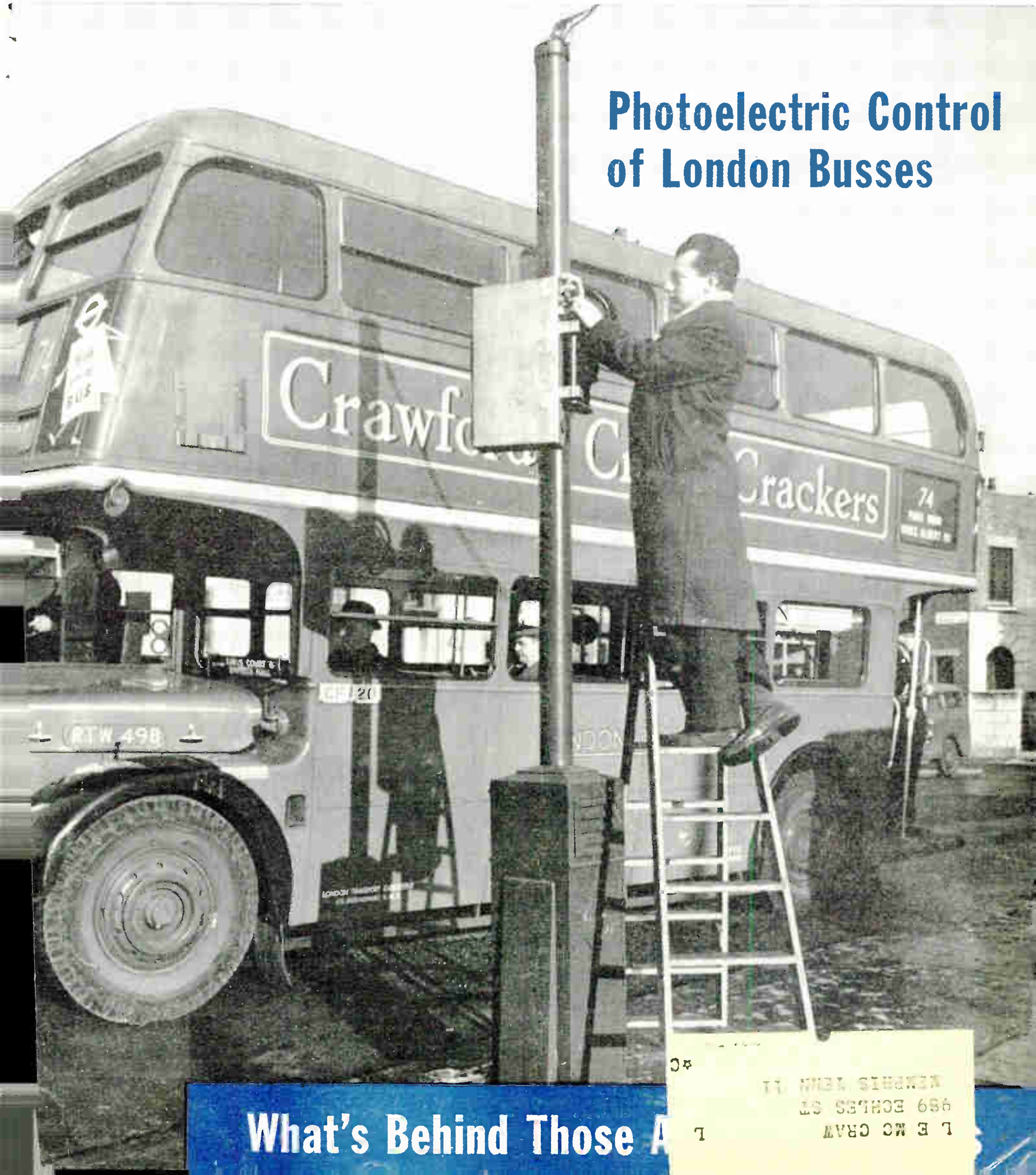
JULY 10, 1959

electronics

A McGRAW-HILL PUBLICATION · VOL. 32, No. 28 · PRICE SEVENTY-FIVE CENTS

Photoelectric Control of London Busses



What's Behind Those A

The Team Approach*

Infrared systems and other modern-day electronic equipment use many special-purpose transformers having unusual electrical requirements. For example, the small cylindrical transformer shown connected to the decade box was designed by Radiation Electronics Corporation to operate at a primary signal level of 10^{-8} volts. Its primary and secondary impedances are 5 and 50,000 ohms respectively (dc resistance of primary only 0.6 ohm). Bandpass is from 12 cps to 45 kc. To measure these transformer characteristics, a test setup composed of the following G-R instruments is used:

1603-A Z-Y BRIDGE (at left) measures transformer impedances in terms of quadrature components at various frequencies and signal levels (transformer input voltage is varied by simply changing the bridge input). This Bridge can be balanced for *any* impedance from short circuit to open circuit, real or imaginary, positive or negative, over the entire audio-frequency range. Basic accuracy is 1%. Price: $370.

1217-A UNIT PULSER (upper center) provides a means for measuring low-frequency response to better than 0.3 cps — well below the range of conventional audio oscillators. Long-duration pulses are fed to the transformer under test, and low-frequency cutoff is determined by the measurement of the resulting pulse droop. Unit Pulser repetition rate 15c to 100 kc; pulse duration 0.2 μsec to 60,000 μsec. Price $235, Power Supply $40.

Photograph Courtesy
Radiation Electronics Corp., Skokie, Illinois

*This group of instruments is useful for the testing of electro-mechanical transducers and audio-frequency devices of all types.

1206-B UNIT AMPLIFIER (beneath Pulser) an ideal general-purpose amplifier — 3-watt output from 20c to 50 kc, 1.5 watts from 10c to 100 kc — less than 1% harmonic distortion. Price $85; Power Supply $40.

1432 DECADE RESISTANCE BOXES provide primary and secondary loads for the transformer under test. Decade Boxes are available in 10 different models in 0.1-Ω steps to 1000-Ω steps, total resistances from 111Ω to 1,111,100Ω. Prices range from $68 to $143.

546-C MICROVOLTER (extreme right) measures transformer gain and usefulness at very low signal levels. Used with an oscillator, the Microvolter supplies small, accurately-known voltages from 0.5 μv to 1.0v open circuit. Basic accuracy is 3%. Price: $140.

Write For Complete Information

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electronics

JULY 10, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 28

Issue at a Glance

Business

Engineering

Departments

Clark Fishel takes the  stand for electronics

Texas Instruments Incorporated is a name that has skyrocketed into prominence since its adoption in 1951 by a company then principally engaged in geophysical instrumentation and exploration for petroleum. In the succeeding eight short years, TI has extended its activity into electrical, electronic and nuclear fields with such vigor that sales have increased twelve-fold to a current rate of over $185,000,000.

Clark W. Fishel is Merchandising Manager of TI, which now is composed of four manufacturing divisions: the Semiconductor-Components Division makes transistors, diodes, rectifiers, resistors, capacitors, IR cells, solar cells, etc.; the Apparatus Division makes radar, sonar, infrared, and magnetic equipment and systems; the GeoSciences and Instrumentation Division is still the world's largest geophysical exploration contractor and makes geophysical and industrial instruments and systems; the Metals & Controls Division makes clad metal products, thermostatic and electrical controls, and nuclear fuel elements and cores.

Mr. Fishel, according to a November 11, 1958 count, 80 members of your organization paid to receive electronics each week. Yet your company ordered 32 company-addressed subscriptions. Would you explain this?

Considering the importance of the electronics industry to us, and the importance of communication to any industry or corporation in a fast-moving technology . . . I would be surprised if it were any different.

Mr. Fishel, TI is currently concentrating 86 pages of advertising in electronics. In 1958 you ran 25 pages of bleed-color advertisements, 15 pages of B&W bleed and 13 covers. Would you tell why electronics plays such a dominant role in your advertising plans?

Because—due to its editorial format and circulation—it covers the industry like a blanket. Certainly I know that we can buy magazines with a cheaper rate per gross thousand or with more readers in some specific category . . . but nowhere else can we find such a catholic combination. Naturally we advertise heavily in it.

