechanical engineers in a unique role

The engineers and scientists of Aerospace Corporation are in the forefront of a rapidly advancing state-of-the-art in sensing and information systems. Their unique role: a critical civilian link uniting government and the scientific-industrial team responsible for development of space systems and advanced ballistic missiles. In providing scientific and technical leadership to every element of this team, they are engaged in a broad spectrum of activities, from formulation of new concepts to technical review and supervision of hardware development by industry. Specific areas of interest include inertial and radio guidance, automatic control, communications, instrumentation, space- and ground-based computing, telemetering, tracking, auxiliary power, infrared, television, optics, and photography. Now more men of superior ability are needed; highly motivated engineers and scientists with demonstrated achievement, maturity, and judgment, beyond the norm. Such men are urged to write Mr. George Herndon, Aerospace Corporation, Room 110, P. O. Box 95081, Los Angeles 45, California.

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government.

AEROSPACE CORPORATION

an ERL-0500/methyl nadic anhydride system.

In filament wound structures required for missiles and rockets, an ERL-0500 based system is particularly effective, since it has low viscosity, a long pot life and readily combines with the commonly used liquid anhydrides. At room temperature an ERL-0500/methyl nadic anhydride system has an initial viscosity of 550 cps. After 72 hours, for example, the system shows only a slightly increased viscosity. The low viscosity and prolonged pot life of these systems permit the winding of complicated glass patterns with practically no limit of winding time or on the complexity of the pattern laid down, and ensure good wet-out of filaments and uniform resin flow. Space hardware filament wound with these epoxy resins were featured at the recent Plastics Show.

An insulated tubing, developed from a modified polyolefin base product, shrinks to form a tight mechanical bond within seven seconds following application of heat (135 C). This tubing is manufactured in an expanded form, so that it may be easily slipped over wire and cables, hosing, terminals or conduit. The material shrinks to a predetermined diameter, forming a secure, tight-fitting bond. A heat gun is recommended for shrinking, although satisfactory results are obtained by oven heating, radiant heat, diping in hot liquid, or other methods. This tubing is marketed under the name of Alphlex Shrinkable Tubing, and was developed by Alpha Wire Corp.[3]

When used as an insulating material, the shrinkable tubing remains flexible and strong from −55 C to 135 C continuous. Within this temperature range it will not melt, harden, run, crack, or blister. Besides its high dielectric and mechanical strength, the shrinkable tubing is resistant to fungus growth and moisture absorption.

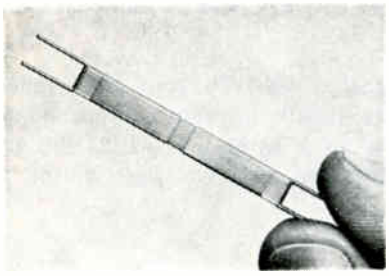
REFERENCES

(1) Allied Chemical Corp., General Chemical Div., 40 Rector St., N. Y. C.

(2) Union Carbide Plastics Co., A Div. of Union Carbide Corp., 270 Park Ave., N. Y. 17, N. Y.

(3) Harold Mason, Alpha Wire Corp., 200 Varick St., N. Y. 14, N. Y.

Directly Heated Cathode Warms Up in 100 Millisec



MANY FINE WIRES, strung parallel to each other across the length of a rectangular frame like the strings of a harp, forms the basis for the design of a cathode element that can deliver full power in 100 milliseconds.[1] The use of extremely thin wires in the emitting element makes possible a high surface-to-volume ratio resulting in fast warmup and thermal equilibrium. The cathode has low inductance and less hum.

The wires offer multiple current paths so that voltages on the order of 1.6 volts are sufficient for operation, the closest approximation yet achieved to the unipotential cathode. The same low voltage power supply that serves the transistor stages can also operate the tubes in which this element is incorporated.

Amperex, who developed this cathode element, has incorporated the Harp Cathode into the type 8042, a fast warmup version of the 6146 tube with the same electrical characteristics. The 8042 (25 watts diss, 175 Mc, ICAS) is immediately available in preproduction quantities. In the near future, Amperex plans a full line of Harp Cathode twin tetrodes.

These tubes will be used as r-f power output stages in transistorized mobile and airborne equipment. The cathode warms up in so short a time that one can transmit instantly from a cold start. This eliminates the need for standby currents which, beside creating power supply problems, generate heat, adversely affecting temperature-sensitive semiconductors and degrading equipment performance.

REFERENCE

(1) Amperex Electronic Corp., Power Tube Division, 230 Duffy Ave., Hicksville, Long Island, N. Y.

Aluminum Joining: Tabulation of Techniques

By G. O. HOGLUND,
Manager, Joining Division,
Alcoa Process Development
Laboratories, and

H. H. CALDWELL,
Electrical Section, Sales Development
Division, Aluminum Company of
America, New Kensington, Pa.

ALUMINUM JOINING is not difficult, although techniques differ in some ways from those used to join other metals. Another persistent fallacy is that effective joining methods are limited in number and scope. Actually, the large family of aluminum alloys offer a wide selection of mechanical and physical properties and a choice of all the major bonding methods.

This discussion will confine itself to welding, brazing and soldering, methods which involve metal flow. In addition, riveting, mechanical fastening and adhesive bonding are all used to advantage in the electrical-electronics industry. The selection of a method will, of course, depend on its advantages and disadvantages in a specific application.

Table I lists alloys, material sizes, procedures and typical applications for welding, brazing and soldering methods. Table II lists their relative advantages and disadvantages. All of the methods, properly used, will give satisfactory electrical joints with conductivities at least as great as the alloy being joined.

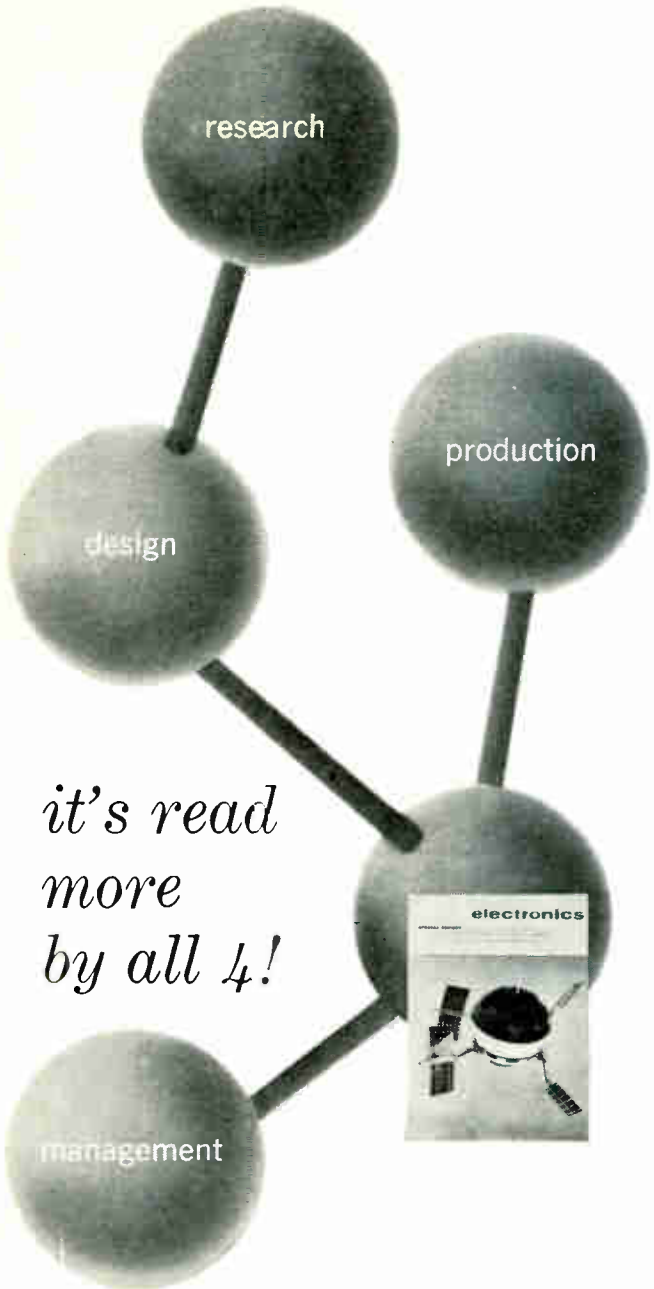
Process heat will cause metallurgical changes in wrought aluminum alloys. The softening or annealing effect lowers tensile and yield strength and increases elongation.

The tensile strength of nonheat-treatable alloys is reduced, near the joint, to that of the annealed or "O" temper of the alloy. It is frequently possible to consider this in the design. By locating joints on the neutral axis or in regions where the service stresses are low, the higher strength of the unheated material away from the joints is used to good advantage. This is also an efficient for heat-treatable alloys.