If it's about electronics, it's advertised and read in **electronics**.

electronics

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ABC ABP

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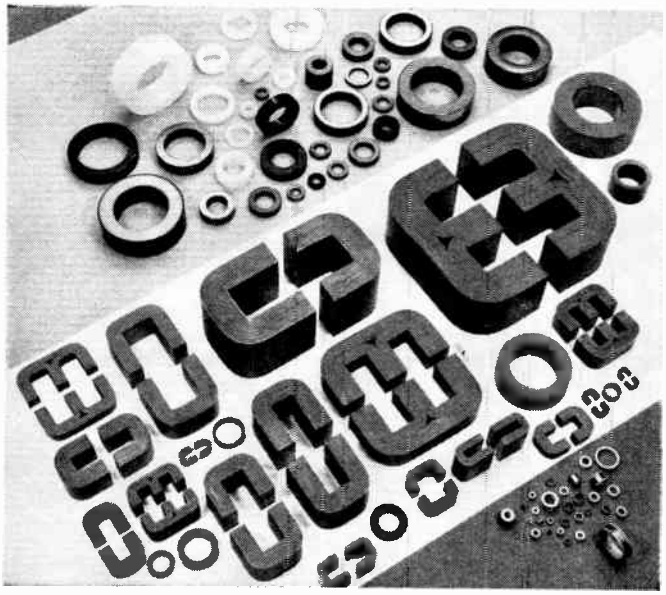
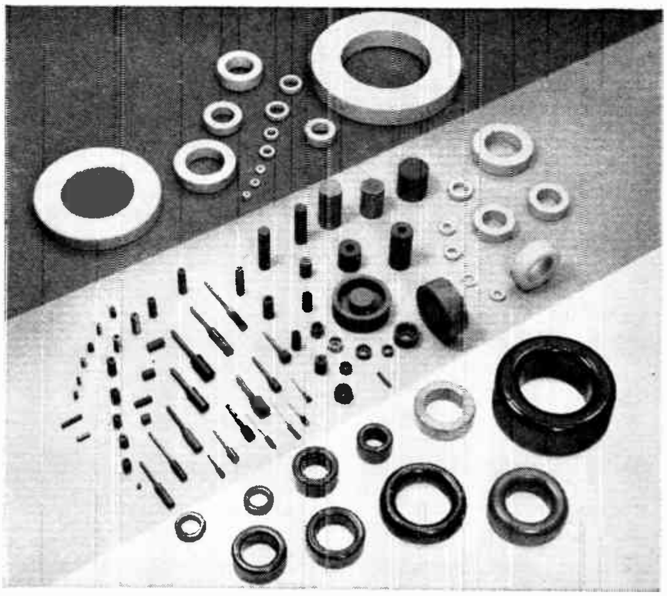


Top to bottom: Tape wound cores, Silectron C, E and O cores, and bobbin cores.



Top to bottom: Mo-Permalloy powder cores, iron powder cores, and Sendust cores.

SILECTRON C-CORES, E-CORES and TOROIDS Arnold C and E cores are made from precision-rolled Silectron strip in 1, 2, 4 and 12 mil thicknesses.

They are supplied in a wide variety of shapes, and in sizes from a fraction of an ounce to several hundred pounds. In addition to standard transformer applications, they may also be supplied for special applications such as saturable reactors, instrument transformers and pulse transformers.

Over 1,000 stock cores are listed in the Arnold Silectron catalog. A wide selection of preferred sizes are carried in stock for immediate shipment. For complete data on C and E cores and Silectron toroids, *write for Bulletin SC-107A.*

TAPE WOUND CORES of High Permeability Materials Arnold tape wound cores are available made of Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750 Electrical Metal, Silectron, or the new rectangular-loop material, Supermendur. All except Supermendur cores are available in standard tape thicknesses of ½, 1, 2, 4 or 12-mils.

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

BOBBIN CORES Arnold bobbin cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps to suit the ultimate use of the core in electronic computer assemblies. Magnetic materials usually employed are Deltamax and Square Permalloy in standard thicknesses of 1, ½, ¼ and ⅛ mil. Bobbins are supplied in ceramic or stainless steel. *Write for Bulletin TC-108A.*

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

These powder cores are supplied in four standard permeabilities: 125, 60, 26 and 14 Mu. They provide constant permeability over a wide range of flux density, and in many cases may be furnished stabilized to provide essentially constant permeability over a specific temperature range. Large warehouse stocks of preferred sizes are carried for immediate shipment. *Write for Bulletin PC-104B.*

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

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

SPECIAL MATERIALS

2V PERMENDUR . . . a ferromagnetic alloy of cobalt, vanadium and iron that possesses high flux density saturation properties. Its magnetostrictive properties are useful in many transducer applications. *Write for Bulletin EM-23.*

VIBRALLOY . . . a ferromagnetic alloy of nickel, molybdenum and iron whose temperature coefficient of elastic modulus is controllable over a wide range. It has high ferromagnetic permeability, and a rather high coefficient of magnetostriction. Used in applications where a zero or controlled thermo-elastic coefficient is desired.

BARIUM TITANATE . . . A piezoelectric ceramic widely used in accelerometers, phono pickups, microphones, ultrasonic grinding and cleaning devices and underwater signaling devices. For more information, *write for Bulletin CM-116.*

WSW 7507

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BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES

SHOPTALK . . . editorial

electronics

July 10, 1959 Vol. 32, No. 28

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Postmaster: please send form 3579 to Electronics, 330 W. 42nd St., New York 36, N. Y.

Member ABP and ABC

THE HOTTEST FRONT. A radio receiver is a better intelligence tool than Mata Hari's bustle ever was. And this goes for all intercept receivers—infrared, radar, communications or special optical.

For more than a decade Russian, American and British aircraft have been probing each other's defenses along the Iron Curtain and the DEW Line. They are looking for missile-control, radar and communications signals.

There is nothing contrary to International Law in this. It is the mid-twentieth-century version of the watch on the Rhine, with electronics taking over from binoculars.

But the activity leads to shooting incidents. In less than ten years there have been 30 incidents involving 80 U. S. Air Force and Navy airplanes. In many cases, the flight crews included an unusually high number of electronics technicians—men who generally stick close to shops on the ground.

Presumably Russian planes near the DEW Line have likewise caused our planes to scramble. The Defense Department says no; some former DEW Line civilians infer otherwise. Last month a Soviet domestic broadcast said a Russian plane had been shot down over the Arctic.

Such electromagnetic reconnaissance is vital defense against a sneak attack and as long as the recon planes do not trespass another nation's airspace they should not become live targets for trigger-happy fighter pilots. In fact, any effective disarmament agreement would necessarily include some kind of aerial inspection to insure compliance on both sides.

Perhaps now is the time to acknowledge recon flights as a necessary and wholly legal fact of life in this electronic age. Perhaps they should be regulated by international agreement—even flown under United Nations' auspices. There are too many lives at stake to let cloak-and-dagger enthusiasts continue to act like small boys sneaking smokes behind the garage.

Associate Editor Mason's on-top-of-the-news story, "Hottest Front In The Cold War," tells what's happening. It starts on p 22.

Coming In Our July 17 Issue . . .

SEMICONDUCTORS AND THE PERIODIC TABLE. For many engineers, the periodic table is something last seen in freshman chemistry. According to C. A. Escoffery of International Rectifier Corporation, a reexamination of the periodic table of elements can yield a great deal of knowledge about the nature and function of semiconductors and can provide insight into probable future developments in this field. Also, our cover will be one you'll want to hang on the lab wall for constant reference.

MEASURING DAYLIGHT. A novel and clever method of illumination intensity measurement is described by E. F. Hasler and G. Spurr of Central Electricity Research Laboratories, England. They have designed a blocking oscillator whose rep rate is controlled by a photocell. Device was developed to measure daylight level in a form suitable for transmission over phone lines to remote sites.

AND MORE. Interesting feature material to appear next week also includes: a word generator for testing digital circuits, by R. G. Norquist of Denver U.; an amplifier circuit which automatically compensates for power supply variations, by J. Holtzman of Hughes Aircraft Co.; a device for checking jitter in pulsed oscillators used in mti radar, by C. Clark of Westinghouse; a magnetically regulated high-voltage d-c supply, by W. J. McDaniel of Philco.

Now you can specify these popular submins for extra-severe duty — in new Raytheon Reliability-Plus types

CK6021WA
CK6111WA
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CK5902WA
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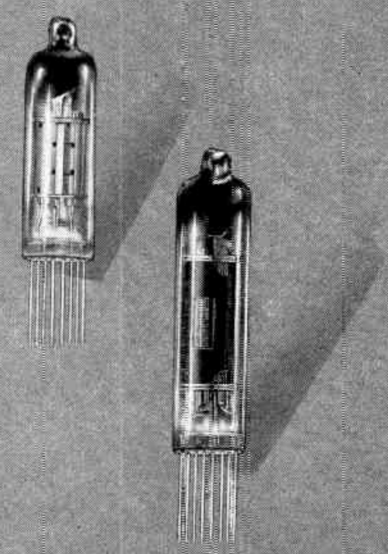

Only Raytheon produces these improved-reliability button base subminiature tubes — electrically identical to and directly interchangeable with prototypes, and controlled throughout production to meet the following tests above and beyond military specifications:

IMPROVED MECHANICAL STABILITY
15G sweep frequency vibration test to 2000 c.p.s.
10G sweep frequency fatigue test to 2000 c.p.s.
75G, 10 millisecond shock test — in addition to usual 1 millisecond test.

IMPROVED PULSE OPERATION
Triode-connected pulse life test (CK6021WA; CK6111WA)

IMPROVED ELECTRICAL STABILITY
2 hour and 20 hour life tests to guarantee stability of characteristics.

IMPROVED HIGH TEMPERATURE LIFE
Life-test end points now 1000 hours instead of 500 hours.

MAXIMUM RATING LIFE

CONTROLLED WARM-UP TIME

REDUCED HEATER-CATHODE LEAKAGE AT HIGH HEATER VOLTAGES (CK6021WA, CK6111WA, CK6112WA)

EACH TUBE MUST MEET RIGID QUALITY CONTROL STANDARDS

- 0.4% AQL for major characteristics — compared with prototypes' 0.65%.
- High sensitivity thyratron short test.
- X-ray inspection — an original Raytheon safeguard.

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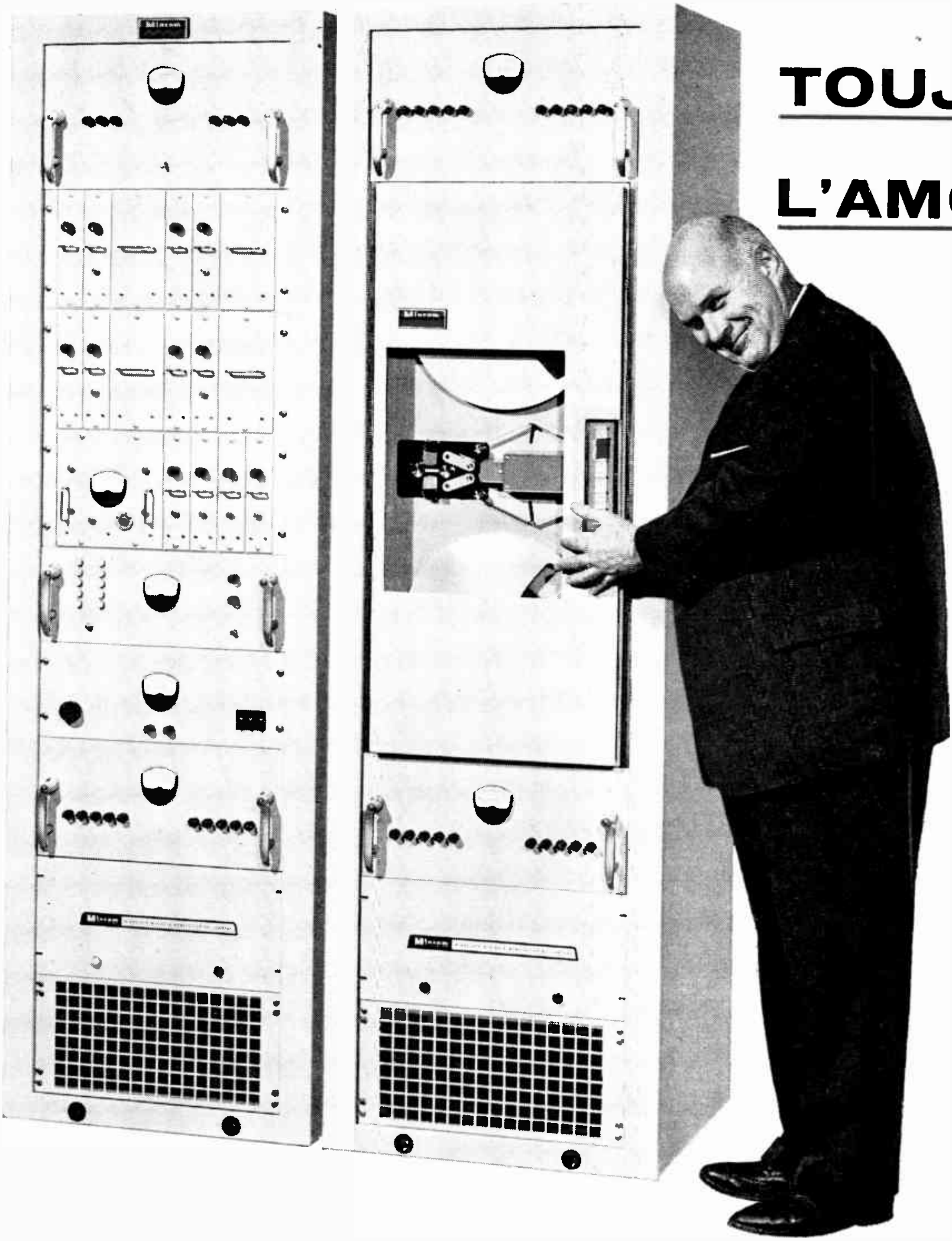

TOUJOURS L'AMOUR

Seven 1-megacycle video channels on a single half-inch tape—that's why there's an affectionate reaction everywhere to the new Mincom Model CV-100 Video Band Magnetic Recorder Reproducer. Tape speed of 120 ips, plus special recording and playback heads, produces reliable frequency response from 400 cycles to 1.0 megacycle (each track). Only 12 moving parts, four simple adjustments. Only 0.1% flutter and wow. No mechanical brakes. All plug-in assemblies, carefree maintenance. Interested? Write for specifications.

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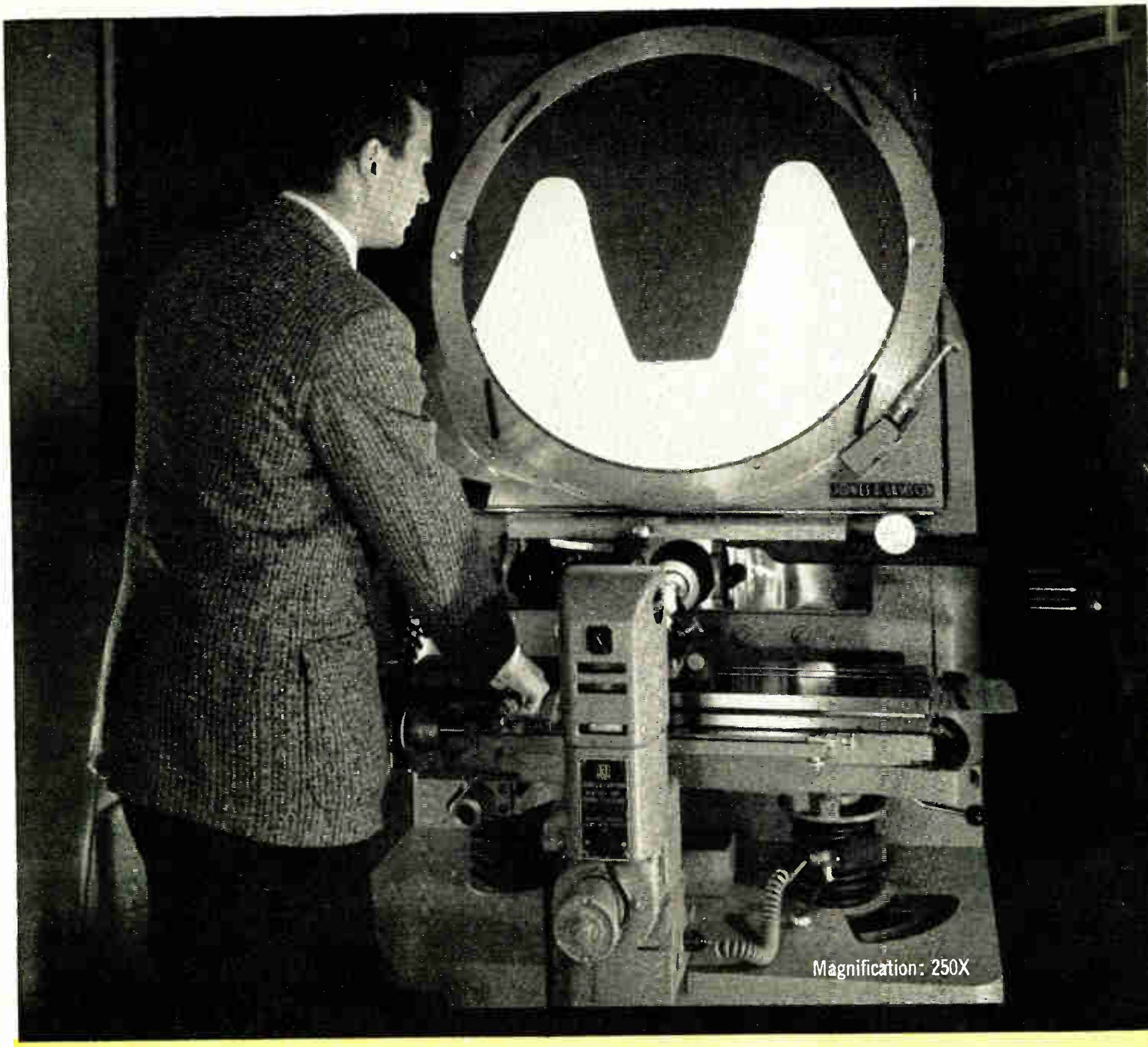
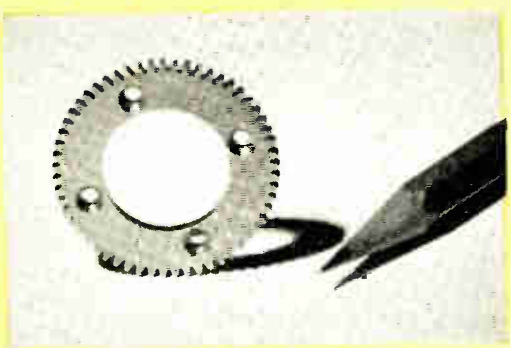