The strength of heat-treatable alloys is also affected by process heat, but strength is not reduced to a point as low as the annealed temper. For example, welding or brazing 6061-T6 alloy may reduce the tensile strength from 45,000 psi to a minimum of 24,000 psi. However, this has been found by

TABLE I—ALUMINUM BRAZING, SOLDERING AND WELDING MATERIALS, METHODS AND APPLICATIONS

Joining Method	Alloys and Material Size	Production Techniques	Typical Applications
Brazing Methods			
Torch, Furnace or Dip	alloys EC, #2EC, 1100, 3003, 3004, 5050, 5052, 6053, 6061, 6062, 6063, 6151, 6951, 43, 356, 406, A612, C612; 0.005 inch and heavier (no maximum)	base material is joined by an aluminum alloy whose melting point is slightly below that of the parent metal; heat is applied, or the assembly is placed in oven or tank	wave guide heat exchangers radiators housings
Soldering Methods			
Torch, Iron, Dip, Wipe, Furnace, Hot Plate, Ultrasonic	alloys EC, #2EC, 1100, 3003, Alclad 3004, 5005, 6061, 6062, 6063, 7072; no maximum or minimum size	lead, tin, zinc or aluminum-zinc is melted into the joint area as oxide is removed by fluxing, rub-tinning or ultrasonic vibration; hard soldering temperature is 715–725F and soft soldering temperature is 338-500 F	transistors cable sheathing lead and ground connections, or any electrical connection with suitable configuration
Welding Methods			
D-C Arc	alloys 1100, 3003, EC, #2EC; wires 0.020 to 5/32 inch diameter	arc established between carbon electrode and the wires produces fusion	pigtail connections any type of wiring
Flash	alloys EC, #2EC, 1100, 3003, and 5000 series; 0.01 to 6 square inches surface area	parts are clamped in dies, arc is established between parts ends, parts are moved together automatically to maintain arc as metal is consumed; when ends are hot enough, the weld is made by driving the ends together with enough speed and pressure to expel molten material and contained impurities; parts are held together until joint cools	copper to aluminum transition joints in wire, rod, tube and bar
Inert Gas Consumable Electrode	all alloys; ⅛ inch and over	welding heat is developed by arc between work and automatically-fed bare electrode	enclosures and structural components all types of connections within size limitations
Inert Gas Tungsten Arc	all aloys; 0.051 to ½ inch	welding heat is developed by arc between work and a tungsten electrode protected by inert gas	enclosures and structural components all types of connections within size limitations
Resistance (Spot and Seam)	almost all wrought alloys; casting alloys 43, 100, D132, 355, 356; 0.010 to 0.125 and heavier	work pieces are pressed together between electrodes; electrical resistance at the interface produces welding heat	semiconductor device cans chassis and cabinets handles electrical connections
Stud	alloys 4043, 6061, 5000 series; surface thickness: 0.020 to 0.125 inch for condenser method; 0.125 inch and over for arc method	aluminum stud is fastened to aluminum surface by condenser (stored energy) or arc welding machine	component-to-chassis fastening covers on cases nameplates
Solid State Bonding Methods			
Pressure Welding	all wrought alloys; 0.00025 to ¼ inch with present tools	pressure makes metal flow; intimate contact between fresh metal and mating surface produces solid state bond	foil capacitor stock capacitor tabs strip transformer coils cable shielding hermetic component seals butt welding wire
Ultrasonic Welding	all alloys; 0.00017 to 0.125 inch for upper material (present equipment); no limit on bottom material thickness	ultrasonic vibration breaks the oxide at the mating surfaces, permitting direct metal contact and solid state bonding	foil capacitor stock capacitor tabs strip transformer coils cable shielding hermetic component seals wire to foil connections



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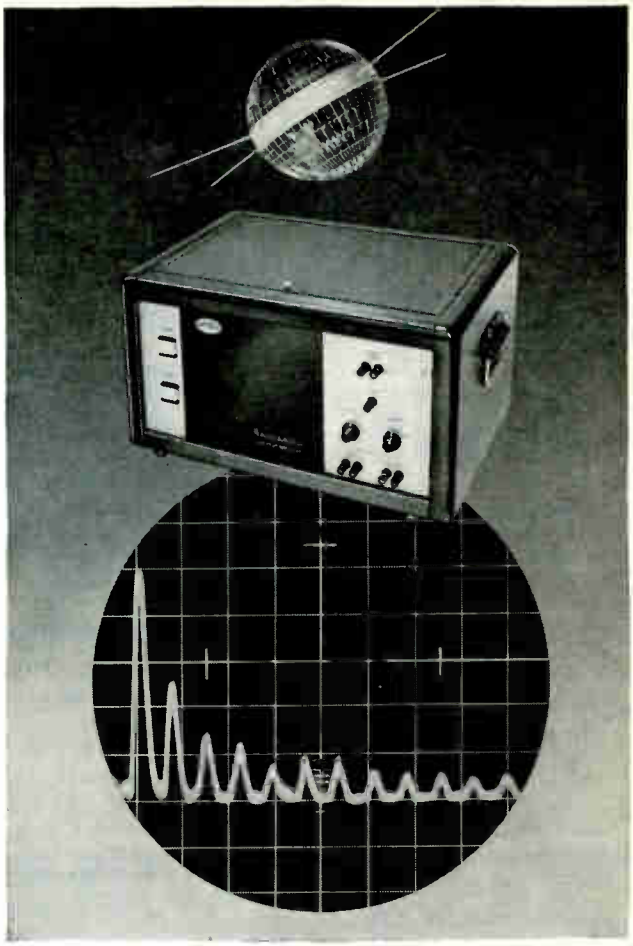

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SPECTRUM ANALYZER

Raytheon Rayspan Spectrum Analyzers, through a unique application of multiple filters, can analyze entire spectrums as wide as 33 kc at scanning rates as high as 200 times per second with excellent resolution and a dynamic range of 40 db. Frequencies as low as 8 cps can be identified. Resolution for two equal-amplitude signals is approximately 0.7% or 3% of the analysis band depending on the Rayspan model employed.

Any model can be adapted for use with high speed, helix recorders to provide permanent records of frequency versus real time. A built-in timing pulse generator allows scan-by-scan synchronization of Rayspan with an oscilloscope.

For complete technical data please write to: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

RAYTHEON

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wide usage to be a suitable joint tensile strength.

The tensile and yield strength of heat-treatable alloys can be made almost equal to that of the heat-treated temper by heat-treatment after joining. Both solution and precipitation heat-treating are needed to attain maximum strength. Soldered parts cannot be solution heat-treated because the solder will melt. Post-joining heat-treatment is widely used on welded or brazed parts.

It is suggested that users call upon the strength data accumulated by Alcoa when an answer to a specific problem is required.

TABLE II—ADVANTAGES AND DISADVANTAGES OF METHODS

Brazing
Advantages: excellent electrical conductivity, requires little operator training, good for complicated assemblies, relatively inexpensive, brazing sheet available does not require additional filler material, fillet formed by capillary action, excellent corrosion resistance
Disadvantages: flux and flux removal required, structure is annealed, narrow brazing range

Soldering
Advantages: inexpensive equipment, little operator training, joins aluminum to copper, offers alternatives to fluxing, good electrical conductivity, economical, low finishing costs, less distortion than welding, multiple joints can be made
Disadvantages: limited corrosion resistance in "non-dry" service (dissimilar metals), low mechanical strength, flux removal necessary if flux is used, not recommended for series 2000 and 7000 alloys

D-C Arc Welding
Advantages: no flux or inert atmosphere needed, excellent electrical characteristics, will join aluminum to copper, can be faster than soldering, better corrosion resistance than soldering, no fumes no post-weld cleaning, equipment is portable
Disadvantages: for pigtail connections only, brittle weld, insulation must be removed from wire ends, mechanical reinforcement (wire twist or clamp) is desirable

Flash Welding
Advantages: good aluminum-to-copper joints, good fatigue strength, strength is 80 percent of parent material, mass production process
Disadvantages: machine not portable, high power demand, high first cost of equipment, die costs

Inert Gas Consumable Electrode Welding
Advantages: fastest arc weld method, no flux, good finish, ductile joints, excellent reproducibility, electrical and mechanical properties equal to annealed parent metal, excellent corrosion resistance, welds difficult alloys, requires least operator training of arc welding methods, can be applied in all positions
Disadvantages: equipment moderately expensive, welding gun not as flexible in use as tungsten arc welding torch, requires inert gas

Inert Gas Tungsten Arc Welding
Advantages: electrical and mechanical properties same as annealed parent metal, excellent finish, versatile position welding and field welding, excellent reproducibility, ductile joints, no flux, excellent corrosion resistance
Disadvantages: skilled operator needed, equipment moderately expensive, requires inert gas (argon or helium)

Resistance Welding
Advantages: economical, fast, no filler metal, machine-controlled process does not require highly-skilled operator, can join high-strength

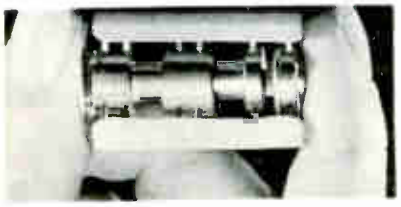
heat-treatable alloys difficult to arc weld
Disadvantages: high first cost of equipment, high power demand, surface precleaning required, work must be brought to machine

Stud Welding
Advantages: good front side appearance (no screw heads, etc.), studs can be threaded internally, good strength and corrosion resistance, good electrical connections, arc stud welding can be done in the field, can be automated
Disadvantages: limited applications, special equipment required