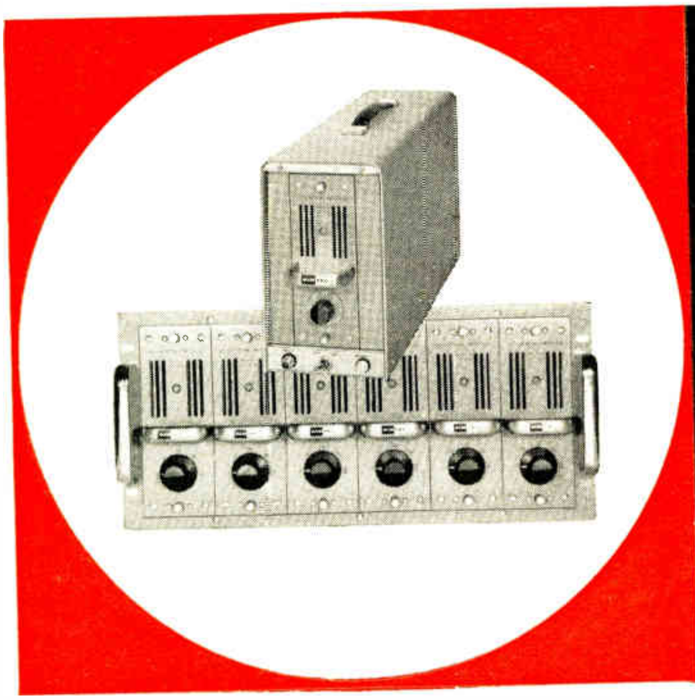
See the sharpness of the shadow produced by a Mercury Arc Lamp!

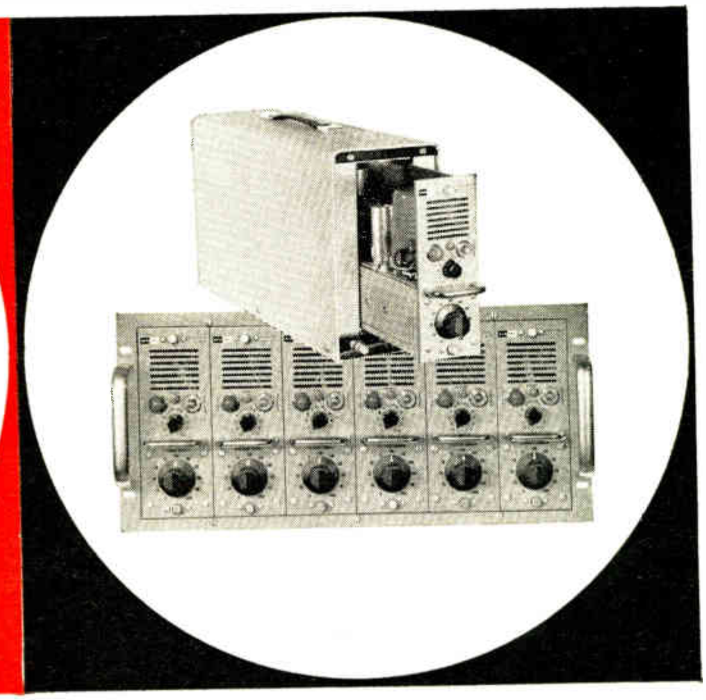


This photo shows the sort of shadow you get with a Mercury Arc Lamp. Note the extreme sharpness of the shadow image's definition, even at 250 magnifications. This unprecedented sharpness means greater precision, greater efficiency in your inspection and measurement operations.

◀ Note the actual size of this gear, which is enlarged for inspection on the FC-30 Comparator screen. Gear has 57 teeth, and has 1.1159″ dia. base circle.

AMPLIFY MICROVOLTS WITH STABILITY... measure strain, temperature, other phenomena, to 0.1% with a KIN TEL DC amplifier





NEW...TRUE DIFFERENTIAL DC AMPLIFIERS ELIMINATE GROUND LOOP PROBLEMS...RESCUE MICROVOLT SIGNALS FROM VOLTS OF NOISE

180 db DC, 130 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ 0.05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 10 volt at 10 ma output ■ 100 cycle bandwidth ■ Integral power supply

Ideal for thermocouple amplification, the Model 114A differential DC amplifier eliminates ground loops; allows the use of a common transducer power supply; drives grounded, ungrounded or balanced loads; permits longer cable runs; and can be used inverting or non-inverting. The 114A can be mounted in either single amplifier cabinets or six amplifier 19″ rack adapter modules. Prices: 114A – $875, six amplifier module – $295; single amplifier cabinet – $125.

WIDEBAND, SINGLE ENDED DC AMPLIFIERS AMPLIFY DATA SIGNALS FROM DC TO 40 KC WITH 2 MICROVOLT STABILITY

±2 microvolt stability ■ <5 microvolt noise ■ 40 kc bandwidth ■ 100 KΩ input, <1 ohm output impedance ■ Gain of 20 to 1000 in ten steps with continuous 1 to 2 times variation of each step ■ ±45 V, ±40 ma output ■ 1.0% gain accuracy ■ 0.1% gain stability and linearity ■ Integral power supply

Millions of cumulative hours of operation have proved KIN TEL Model 111 series DC amplifiers to be the basic component for all data transmission, allowing simple, reliable measurement of strain, temperature and other phenomena. DC instrumentation systems – with their inherently greater accuracy, simplicity, and reliability than AC or carrier systems – are made entirely practical by the excellent dynamic performance, stability, and accuracy of KIN TEL DC amplifiers. Price: 111BF–$625, six amplifier module–$295, single amplifier cabinet – $125.

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KIN TEL
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ELECTRONICS, INC.

ELECTRONICS NEWSLETTER

DIODE PARAMETRIC AMPLIFIER developed by Hughes Aircraft Co. is claimed to double the range of existing radars aboard airliners and in air traffic control systems. Firm says it's inexpensive, easily maintained and simple to install in present gear. Hughes says the diode paramp requires no large external gear such as field magnets and focusing coils, claims pump power requirements are less than for ferrite paramps. Development of the diode paramp is still going on, but a semiconductor diode described as the "heart" of the device is in production. In the lab a noise temperature of 100 K has been obtained at room temperature; a 3,000 mc amplifier gives 30 db of amplification with two mc bandwidth or 10 db of amplification with 25 mc bandwidth.

Passive underwater sound ranging method will be studied by Fairchild Astrionics division of Fairchild Engine & Airplane Co. under a $31,879 contract awarded by Navy's BuShips.

TIROS METEOROLOGICAL SATELLITE, 40 inches in diameter and weighing 250 lbs, will probably be launched by year's end. It will carry two tv cameras and two sets of radiation detectors performing separate experiments. Data will be stored on tape and extracted when the satellite comes into the range of an antenna readout station. Each time it is interrogated, TIROS will be scheduled to take more pictures on its next orbit. Second TIROS is scheduled for firing next spring.

RADIO INTERFERENCE should be considered in the initial stages of design of all new weapon systems. Recommendation was made at last month's IRE seminar on r-f interference by Col. C. H. Lewis, director of electronics for Air Research and Development Command. He added that the interference problem then required continuous attention throughout the program to avoid the malfunctioning of a system. Lewis said the Air Force was concerned that contamination from radio signals might limit the usefulness of the electromagnetic spectrum.

British space research experts have been meeting with NASA officials to discuss U.K. space research proposals, satellite instrumentation and launching, and possible collaboration between Britain, the U.S. and other countries.

BALLISTIC MISSILE DEFENSE effort by the Navy is underscored by a batch of research contracts announced recently by the Office of Naval Research. The contracts, all designated "research on defense against ballistic missiles," went to: Hughes Aircraft, $117,783; Allied Research Associates, $121,061; General Electric, $166,347; University of Chicago, $96,225; Aeronutronic Systems, $143,007; Convair, $128,079.