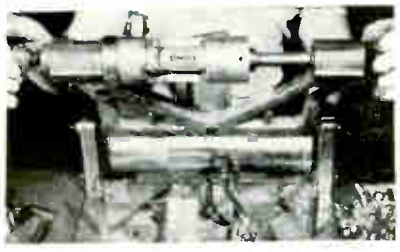
Pressure Welding
Advantages: no flux, heat or current needed, electrical and mechanical properties equal to parent material, easily portable, joins aluminum to copper and other nonferrous metals, inexpensive, little operator training needed
Disadvantages: surfaces must be specially cleaned, approximately 60 percent deformation of cross sectional area in lap welds, difficult to inspect

Ultrasonic Welding
Advantages: no flux, heat, or current, no surface preparation, little or no deformation, joins multiple sections or thin-to-heavy sections, electrical and mechanical properties equal to parent material, excellent reproducibility, little operator training needed, fairly high speed, welds aluminum to copper and some other metals
Disadvantages: expensive equipment, one member limited to foil or light gauge sheet, not portable

Colored Rods Pinpoint Production Problems



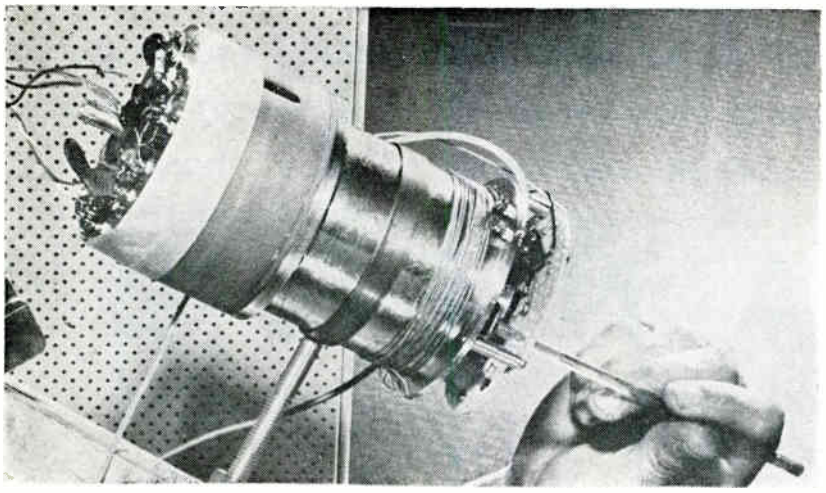
Colors of rods identify gun and production equipment



Parts assembled in mandrel are pressed into heated rod

COLORED SUPPORT rods are used by cathode ray tube gun makers for gun identification and production control. The Lansdale Division of Philco Corp., Lansdale, Pa., buys Multiform rods colored tan, blue, green and white. The color used on two side rods identifies the type, the third identifies the equipment used in fabricating the gun. Should subsequent testing indicate gun misalignment, the source of the trouble can be readily determined.

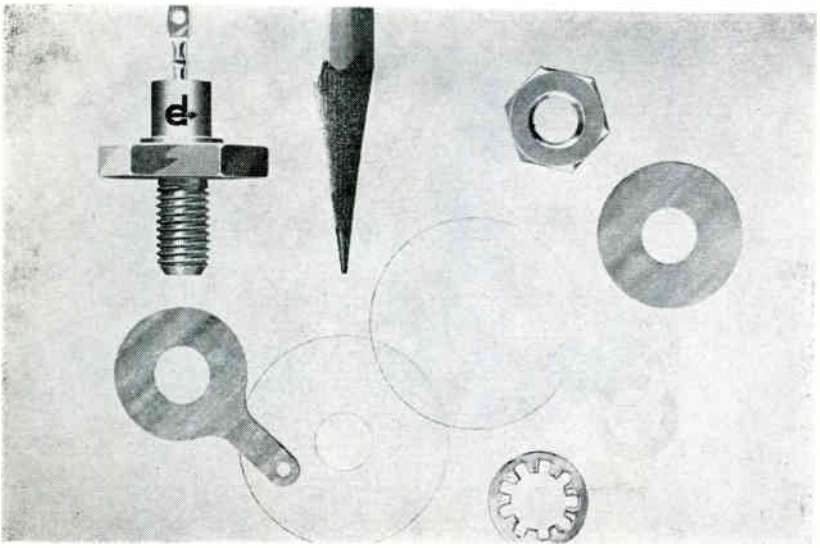
New On The Market



Space-Age Timepiece
RUBIDIUM GAS CELL

FMA, INC., 142 Nevada St., El Segundo, Calif. Rubidium frequency standard provides a frequency source stable to 1 part in 10^{11} over a period of one month—comparable to a clock that loses but 1 sec in 300 years. It is small, rugged and consumes small amounts of power. Its characteristics are suitable for many applications in the high-frequency electromagnetic spectrum required in the communications, navigation and computational systems of aircraft and missiles.

CIRCLE 301 ON READER SERVICE CARD



Zener Diode
SILICON DIFFUSED-JUNCTION

DICKSON ELECTRONICS CORP., 248 Wells Fargo Ave., Scottsdale, Ariz.. introduces a 50-w silicon diffused-junction Zener diode in a DO-5 11/16 in. stud package. Units cover the 6.8 through 100-v range and have a tolerance of 5 percent. Cases are hermetically sealed with junctions isolated from deleterious ambients by rugged, resistance-welded, glass-to-metal seals. External surfaces are corrosion resistant. Units are priced from $6.25 to $11.75 in quantities 1 to 24, depending on voltage tolerance.

CIRCLE 302 ON READER SERVICE CARD

Silicon Solar Cell
N-P TYPE

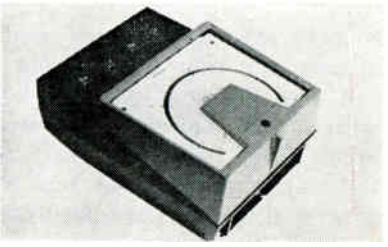
HOFFMAN ELECTRONICS CORP., 1001 North Arden Drive, El Monte, Calif., has developed the *n-p* type silicon solar cell. Until now cells were made by forming a thin skin of boron diffused *p*-type material on an *n*-type substrate. With *n-p* cells the *n*-type skin is formed by diffusing phosphorous onto *p*-type silicon; *n-p* cells promise a good future in solar power supplies on space craft. Available in sample quantities at $15 each.

CIRCLE 303 ON READER SERVICE CARD

Lightweight Antenna
EASY TO FABRICATE

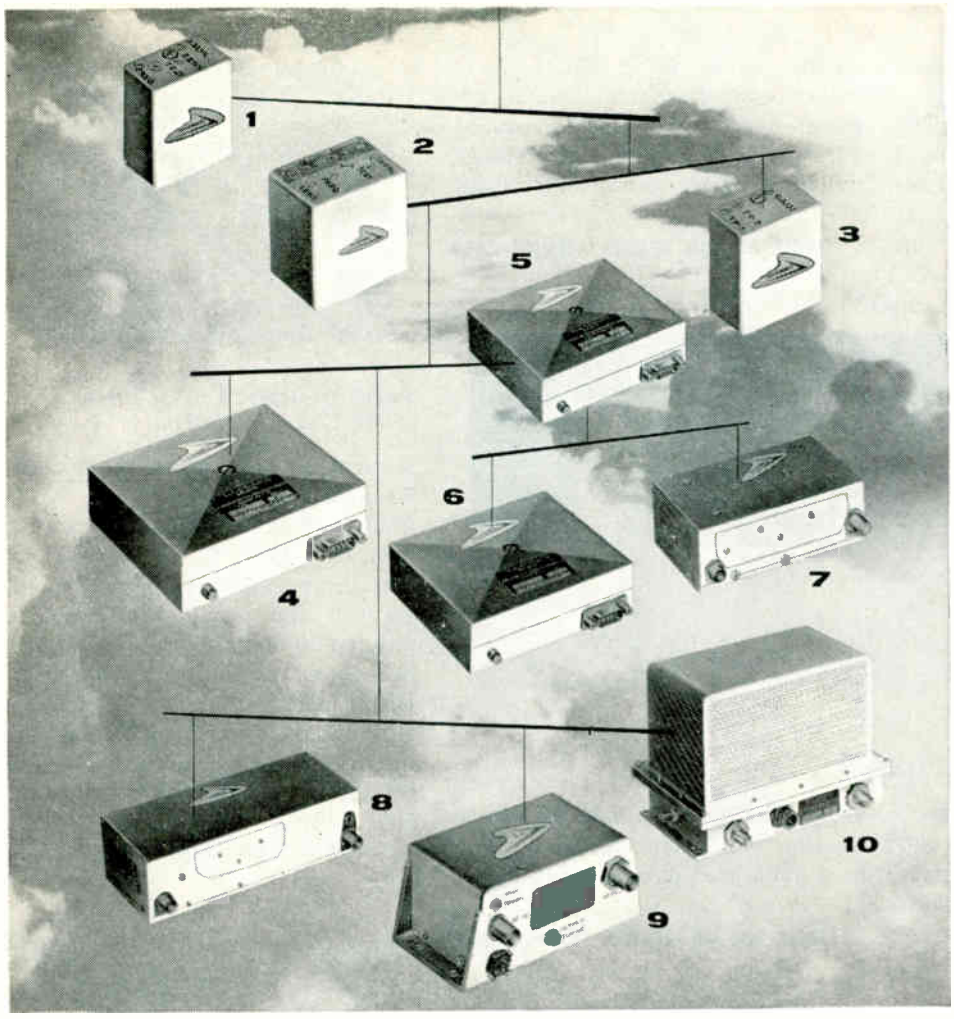
SYLVANIA ELECTRIC PRODUCTS INC., Mountain View, Calif., has developed an antenna composed of a lightweight, rigid foam reflector and an antenna positioning device that can move the reflector through any angle of azimuth and elevation. Unit is inexpensive, strong and easy to fabricate. Potential uses include satellite communication and radio and radar astronomy.