FERRITE OSCILLATORS and amplifiers enthusiastically proposed recently by Soviet scientists sound suspiciously like the ferromagnetic amplifier or mavar that was not only propsed but built at Bell Telephone Laboratories in 1957 (ELECTRONICS, p 65, Sept. 26, '58). The device achieves low noise amplification at room temperature, unlike the maser which must be supercooled. Theory was described at a Soviet radio-electronics conference conducted with ceremonies honoring the 100th birthday of Popov.

MAGNET FACILITY for experiments in very high magnetic fields is proposed by MIT. The research station, for which MIT seeks government support, would generate 8 megawatts continuously and up to 30 megawatts for two to three seconds. Facility would provide continuous fields up to 250 kilogauss, serve as tool for further development of the art of high magnetic field environment. Magnet Society, organized recently at MIT, is collecting new technical data on high magnetic fields.

Ceramic magnets made of compressed iron and barium oxide powders are being made by the Soviet Academy of Sciences. The material is baked in an electric furnace before being placed in a strong magnetic field to acquire the properties of a permanent magnet. Soviets say method produces good magnets, saves millions of dollars worth of expensive alloys.

INTERNATIONAL GEOPHYSICAL COOPERATION (IGC), the outgrowth of IGY, gets initial push with the award of 41 National Science Foundation grants totaling $1,686,225. Grants include $350,000 to the University of Minnesota for continuous balloon monitoring of cosmic rays and solar phenomena; $138,000 to the University of Alaska for study of the role of height in auroral spectroscopy; $68,400 to the University of Maryland for theoretical and experimental research in general relativity.

ARMY SERGEANT MISSILE CONTRACT of $17.8 million for production and continued development of the guidance system has been awarded to Sperry Utah Engineering Laboratory. Award marks full funding of the original letter contract, supplements previous contracts totaling $22 million.

TRANSISTORIZED COMPUTER with a 2-mc clock rate is now being manufactured in West Germany by Telefunken GmbH. The TR-4 computer performs some 50,000 operations a second, uses ferroelectric high-speed storage supplemented by tape units. Machine operates with fixed or floating point, can be shifted from general program to special-purpose closed-loop operation by changing printed-circuit cards in the program control circuits.

WASHINGTON OUTLOOK

WASHINGTON—ELECTRONIC PROBLEMS are not to blame for failure to make the Atlas ICBM operational. Rather, Pentagon insiders tell ELECTRONICS that the much-publicized delay stems from "essentially mechanical and structural things". They say that the five consecutive test failures did not result from any fundamental design problem.

One top-ranking official revealed: "The telemetry readings have showed us a pressure loss here and there, a valve that didn't operate, even transient signals in the guidance." All of which add up, he says, to the typical random shortcomings encountered with many missiles in shifting from test models to initial operational capability. Asked if the "transient signals in guidance" could have been radio interference, he refused to amplify his statement.

All Atlas vehicles now at the flight test stage are undergoing retrofits. Test launchings are expected to be resumed within a month and the first operational model is set to be ready at the Vandenberg AFB in two months —at least two months behind the initial target date. Presumably the first operational models will use radio-inertial guidance rather than the newer pure inertial gear.

All along, many Pentagon experts have been skeptical about the original July 1 objective for initial operational capability. The target date was set under congressional pressure, the critics say, and to meet it Convair was forced to "under-design" the "D" series of final engineered models. The result, they claim, was a run-in with "new reliability variables"— and the accompanying test failures.

- **Development** of specially-designed electronic systems for the highly-vaunted nuclear-powered airplane will be indefinitely postponed, in the wake of the administration's rejection of the Air Force proposal to build a prototype aircraft.

  The new decision reaffirms the policy to confine the costly project ($850 million spent to date) to development of the propulsion system, with only limited design work on the airframe.

  As the project shapes up now, there is no intention to push it into the weapon-system stage, which would generate requirements for electronic and other subsystems, until the nuclear power plant has successfully undergone extensive ground testing.

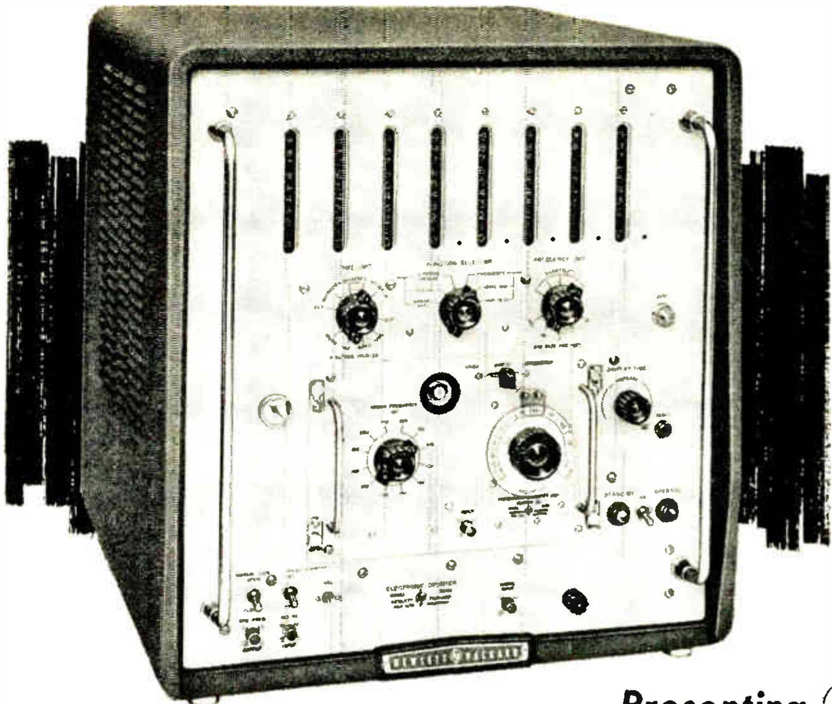
- **The Pentagon** is under new pressure to strengthen procurement policy on subcontracting to small business. It comes from members of the Defense Dept.'s Small Business Advisory Committee which met recently in closed session with top Pentagon procurement officials.

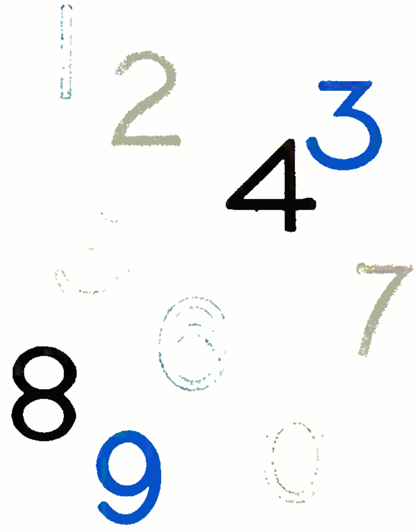
  Individual proposals were made for tougher requirements on prime contractors to let subcontract work to smaller firms and the establishment of specific dollar volumes of subcontracting to be awarded.

  Prime contractors are required only to "make the maximum practicable utilization" of smaller firms as subcontractors. The subs are selected by the primes and deal directly with them. A more formal arrangement exists with some 250 of the larger primes under which the producers set up special small business subcontracting procedures. But there's no provision for a guaranteed level of subcontracts.

  The Pentagon says that $3 billion worth of subcontracts were awarded in calendar 1958 to small business. The figure is based on reports from 291 prime and major subcontractors and represents about 17 percent of these companies' total military contract receipts.

  Three electronics management men sit on the Pentagon's Small Business Committee—Warren W. Frebel of Magnavox, Walter F. Joyce of Texas Instruments and William R. Sweeney of SoundScriber Engineering Corp.





Presenting -hp- 524D Electronic Counter

New 8-decade numerical readout!
New 5/10⁸ per week stability!

SPECIFICATIONS
(Basic 524D without plug-ins)

Frequency:
- **Range:** 10 cps to 10.1 MC
- **Gate Time:** 0.001, 0.01, 0.1, 1, 10 secs or manual
- **Accuracy:** ± 1 count ± 0.000005%
- **Reads in:** KC. Automatic decimal

Period:
- **Range:** 0 cps to 10 KC
- **Gate Time:** 1 or 10 cycles of unknown
- **Accuracy:** ± 0.3% (1 period)
  ± 0.03% (10 period average)
- **Stan. Freq. Counted:** 10 cps, 1 KC, 100 KC, or 10 MC, or external
- **Reads in:** Secs, msec, μsec

General:
- **Registration:** 8 places (99,999,999 max.)
- **Stability:** 5/100,000,000. May be standardized with WWV or external 100 KC or 1 MC primary standard.
- **Display Time:** Variable 0.1 to 10 secs; or "Hold"
- **Input Voltage:** 1 v min, 1.5 v peak. Rise time 0.2 seconds max.
- **Input Impedance:** Approx. 1 megohm; 40 μμf shunt.
- **Price:** $2,150.00 f.o.b. factory.

Data subject to change without notice

plus all these frequency and time measuring advantages!
Direct, instantaneous, automatic readings
Frequency coverage 10 cps to 220 MC*
Time interval 1 μsec to 100 days
Resolution 0.1 μsec
High sensitivity, high impedance
No calculation or interpolation

New convenience of uniform 8-decade numerical readout without meters — new 5 parts in 10⁸ stability simplifying standards and other microwave measurements — this is the capsule story of the new *-hp-* 524D Electronic Counter.

Electrically similar to the widely used *-hp-* 524B Counter, the new 524D provides for full frequency measurements from 10 cps to 10 MC and period measurements from 0 cps to 10 KC. Low cost plug-in units extend frequency measuring range to 220 MC, permit period measurements of over 10,000 periods, and increase sensitivity for precise measurement of weak signals. Still another plug-in provides for time measurements from 1 μsec to 100 days with 0.1 μsec resolution. When used with *-hp-* 540A Transfer Oscillator, the 524D will measure accurately to 12 KMC. For complete details, write or call your *-hp-* representative; or write direct.

*with plug-ins

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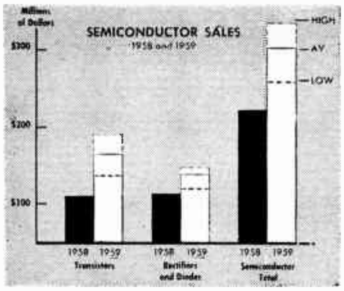
5022A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

-hp- world's most complete line of electronic counters



Paul Petrack takes the stand for electronics

ITT (International Telephone & Telegraph Corp.), Components Division, Clifton, New Jersey is a leading electronics manufacturer of electron tubes, fixed capacitors, silicon power diodes, selenium rectifiers, hermetic seals, miniature switches, and other component parts.

Former Chief Engineer, and present Product Manager for silicon products, Paul Petrack is a market expert for electronics components. His functions require him to determine what products will be in greatest demand (according to the industry's latest technical developments) and what products will be the most profitable to market.

According to the subscription records, electronics is sent to your home. Why?

Because I have more time to read it and more time to digest it.

Does electronics help you create new business for ITT?

Yes, by keeping me aware of new developments in industry, the state of the art, and market potentials for existing products, we are better able to direct our efforts toward meeting our product goals.

What "product image" has electronics conveyed to you over the years?...or, How would you define electronics' position in the electronics industry?

I consider electronics *required reading...it is clear, concise and complete.*

If it's about electronics, it's advertised and read in electronics

electronics

Published WEEKLY plus the mid-year electronics BUYERS' GUIDE
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ABC   ABP

Stock Splits Announced

Stock splits are starting to become increasingly significant as the electronics industry grows. Among those recently announced are:

• **National Aeronautical Co.**, Philadelphia, announces plans for a two-for-one split of the corporation's common stock. The split will be subject to stockholders' approval at a meeting slated for August 1. The firm's board of directors also announces plans to increase quarterly stock dividends on common shares from seven cents to eight cents. The increased dividend will be payable to stockholders of record July 21, 1959. National Aeronautical's present shares were split on a five-for-one basis on March 31, 1958. The firm makes a diversified line of commercial aviation electronic products marketed under the trade name of NARCO.

• **Baird-Atomic** stockholders voted a two-for-one split this month and authorized an increase in common stock from 500,000 shares to 1½ million shares. A registration statement has been filed with Securities and Exchange Commission covering a proposed public offering of 180,000 shares of common stock. The Boston firm reports a backlog of over $6 million. An increase in orders for special military infrared equipment is seen as a factor in the firm's increased sales.

• **Electronic Communications Inc.**, St. Petersburg, Fla., will issue one additional share of common stock as a dividend on each two shares now held by stockholders of record July 31, 1959. The additional shares will be mailed to stockholders on August 17. As a result of this distribution, each share of the firm's convertible preferred stock will be convertible at the holder's option for 1½ shares of common stock in lieu of the present share-per-share conversion privilege. Directors also declared a regular quarterly stock dividend of 15 cents a share on convertible preferred stock, payable next Wednesday to holders of record July 1, 1959.

• A merger between **Automation Instruments**, Pasadena, Calif., and **Mid-Continent Mfg. Co.**, also forms part of current financial news. Mid-Continent, with facilities at Manhattan Beach, Calif., and Tulsa, Okla., manufactures structural components, produces electronic and electromechanical products and is engaged in leasing industrial equipment. Automation Instruments, which manufactures ultrasonic and other nondestructive test gear, has exchanged 500,000 of its common shares for all of the outstanding stock of Mid-Continent, raising the total shares outstanding to 984,927.

• **Thompson Ramo Wooldridge, Inc.**, Los Angeles, reports purchase of a controlling interest in **Magna Products** of Santa Fe Springs, Calif. Magna produces specialty chemicals and electronic instruments for the chemical and petroleum industries. TRW will hold 51 percent of Magna's stock. No plans are contemplated for changes in the purchased firm's management or operations.

25 MOST ACTIVE STOCKS

WEEK ENDING JUNE 26

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Univ Control	1,980	20⅜	17¼	18¾
El-tronic	1,211	1½	1¼	1¼
Sperry Rand	854	25¼	24½	25
Avco Corp	745	15⅞	14⅝	15¼
RCA	738	65¼	63½	65⅛
Gen Tel & Elec	686	69¼	64¼	69⅛
Raytheon	663	58⅜	53⅜	57½
Gen Dynamics	634	56⅜	53½	55¾
Int'l Tel & Tel	534	38½	36⅞	38½
Texas Instr	505	151¼	135	150¾
Cornell Dubil'r	467	30½	26	26½
Elec & Mus Ind	444	7⅝	7	7¼
Siegler Corp	425	36	31⅛	34⅞
Gen Electric	424	80	78¾	79⅞
Gen Instr	350	32⅜	29	32
Standard Coil	301	19⅛	17¾	18⅝
Philco	253	31¼	29½	30¾
Beckman	245	61¾	56¼	61⅜
Burroughs	240	35⅞	34⅝	35¼
Litton Ind	240	118¾	111	114⅝
Ampex	236	77¾	70½	77⅜
Zenith Radio	235	128¾	123¼	125
Westinghouse	233	93⅜	91	92
IBM	228	445¾	433¾	444
Gen Precision	220	41½	38⅜	41¼

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

S. S. White DRIVE AND CONTROL IDEAS FOR ENGINEERS

Tips on better designing with flexible shafts

More Savings with Ready-to-Attach S. S. White Standard Flexible Shafts

NEW, EXTRA-HEAVY-DUTY SHAFT ADDED TO "OFF-THE-SHELF" LINE

Here's a time and money saving idea...the majority of flexible shaft needs can be met with ready-to-attach S. S. White **standard** flexible shafts.

This line has been recently expanded by the addition of the .500″ dia. standard shaft to handle extra-heavy loads.

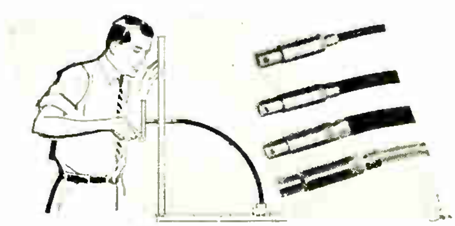
Flexible shafts allow you to simplify design ...position controls and driven parts to best advantage...eliminate expensive gears, universals, rods and costly alignment problems.

S. S. White **standard** flexible shafts are low in cost and readily available because they are **stock** items. They save you engineering time because the designing has already been done for you by S. S. White, first name in flexible shafts. **They come complete and ready to attach directly to your mating spindle.**

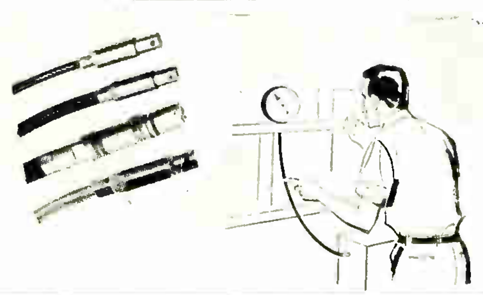
Another plus! Convenient, low-cost, readily available, S. S. White standard flexible shafts are the ideal way to test the advantages of flexible shafts in your products.

Where to use S. S. White Standard Flexible Shafts

REMOTE CONTROL of valves, actuators, switches, indicators and other mechanical or electrical equipment. S. S. White standard remote control flexible shafts come in four different shaft diameters to handle a wide range of requirements.



POWER DRIVE for an endless variety of applications . . . portable tools, instrument drives, machine tools, pumps . . . anywhere the designer needs to transmit power around obstructions or to movable parts, by means of a single, self-contained, easily applied unit. Four standard sizes.