CIRCLE 304 ON READER SERVICE CARD



Ammeters, Voltmeters
TAUT-BAND SUSPENSION

WESTINGHOUSE ELECTRIC CORP., P.O. Box 2099, Pittsburgh 30, Pa. Port-



1 1270 high performance, high level VCO, 2 cubic inches volume.

2 1274±5 millivolt floating input VCO for grounded and ungrounded differential signals—4½ cubic inches.

3 1170 wideband amplifier for use with 1270 and 1274 subcarrier oscillators.

4 1053 1 watt all-transistor FM transmitter (silicon) 100° C. 350 ma at 28 vdc; 20 cubic inches, 17 ounces, unlimited altitude.

5 1055 2 watt all-transistor FM transmitter (germanium) 60° C; case same as 1053.

6 1051 FM transmitter, 3 watts, tubed output stage; case same as 1053.

7 1008 compact 2 watt tubed FM transmitter.

8 1009 12 watt FM transmitter, unlimited altitude.

9 1114 15 watt RF power amplifier.

10 1090A frequency converter . . . 8 watt RF output at 2200-2300 mc; unlimited altitude.

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The new oscillators—1270 high level and 1274 low level—provide mechanical interchangeability as well as outstanding electrical and environmental characteristics. The transistorized transmitters provide 1 or 2 watt true FM output with maximum efficiency in size, weight and power consumption. The tubed transmitters (1008-1009), amplifier (1114) and 2200mc converter provide the maximum performance compatible with the state of the vacuum tube art. All of the units are capable of being easily combined into various custom systems.

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able a-c and d-c ammeters and voltmeters feature taut-band suspension frictionless mechanisms. The moving element of the taut-band suspension system is suspended between bands of high-strength metal ribbon which are supported on springs at each end. There is no wear between moving parts and maintenance is greatly reduced. First units, available in September, will have ½-percent accuracy rating.

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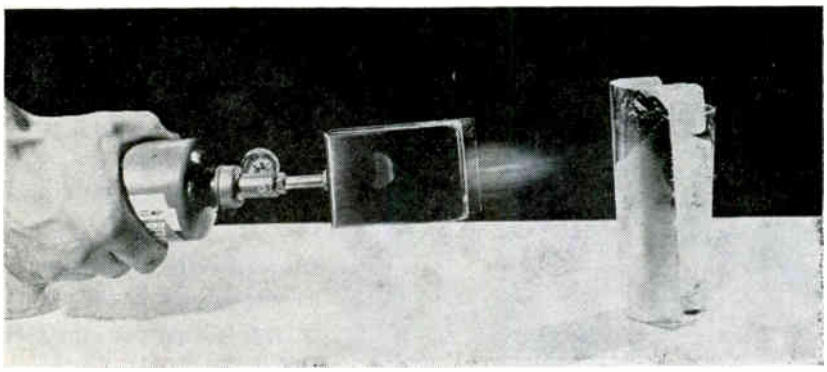


Heat Reflective Tape
PROTECTS MISSILE COMPONENTS

MYSTIK ADHESIVE PRODUCTS, INC., 2635 N. Kildare Ave., Chicago 39, Ill. Mystik No. PD-455 is a laminate of aluminum foil and glass cloth with a silicone adhesive. It was developed as a heat shield to protect missile components from radiant heat generated during blast-off.

CIRCLE 306 ON READER SERVICE CARD

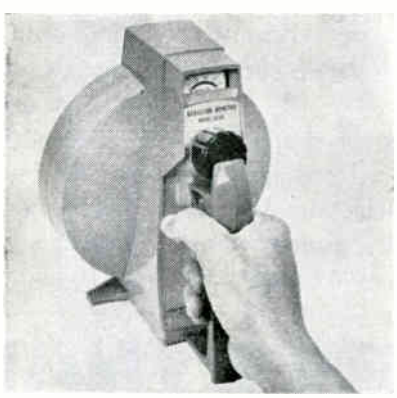
Pulsed Ruby Laser
FOR RESEARCH

RAYTHEON CO., 130 Second Ave., Waltham 54, Mass. A pulsed ruby laser, priced at $5,850, includes the laser head and power supply. The head, 8 in. long and 5 in. in diameter, houses a chromium doped ruby and single xenon flash tube. Improved optical design permits laser action with less than 200 joules. Power supply is in a mobile console. Input required is 115 v, 60 cps. Charge time is normally 15 sec max.

CIRCLE 307 ON READER SERVICE CARD

Radiation Detector
ELECTROMAGNETIC

SPERRY MICROWAVE ELECTRONICS CO., Clearwater, Fla. Model B86B1 electromagnetic radiation detector weighs under 2 lb. It operates over a frequency range of from 400 Mc to 10,000 Mc, has a single integral antenna and uses standard, large-capacity mercury batteries. Instrument responds to all planes of polarization—linear, left- and right-hand circular, random, pulsed or continuous wave.



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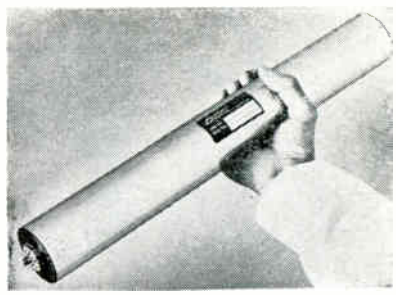


Low Noise T-W Tube
METAL-CERAMIC

MICROWAVE ELECTRONICS CORP., 4061 Transport St., Palo Alto, Calif. Model 2110A metal-ceramic twt, for operation from 2.3 to 4.45 Gc, is periodic permanent magnet (ppm) focused and provides 10-mw output and 30-db gain with a maximum broadband noise figure of 10 db. Effect of stray magnetic fields is eliminated and tubes may be used in close proximity to magnetic materials or to each other. Price, $3,500; delivery 30 days.

CIRCLE 309 ON READER SERVICE CARD

Variable Heatsink Oven
SMALL IN SIZE

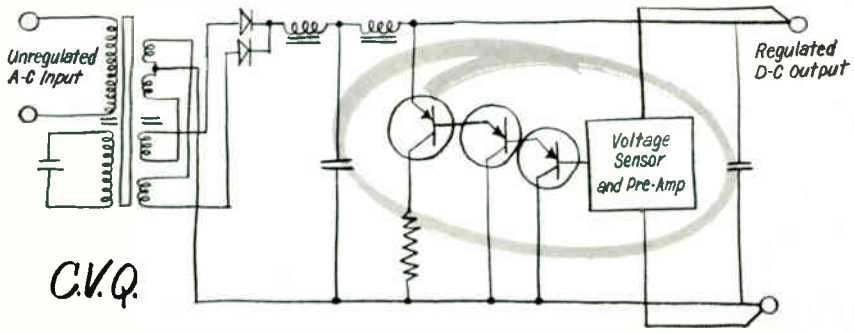
VIKING INDUSTRIES, INC., 21343 Roscoe Blvd., Canoga Park, Calif. Series 900 variable heatsink oven is designed to thermally stabilize power dissipating circuitry. Three models are available with circuit power ratings of 1, 3, and 10 w and heater power ratings of 7, 14, and 28 w. Standard operating ambient is − 55 C to + 60 C.

CIRCLE 310 ON READER SERVICE CARD

Capacitors
POLYCARBONATE TYPE

COMPONENTS SPECIALTIES, INC., 3 Foxhurst Road, Baldwin, L. I., N. Y., has introduced a complete line of subminiature polycarbonate capacitors for all printed circuit applications. These low voltage capacitors operate at 75 v and are