1058

S. S. White FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION (Dept. E)
10 East 40th Street, New York 16, N.Y.
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

Selection of S. S. White standard flexible shafts: complete description and application data available. Write for bulletin 5801.

WRITE FOR COMPLETE DATA!

Selection of specialized flexible shafts to meet unusual requirements: useful shaft data and also information on how to take advantage of S. S. White engineering services. Write for bulletin 5601.

P-C Board Business Rising

PRINTED-CIRCUIT board business is due for a 30-percent gain in volume this year. Production worth \$30-\$35 million is expected in 1959. It was \$20-\$25 million last year.

That's the estimate of W. J. McGinley, president of both the Institute of Printed Circuits and Methode Manufacturing Corp.

Reasons for Optimism

Production estimates represent value of finished boards ready for component insertion, and include the production of both independent and captive plants, he explains. The dollar values are equivalent to 10 million square feet of board production in 1959 and eight million square feet in 1958.

Growing number of military printed-circuit board applications, greater use by computer, communication equipment, automobile, appliance and other manufacturers—plus the rising level of business activity—support the optimistic expectation for 1959, says McGinley. Moreover, the circuit board business, which had been growing at an average rate of 10-15 percent per year, practically stood still in 1958.

Other manufacturers' estimates vary somewhat from McGinley's prediction of 1959 volume, but are in the same ball park.

Dollar Value Rising

Alan Kingsbury, marketing manager for Photocircuits, looks for 1959 production of about nine million square feet, worth some \$36 million. RCA's prediction for this year is \$35-\$40 million, but no square footage estimate is available.

Dollar value of production is rising at a faster rate than number of board square feet produced. Reason is trend toward use higher-priced circuit board base materials which represent about a third to a fourth the cost of finished boards. Recent survey by the Institute among board material manufacturers showed rising use of glass-supported or special premium quality paper base materials.

Industrial users account for largest portion of printed-circuit board business, about 40 percent of dollar value of production, says McGinley. Next largest customer group is the military with 35 percent of the total, followed by entertainment equipment manufacturers with 25 percent.

However, customer usage based on number of square feet of board is another story. Entertainment equipment manufacturers take three-quarters of the industry's square footage output. Industrial manufacturers and military users take the remaining quarter, board manufacturers say.

Average value of circuit boards used in radio and tv sets is 40 cents and 90 cents, respectively, says McGinley. Cost of circuit boards used in computers and military equipment is much higher.

Production Up 800%

The printed-circuit board industry has made giant production strides in a short period of time. RCA estimates value of current year production represents an 800 percent gain over that of five years ago.

The industry will continue to grow at a good pace over the next five years, says McGinley. He looks for continuation of the 10-15 percent annual growth rate over the period, with increased usage by military and industrial customers accounting for bulk of the expected volume increases.

Market researchers looking for more detailed printed-circuit statistics may not have to wait long. IPC hopes to make a major survey next year.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	June 19, 1959	May 22, 1959	Change From One Year Ago
Television sets	121,369	115,952	+48.0%
Radio sets, total	310,859	274,571	+93.6%
Auto sets	138,427	120,205	+149.6%

STOCK PRICE AVERAGES

(Standard & Poor's)	June 24, 1959	May 27, 1959	Change From One Year Ago
Electronics mfrs.	95.63	91.64	+82.2%
Radio & tv mfrs.	108.39	109.10	+125.9%
Broadcasters	101.15	99.38	+63.7%

Crosley helps put the "Sunday Punch" in POLARIS

Making sure the Navy's *Polaris* missile detonates at the right time and at the right place is a prime responsibility of Avco's Crosley Division.

A long record of success in the arming and fuzing of many different types of ordnance brought Crosley the Navy Ordnance Laboratory's prime contract for this difficult assignment.

Since first undertaking the task, Crosley has expanded its *Polaris* development work, without once losing step in the demanding *Polaris* timetable.

Arming and fuzing is just one area in which Crosley contributes to the development and performance of missiles. It is the country's leading producer of Command Receivers for missile-range safety applications and for high-performance drones and decoys. It is an important subcontractor to Hughes Aircraft on the *Falcon* missile. Crosley also has contributed to the development of the *Jupiter*, *Sergeant* and *Redstone* missiles.

Crosley's technical competence, dependability, and coordinated project administration are ready to serve the Free World's defense requirements wherever needed most.

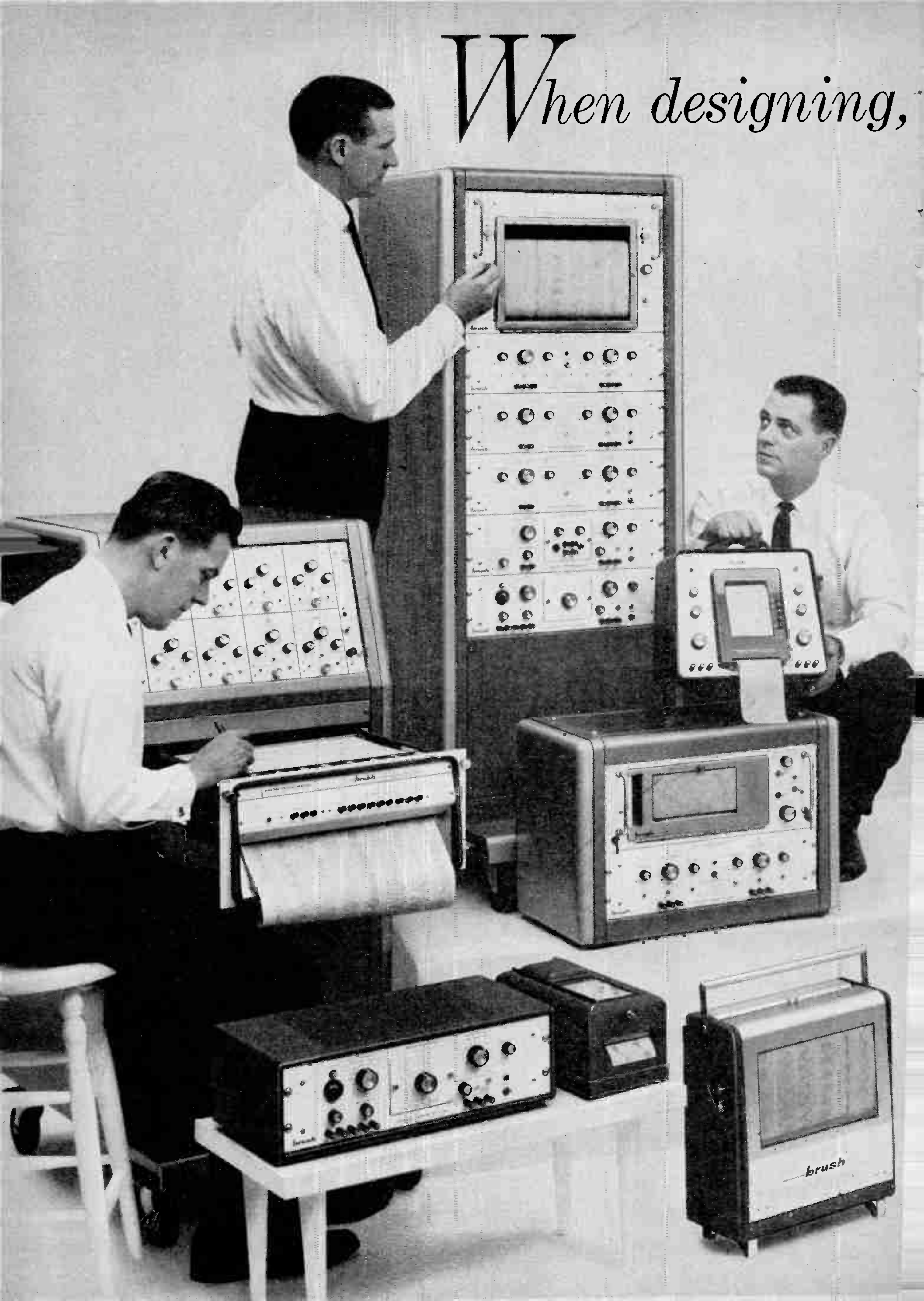
For more information, write to: Vice-President, Marketing—Defense Products, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.

ENGINEERS!

Creative research and development engineers experienced in electronics, mechanics, weapons systems, and ordnance warheads are urged to investigate the wide range of opportunity at Crosley. Write to: Director, Technical and Scientific Personnel, Dept. E-79E, Avco/Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.

Avco / Crosley

CIRCLE NO. 19 READER SERVICE CARD


When designing,
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testing or monitoring . . .

YOU CAN RECORD RESULTS BETTER WITH BRUSH

All Brush Recording Systems reflect advanced concepts in design that mean exceptional versatility, accuracy and reliability in your data collecting operations.