SOLA writes this new Rx for reliable d-c power



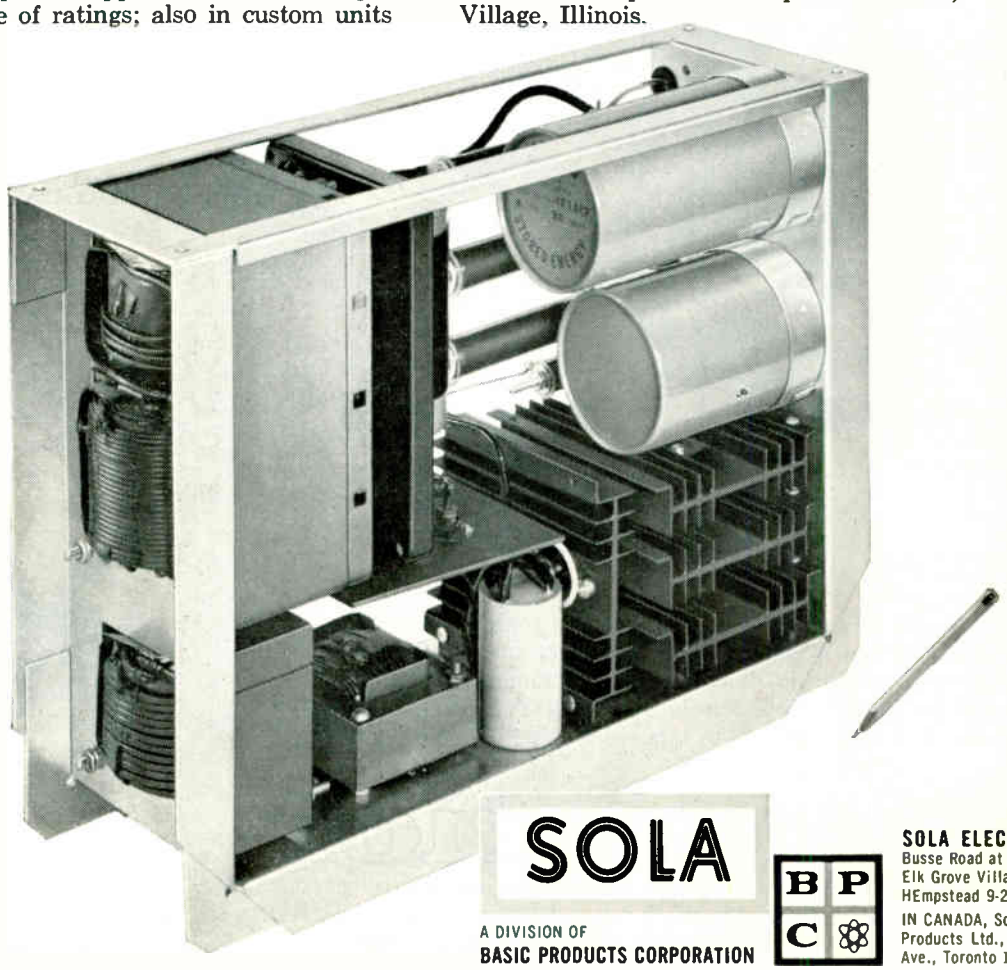
This schematic tells "CVQ's" secret at a glance . . . how SOLA's remarkably reliable new power supply achieves d-c output ideal for computers and other voltage-sensitive equipment. "CVQ" integrates the advantages of shunt-circuit regulation with the *inherent* high stability of the SOLA static-magnetic transformer. And the result is transistorized voltage regulation *with split-cycle response!*

"CVQ" answers the demands of dynamic loading. Voltage variations are ironed out down to the last transient — even to the last ripple of the a-c source. And the SOLA static-magnetic transformer *automatically* prevents damage in event of a short circuit.

SOLA "CVQ" d-c power supplies are available *right now*, in a wide range of ratings; also in custom units built to your specific requirements. Advantages include:

- More watts per dollar.
- Continuous automatic protection without fuses, both for output short circuits, and for open circuits in the voltage-sensing circuitry.
- Output regulated within ±0.04% for line voltage variations ±15%; 0.2% static-load regulation, 0 to full load. Excellent response time.
- Standard models available in the 120-watt range for 5, 6, 10 and 12 volts d-c (100-130/181-235/200-260 volt input).
- Compact mechanical layout — only 12¼ x 5¼ x 19".

Get full facts by writing for new SOLA Catalog DCX-361A. Or telephone HEmpstead 9-2800, Elk Grove Village, Illinois.



SOLA

A DIVISION OF
BASIC PRODUCTS CORPORATION

BPC

SOLA ELECTRIC CO.
Busse Road at Lunt,
Elk Grove Village, Ill.
HEmpstead 9-2800
IN CANADA, Sola-Basic Products Ltd., 377 Evans Ave., Toronto 18, Ontario

available in both flat and round types.

CIRCLE 311 ON READER SERVICE CARD

Spectrum Analyzer
ONE-THIRD OCTAVE

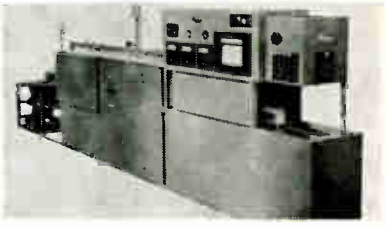
DAYSTROM, INC., 4455 Miramar Road, La Jolla, Calif. Portable one-third octave spectrum analyzer for self-noise analysis will be used aboard naval vessels. Inputs from ten lead zirconate hydrophones plus five other sonar inputs are manually selected for automatic plotting. Three modes of operation: 8 and 20 second integration periods and peak sampling integration period. Integration is performed simultaneously in 31 one-third octave bands.

CIRCLE 312 ON READER SERVICE CARD

Tachometer

PIONEER ELECTRIC & RESEARCH CORP., Forest Park, Ill. Miniature tachometer checks both constant speed and changing speed equipment. Calibrates speeds from 0 to 12,000 rpm.

CIRCLE 313 ON READER SERVICE CARD



Furnace
COMBINATION UNIT

BTU ENGINEERING CORP., Bear Hill Road, Waltham 54, Mass. The Tandem Transheat is a furnace that

combines degassing and oxidation of Kovar into one continuous operation, prior to use in glass-to-metal seals. Advantages are the prevention of contamination after degassing and the creation of a highly uniform and reliable oxide coating on the Kovar which assures a proper seal with uniform production results. The furnace reduces production costs by eliminating double handling.

CIRCLE 314 ON READER SERVICE CARD

Commutator

ARNOUX CORP., 11924 W. Washington Blvd., Los Angeles, Calif. The 30-channel unit, for airborne telemetry, is 16 cubic in. and weighs 20 ounces.

CIRCLE 315 ON READER SERVICE CARD

Delay Lines
VARIABLE TYPE

COMPUTER DEVICES CORP., 6 W. 18th St., Huntington Station, N. Y., announces a series of miniature continuously variable lumped and distributed constant delay lines. Model V172 lumped constant type (illustrated) has a time delay of 0 to 0.55 μsec; rise time, 0.08 μsec; impedance, 1000 ohms; resolution, 1/1000; temperature coefficient, less than 50 ppm.

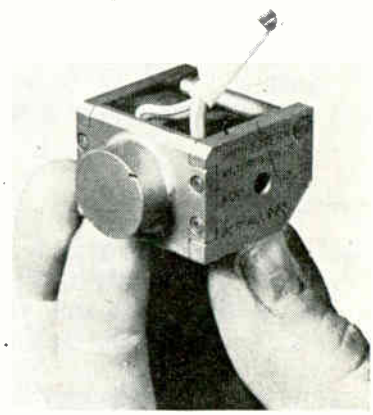
CIRCLE 316 ON READER SERVICE CARD

Power Resistor
ADJUSTABLE

INVAR ELECTRONICS CORP., 1723 Cloverfield Blvd., Santa Monica, Calif. Model OX Powertrim adjustable power resistor eliminates finger burn or shock hazards during ad-

justment. It provides stack mounting with 4-40 screws or chassis mounting utilizing a single ⅜ in. volume-control hole. Unit requires only ½ cu in. of packaging space.

CIRCLE 317 ON READER SERVICE CARD



Proportional Solenoid
WEIGHS LESS THAN 4½ OZ

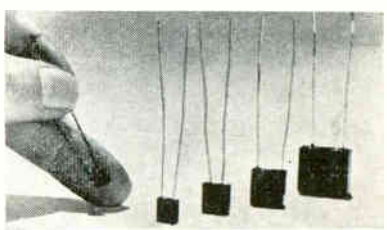
MIDWESTERN INSTRUMENTS, INC., P. O. Box 7509, Tulsa 18, Okla. Model 15 is a minute proportional solenoid for applications requiring relatively small, high-force displacements proportional to input signals. It can be mounted to provide force in any direction, operates dependably in environmental temperatures to 400 F, and is submersible in fluid or gas.

CIRCLE 318 ON READER SERVICE CARD

Static Relay

AIRBORNE ACCESSORIES CORP., 5456 W. Washington Blvd., Los Angeles, Calif. Relay responds to 0.5 microwatt excitation, handles up to 750 w, 60 cycle loads, and resists shock and vibration.

CIRCLE 319 ON READER SERVICE CARD



Ceramic Capacitors
GENERAL PURPOSE

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J. Type CK ceramic capacitors operate over

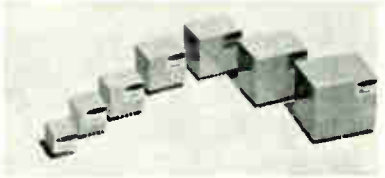
a temperature range of − 55 C to + 150 C and are available in five molded plastic case sizes—from 0.2 in. sq to 0.6 by 0.5 in. Line is widely applicable in airborne communications equipment, computers, and ground-support equipment.

CIRCLE 320 ON READER SERVICE CARD

Tuneable Load

MAURY & ASSOCIATES, 10373 Mills Ave., Pomona, Calif. Coaxial terminations for vswr measurements can achieve vswr of 1.005 at single frequencies and 1.02 maximum for a full octave.

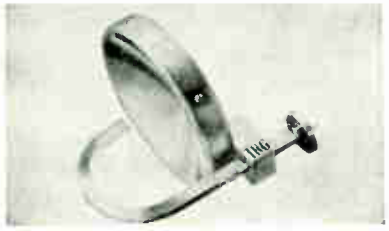
CIRCLE 321 ON READER SERVICE CARD



Transformers
MULTIPURPOSE

MAGNETIC CIRCUITS ELEMENTS INC., Montrose, Calif., has available seven sizes of small, lightweight multipurpose transformers, 400 cps/20 Kc. These type C transformers, with can and terminal construction, are valuable for laboratory breadboard use and are sufficiently rugged and durable for frequent re-use, permanent installation or production requirements.

CIRCLE 322 ON READER SERVICE CARD



Parabolic Antenna
THREE-IN. DIAMETER

TECHNICAL RESEARCH GROUP, INC., 9 Union Square, Somerville, Mass., has available a parabolic antenna in V, E and F bands. It has a 4.0 deg beam width at 70 Gc. It is rated at 22 db max side lobe; 32.9 db gain; 1-in. focal length. Antenna is designed for millimeter systems and antenna test applications.

CIRCLE 323 ON READER SERVICE CARD

Literature of the Week

HIGH SPEED RELAYS James Electronics Inc., 4050 No. Rockwell, Chicago 18, Ill. Catalog describes and gives circuit and application diagrams for a line of spdt, dpdt and 3 pdt Micro-Scan relays.
CIRCLE 324 ON READER SERVICE CARD

INDUCTIVE - COUPLING DEVICES Dychro Corp., 49 Walnut St., Wellesley 81, Mass., announces a technical bulletin describing the operating principles and applications of Inductosyns.
CIRCLE 325 ON READER SERVICE CARD

FACILITIES BROCHURE McDonnell Automation Center, Box 516, St. Louis 66, Mo., has published a brochure explaining generally the wide range of services offered, including consulting, systems design, programming and data processing.
CIRCLE 326 ON READER SERVICE CARD

DIGITAL RECORDER Minneapolis-Honeywell Regulator Co., 10721 Hanna St., Beltsville, Md. Flyer describes IDR6150 incremental digital recorder that has applications in computer programming, seismology and geology.
CIRCLE 327 ON READER SERVICE CARD

WIRE STRIPPER Eubanks Engineering Co., 260 N. Allen Ave., Pasadena, Calif., offers a 6-page brochure on the model 810A automatic wire stripper, with descriptions and photographs of new quick-change features.
CIRCLE 328 ON READER SERVICE CARD

C-R TUBES Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y. A 12-page brochure on industrial and military cathode ray tubes is available.
CIRCLE 329 ON READER SERVICE CARD

SSB TRANSCEIVER RF Communications Associates, Inc., 13 Canal St., Rochester 8, N.Y. Bulletin describes model SB-6F ssb transceiver designed for long and short range h-f communications.
CIRCLE 330 ON READER SERVICE CARD

RESONANT REED RELAY Bramco Inc., 4501 Belvidere, Detroit 14, Mich. Preliminary spec sheet No. 89 covers model BH-1-RM resonant reed relay that features balanced reed and frame, shock mounting and hermetic sealing.
CIRCLE 331 ON READER SERVICE CARD

SILICON DIODES Computer Diode Corp., 250 Garibaldi Ave., Lodi, N. J. A 4-page brochure lists the characteristics of 86 conventional glass silicon diodes.
CIRCLE 332 ON READER SERVICE CARD

MICROWAVE POWER FILTERS General Electric Co., Schenectady 5, N. Y. Booklet PT-52 describes five filters designed to suppress harmonics generated in high-power transmitters ranging from 400 to 6,000 Mc.
CIRCLE 333 ON READER SERVICE CARD

POTENTIOMETERS International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Bulletin AE26 describes a line of multiturn pots for either bushing or servo mount.
CIRCLE 334 ON READER SERVICE CARD

SWEEPING OSCILLATOR Kay Electric Co., Maple Ave., Pine Brook, N. J., has available a mailing piece describing the Ligna-Sweep SKV sweeping oscillator with a range of 200 cps to 220 Mc.
CIRCLE 335 ON READER SERVICE CARD

EPOXY PELLET ADHESIVES Epoxy Products, Inc., 137 Coit St., Irvington, N. J. Information bulletin No. 6 gives the characteristics and applications of epoxy E-Form adhesive pellets.
CIRCLE 336 ON READER SERVICE CARD

LIGHT INDICATOR MODULES Raytheon Co., 55 Chapel St., Newton 58, Mass. Light indicator modules for computer and instrument manufacturers are described in a recent folder.
CIRCLE 337 ON READER SERVICE CARD

PREAMPLIFIER Infrared Industries, Inc., P. O. Box 42, Waltham, Mass., has available a specification sheet describing a miniature low-noise preamplifier.
CIRCLE 338 ON READER SERVICE CARD

Service Spurs Spellman Growth

SPELLMAN HIGH VOLTAGE CO., producer of high voltage power supplies and associated equipment for the last 16 years, recently moved to larger quarters in the Bronx, N. Y.

The new plant has 5,000 sq ft of production and test floor space plus 1,800 sq ft of office space.

William Spellman, president of the company, also announces a new transformer division has been started, specializing in high voltage custom transformers.

The Spellman High Voltage Co. was originally formed to produce projection television sets and, says Spellman, had to design its own h-v power supplies since none could be found to suit its needs. This led to the present line of supplies.

As a second sidelight of growth in this field, the company says it has built a considerable business in the supply of corona discharge balls for many other concerns working with high voltage.

To quote Spellman: "Our business was built on service. Now, in larger quarters, we will be able to continue supplying this service, even though there has been a very large increase in orders."

GE Names Brown To High Post

ROBERT J. BROWN has been appointed head of General Electric's multimillion dollar ground and shipboard military electronics business, according to George L. Haller, GE vice president and general manager of the Defense Electronics Division.

As general manager of the company's Heavy Military Electronics Department, Brown is responsible for directing one of the firm's largest defense operations in terms of sales volume and employees, Haller disclosed. Brown was formerly manager-marketing of General Electric's HMED.

Set Up New Company For Crystal Production

ELECTRONIC CRYSTALS, INC., a new company, was recently formed in Orlando, Fla., to concentrate on the research, development and manufacture of highly specialized types of premium quartz crystals, according to Robert B. Corbin, vice president in charge of production.

In addition to Corbin, other officers of the company are: Sidney M. Kaplan, president; William H. Horton, executive vice president; Ben B. Moss, secretary-treasurer and Robert Angove who will serve as crystal engineer.

Antenna Systems Forms Pacific Division

ANTENNA SYSTEMS, INC., Hingham, Mass., announces formation of a Pacific Division in National City, Calif. This division will have all the facilities necessary to offer a complete antenna service including design, construction and installation of antennas in the field of scatter communications, missile tracking, radar, and radio astronomy.

Elect Allen President Of New DCA Unit

DYNAMICS CORP. OF AMERICA has announced that Charles L. Allen, for the past five years assistant to the president of DCA, has been elected president of International Fermont Machinery Co., recently-acquired DCA subsidiary.

Hurst Transfers To Erie-Pacific

ARTHUR H. HURST has been appointed as application engineer in

ARNOLD/TOROIDAL COIL WINDER

sets up quickly...easy to operate...
takes wide range of wire sizes

SPECIFICATIONS:

- Min. finished hole size: .18 in.
- Max. finished toroid O.D.: 4.0 in.
- Winding speed: 1500 turns/min.
- Wire range: AWG 44 to AWG 26
- Dual, self-checking turns counting system
- Loading (wire length) counter
- Core range: ¼" I.D. to 4" O.D. to 1½" high

LABORATORY USE

- Change wire and core size in 45 sec.

PRODUCTION USE

- 1500 turns per minute
- Insert core and load in 20 sec.

includes all rings, counters and accessories

immediate delivery. literature on request

ARNOLD MAGNETICS CORP.
6050 W. Jefferson Blvd., Los Angeles 16, Calif.
VErmont 7-5313

CIRCLE 209 ON READER SERVICE CARD

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Large production gives you low prices!
– that's why...

Over 100 O.E.Ms have standardized on

AMPERITE

Thermostatic DELAY RELAYS

2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —35° to +80° C. Heaters consume approximately 2 W. and may be operated continuously. The units are rugged, explosion-proof, long-lived, and—inexpensive!

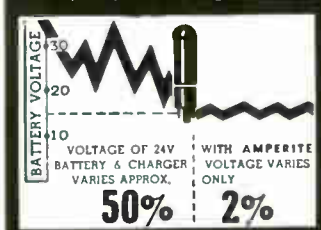
TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.**

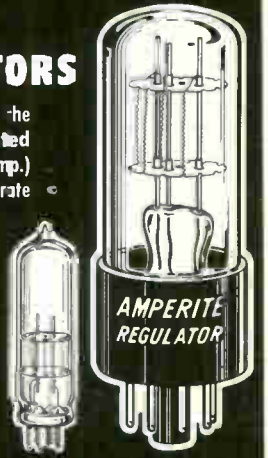
Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—50° to +70° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE

561 Broadway, New York 12, N. Y. . . . CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

CIRCLE 93 ON READER SERVICE CARD

the sales department of Erie-Pacific, division of Erie Resistor Corp., Hawthorne, Calif.

He was transferred to the west coast division from the parent company, Erie Resistor Corp., Erie, Pa., where he worked on transistorized logic circuit design and systems work involving logic circuits.

Philip S. Fogg Takes Additional Post

PHILIP S. FOGG, board chairman of Consolidated Electrodynamics Corp., Pasadena, Calif., and vice chairman of Bell & Howell Co., has been elected chairman of the board of Consolidated Systems Corp., an associate company of Allis-Chalmers, Bell & Howell, and CEC.

He succeeds William E. Roberts, formerly executive vice president of Bell & Howell.

Ling Temco Hires Charles O'Neil

CHARLES E. O'NEIL has joined the staff of Micromodular Components Division of Ling-Temco Electronics, Inc., Anaheim, Calif., as manufacturing manager.

Before taking this post, O'Neil was with Rheem Semiconductor Corp. where he established techniques for large-scale production of diodes in tightly matched groups—

with typical matching control applications on the order of one millivolt.

Fairchild Semiconductor Hires Irvin Solt

IRVIN H. SOLT, JR. has been named to head the new microwave physics section of the research and development laboratory of Fairchild Semiconductor Corp., Mountain View, Calif.

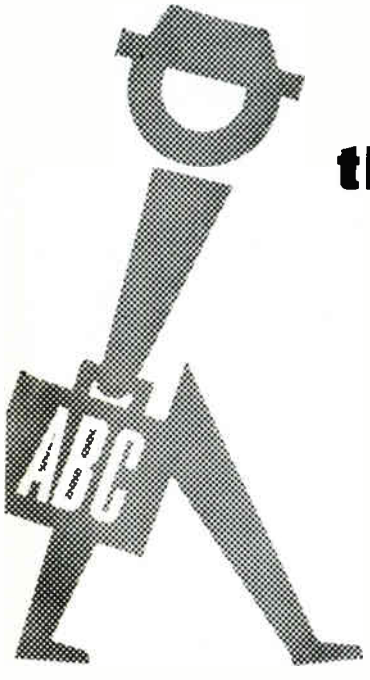
Solt, who was an experimental physicist with the Hughes Aircraft Company's research laboratories at Malibu, Calif., prior to joining Fairchild, will investigate the applications of semiconductor technology to microwave components.

PEOPLE IN BRIEF

Daniel J. Love, formerly with Information Systems, Inc., joins Control Corp. as product manager for advanced control systems. **D. G. Wilson**, vice president of research for P. R. Mallory & Co., accepts the additional post of vice president of engineering. **Eugene Michaels** transfers from Litton Industries to Technology Instrument Corp.'s California facilities as project engineer. **Claude T. Brown**, formerly a Navy consultant, and **William B. D. Harris**, recently an engineering consultant firm president, join the engineering staff of American Bosch Arma Corp.'s Tele-Dynamics Div. **William S. Stroud**, ex-Convair Electronics, appointed manager of industrial engineering at the San Diego Branch of General Dynamics/Electronics' military products division. **Philip C. Ross** leaves General Electric to join Electro-Tec Corp. as engineering manager of switch devices. **Alfred Gartenhaus**, previously with RCA, named a technical staff member at Auerbach Electronics Corp. **James A. Witzler** of Branson Corp. promoted to general manager. **Robert S. Butts** of Melpar, Inc., elected to the board of directors of Vari-L Company, Inc. **Ralph J. Steinitz** leaves Bendix Radio to join Electronic Modules Corp. as senior design engineer.

here,

there . . .



almost everywhere

Members of the specially trained, 70-man field auditing staff of the Audit Bureau of Circulations* make regular calls on 2,900 publications . . . ours included . . . located in almost as many places.

The ABC auditor's call might last a day, a week, or even several months . . . just as long as it takes him to make a complete audit of our circulation records and obtain the information about our circulation audience that ABC will later publish.

Actually, he is working for you — our readers and our advertisers. Knowing full well that we will stay in business only so long as our publication continues to serve the interests of our readers, this audit of our *paid* circulation provides us with a regular and objective review of how well you think we are doing.

Knowing full well that sales messages must reach a responsive audience in order to be effective, our advertisers are also interested in the ABC auditor's call. The hard, and sometimes cold, facts he reports about our circulation provide you with an informed basis for investing your advertising money.

Yes, the ABC auditor has been here . . . and he will be here again, calling to check on how well we are doing our job and to provide the facts to help us *and our advertisers* do even better.

electronics

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electronics

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ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

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Your Qualificatian form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

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1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

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CORNING ELECTRONIC COMPONENTS Corning Glass Works Bradford, Pa.	98	2
ESQUIRE PERSONNEL Chicago, Illinois	166*	3
GENERAL ELECTRIC CO. Defense Systems Dept. Syracuse, New York	164*	4
GENERAL ELECTRIC CO. Professional Placement Center New York, New York	100	5
GRUMMAN AIRCRAFT ENGINEERING CORP. Bethpage, L. I., New York	99	6
IBM CORPORATION New York, New York	163*	7
LOCKHEED MISSILES & SPACE DIV. Sunnyvale, California	19	8
MITRE CORPORATION Bedford, Mass.	98	9
NATIONAL SCIENTIFIC LABS., INC. Washington, D. C.	166*	10
PERKIN-ELMER CORP. Norwalk, Connecticut	164*	11
REPUBLIC AVIATION Farmingdale, L. I., New York	166*	12
SCIENTISTS, ENGINEERS & EXECUTIVES INC. Washington, D. C.	166*	13
SIKORSKY AIRCRAFT Div. of United Aircraft Corp. Stratford, Connecticut	165*	14
WESTERN ELECTRIC ENGINEERING RESEARCH CENTER Princeton, New Jersey	98	15
P-6754	100	16

* These advertisements appeared in the 6/9/61 issue.

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME .....

HOME ADDRESS .....

CITY ..... ZONE ..... STATE .....

HOME TELEPHONE .....

Education

PROFESSIONAL DEGREE(S) .....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

FIELDS OF EXPERIENCE (Please Check) 6161

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other .....
☐ ECM	☐ Operations Research	☐ .....
☐ Electron Tubes	☐ Optics	☐ .....
☐ Engineering Writing	☐ Packaging	☐ .....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	.....	.....
RESEARCH (Applied)	.....	.....
SYSTEMS (New Concepts)	.....	.....
DEVELOPMENT (Model)	.....	.....
DESIGN (Product)	.....	.....
MANUFACTURING (Product)	.....	.....
FIELD (Service)	.....	.....
SALES (Proposals & Products)	.....	.....

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

ENGINEERS • SCIENTISTS

THINKING AHEAD

••• to the Command and Control System Requirements of the '70's

This is one of the responsibilities of The MITRE Corporation. MITRE, an independent system engineering organization, is engaged in the design, development and evaluation of the Command and Control Systems for the future. As Technical Advisor to the Air Force Electronics Systems Division, MITRE's tasks are:

... to provide technical advice and system engineering support for the development of command and control systems for the Aerospace Defense Environment *of this decade.*

... to assist in the formulation of the new system requirements of the '70's and beyond. As part of its work activity, MITRE has a comprehensive program of analytical studies relating to anticipated threats and countermeasures to meet them in such critical areas as:

Advanced ICBM Defense
Satellite Interceptors
Advanced Strategic Delivery Systems
Ferret and Intelligence Processing Systems
Survivability Techniques

These broad technical objectives offer exceptional opportunities for well-trained engineers and scientists.

Openings are also available at MITRE's facility in Montgomery, Alabama.

Inquiries may be directed in confidence to
VICE PRESIDENT — TECHNICAL OPERATIONS

THE MITRE CORPORATION

Post Office Box 208, 17-WM, Bedford, Massachusetts

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

A brochure more fully describing MITRE and its activities is available upon request.

Systems Analyst

The Western Electric Engineering Research Center has a challenging opportunity for an individual experienced in systems analysis, logic design, and computer applications.

He should possess a high degree of creative and analytical ability, and a mathematical background sufficient to assume primary responsibility for conducting research on information retrieval.

Personal benefits including pension and stock purchase plans are second to none in industry.

All qualified applicants will continue to receive consideration for employment without regard to race, creed, color or national origin.

If you would enjoy creative work in a country setting and community living that offers the cultural atmosphere of Princeton, write in confidence to:

Mr. W. F. DeHaven

WESTERN ELECTRIC

ENGINEERING RESEARCH CENTER

Post Office Box 900

Princeton, New Jersey

Electro-Optics

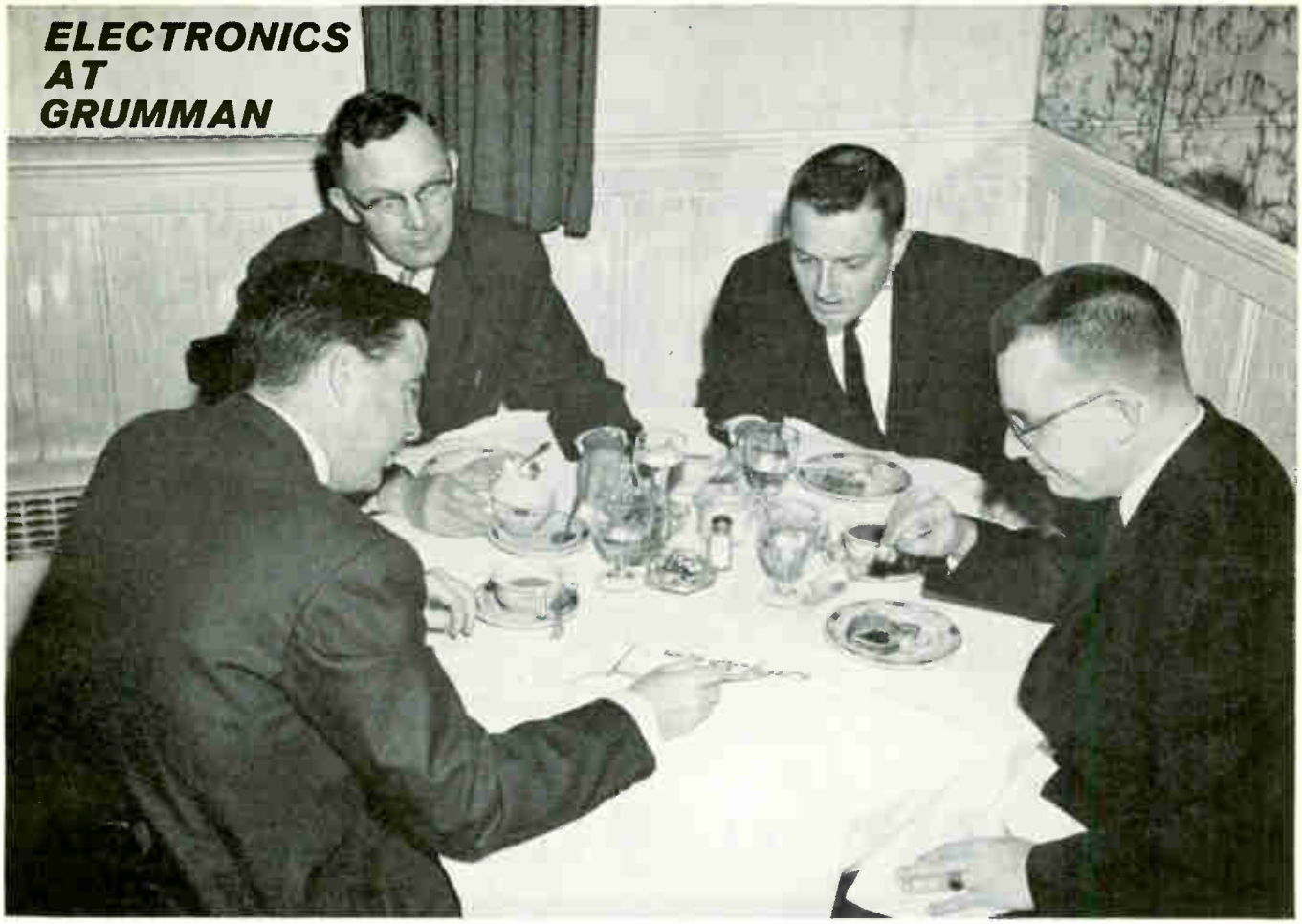
Corning Electronic Components, Corning Glass Works needs men with the following qualifications:

1. Postgraduate study in EE, Physics, or Math
2. Two or more years experience
3. A desire to contribute to the development of light modulating devices and electro-optical systems.

Corning Electronic Components is situated in Bradford, Pa., adjacent to Allegheny State Park, near Chautauqua Lake and 80 miles south of Buffalo, N. Y.

Please write R. J. Stone or call collect:
FO 2-5571.

CORNING ELECTRONIC COMPONENTS
CORNING GLASS WORKS BRADFORD, PA.



...INSPIRATION BREAK

A restaurant is hardly the place for expressing the radiation characteristics of an antenna, but that's how it goes at Grumman. Patrons at restaurants in and around Bethpage, L.I. can easily spot Grumman engineers who, usually in groups of three or four, are engrossed in some theoretical discussion. While no statistics are available it is the Grumman impression that many an inspiraton to the solution of a knotty technical problem has occurred off the Company premises.

Perhaps the best way to describe the Grumman engineer is by what he doesn't like...which is being channeled down a narrow path where he can't branch out and use his own initiative. Technical areas and responsibilities are broad at Grumman and the Grumman engineer expands to meet them. We have found that the informal approach breeds first class engineering ideas.

Engineers seeking this kind of environment for their own abilities are cordially urged to consider the following responsible positions.

Digital Computer Systems Engineer — BSEE with a minimum of 4 years experience in the analysis design and development of digital computers. Will participate in the integration of digital computer into a complex weapons system. A significant part of the effort will be devoted to extensive laboratory and flight development programs.

Secondary Power Engineer — EE or Physicist with understanding of electrical energy generation, thermodynamics and preferably some knowledge of direct conversion of electrical energy from heat and solar energy. To analyze and compare sizes, weights efficiencies of various means of obtaining electrical energy from solar nuclear and chemical energy: to perform preliminary design of secondary power systems for satellites and space vehicles: to participate in hardware development programs.

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Control panel detaches from camera for remote operation via stock cable

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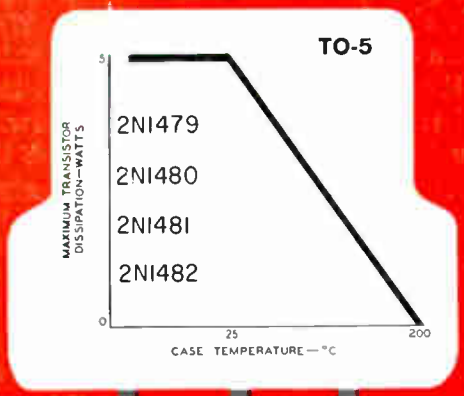

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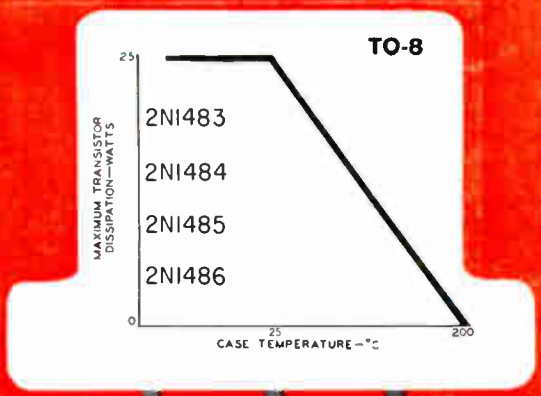

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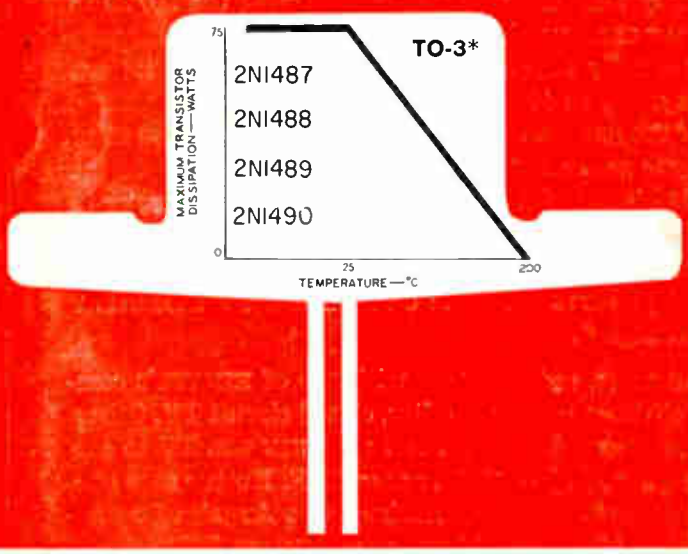

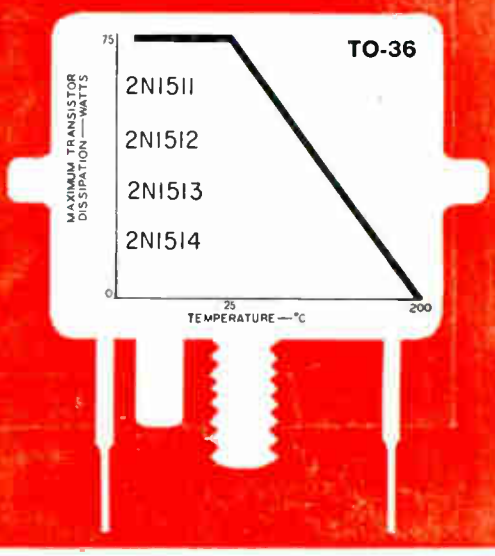

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COLLECTOR-TO-BASE VOLTS	60V	100V	60V	100V	60V	100V
COLLECTOR-TO-EMITTER VOLTS With base open (sustaining voltage)	40V	55V	40V	55V	40V	55V
With emitter-to-base reverse biased (V_{EB}=1.5 volts)	60V	100V	60V	100V	60V	100V
EMITTER-TO-BASE VOLTS	12V	12V	12V	12V	10V	10V
COLLECTOR CURRENT (Amps.)	1.5a	1.5a	3a	3a	6a	6a
EMITTER CURRENT (Amps.)	1.75a	1.75a	—3.5a	—3.5a	—8a	—8a
BASE CURRENT (Amps.)	1a	1a	1.5	1.5a	3a	3a
TRANSISTOR DISSIPATION: (Watts) At case temperature of 25°C	5w	5w	25w	25w	75w	75w
At case temperature of 100°C	2.86w	2.86w	14.1w	14.1w	43w	43w
CASE TEMPERATURE RANGE: (°C) Operating and Storage	—65 to +200°C					

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