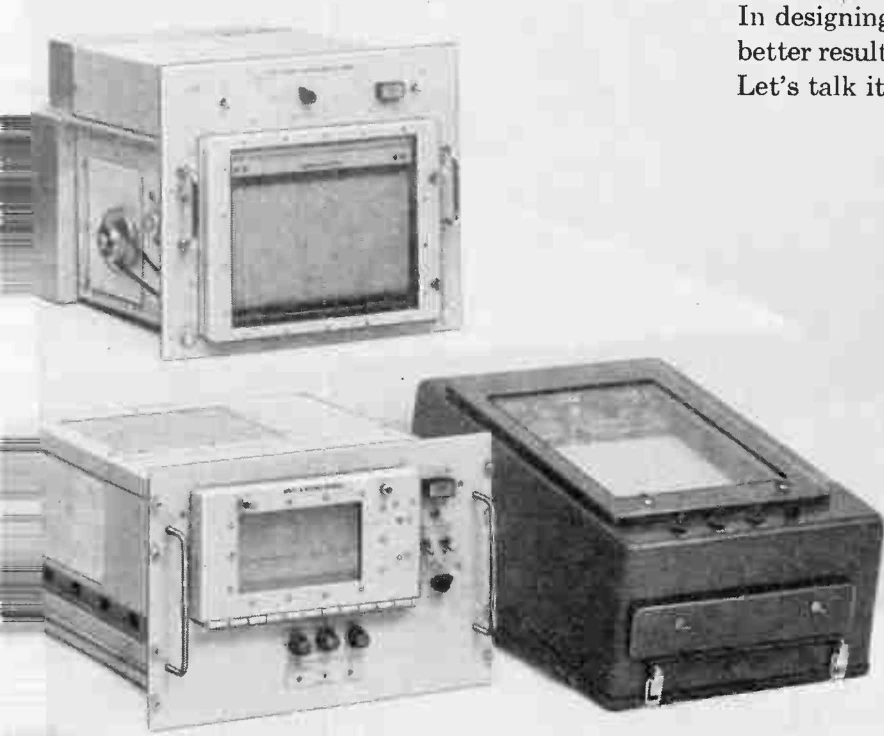
Your most exacting requirements can be met by these *direct writing* systems whether military or industrial. They display information *instantly*—give you precise data for quick decisions. You control the data you need, exclude the extraneous, and have optimum flexibility for future applications not yet contemplated.

Widest choice of equipment in the industry. Ink, electric or thermal writing . . . curvilinear or rectilinear readout . . . horizontal or vertical presentation . . . chart speeds from 10 inches/day to 4 feet/second . . . complete selection of amplifiers . . . rack mounted, bench top or portable configurations.

A pioneer in instrumentation since 1930, Brush has always built for ruggedness and precision. Installations are right. Operating manuals contain clearly written instructions. Your personnel are trained properly.

In designing, testing or monitoring you can get better results from Brush *Ultralinear* Recording Systems. Let's talk it over. Set a date. We'll be there.

Write for free informative booklet, "New Concepts in Recording." Contains helpful ideas and suggestions.

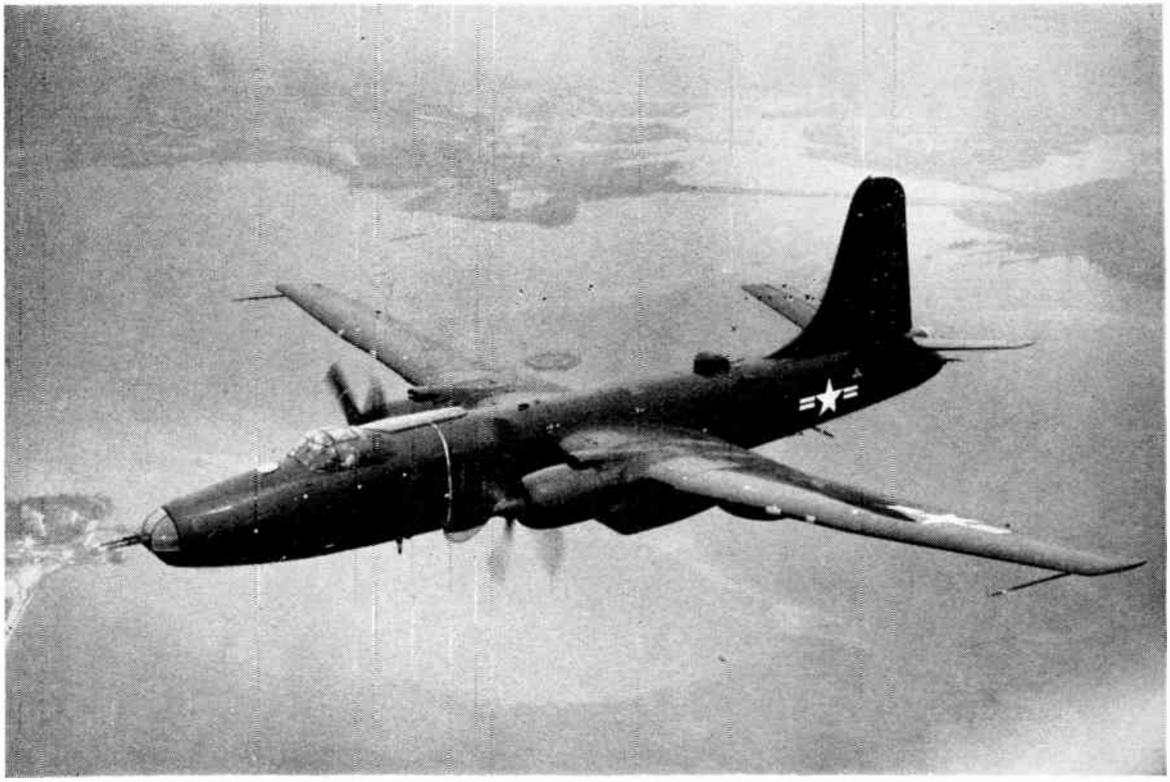


brush INSTRUMENTS

DIVISION OF CLEVITE CORPORATION

37TH AND PERKINS CLEVELAND 14, OHIO

Factory branches, service and warehousing at Arlington, Va., Boston, Cleveland, Los Angeles, San Francisco and Seattle; engineering representatives in all key locations.



Navy P4M Mercator reconnaissance plane, recently attacked by two MIGs over Sea of Japan, flies the . . .

Hottest Front In The Cold War

It's an open secret that military planes are patrolling international waters and the borders between the free world and Communist countries. Russia is making the operation increasingly risky

THE WAR BETWEEN the free world and the Communist world has ricocheted between hot and cold for the past 15 years—staying for the main part cold. But, for some, it has been steadily getting hotter for more than a decade.

These are the airmen—Russian, American and British—who fly almost daily missions along the borders of the Iron Curtain and our own DEWline, searching terrain, probing defenses, trying radar networks.

Fills Key Role

In these operations, electronics plays a major role. Communications and radar intercept receivers, synchroscopes and pulse analyzers, spectrum analyzers and magnetic tape recorders, direction finders, computers, frequency meters, infrared equipment and precise navigation gear are all necessary equipment.

Improved and new detection gear is constantly sought by the Defense Department. The annual procurement for electronic counter measures gets bigger every year. If a disarmament pact should ever be signed, reconnaissance equipment would be more necessary than ever before.

Two MIGs Attack

Most recent "incident" occurred last month when a U. S. Navy P4M Mercator reconnaissance patrol plane was attacked by two MIG jet fighters over international waters in the Sea of Japan about 85 miles east of Wonsan, North Korea.

Originally designed for anti-submarine warfare work, the Martin Mercator had been converted for reconnaissance missions. The front gun turret was replaced with infrared scanning gear. The top gun turret of the P4M had been removed to allow for the extra weight of other new electronic equipment—type not disclosed.

No Receivers, Recorders

Crew members, the day of the attack, had been using the equipment to look for unusually "hot" areas which might reveal traces of surface ships' stack gases or submarine snorkel gases, a Navy spokesman told ELECTRONICS. Over or near land, the scanner can pick up underground installations or detect various kinds of camouflaged activity.

The Navy said that no radio re-

(Continued on p 27)

How Primes Pick Subcontractors

WASHINGTON—Quality, delivery schedule and price are the three factors considered foremost by prime contractors in choosing a subcontractor in the field of missiles and electronics, executives in the field say.

The trend of military electronics is toward the buying of smaller numbers of items but with larger costs, which favors the small manufacturer.

The opportunity for profit, one spokesman says, is greater for the subcontractor because he has a better chance to get fixed-fee contracts and "here is where a firm can make money."

Evidence, based on a recent Electronic Industries Association survey, indicates many small manufacturers do not know how to get business or sub-contracts. Attention was called to the services performed by the Small Business Administration.

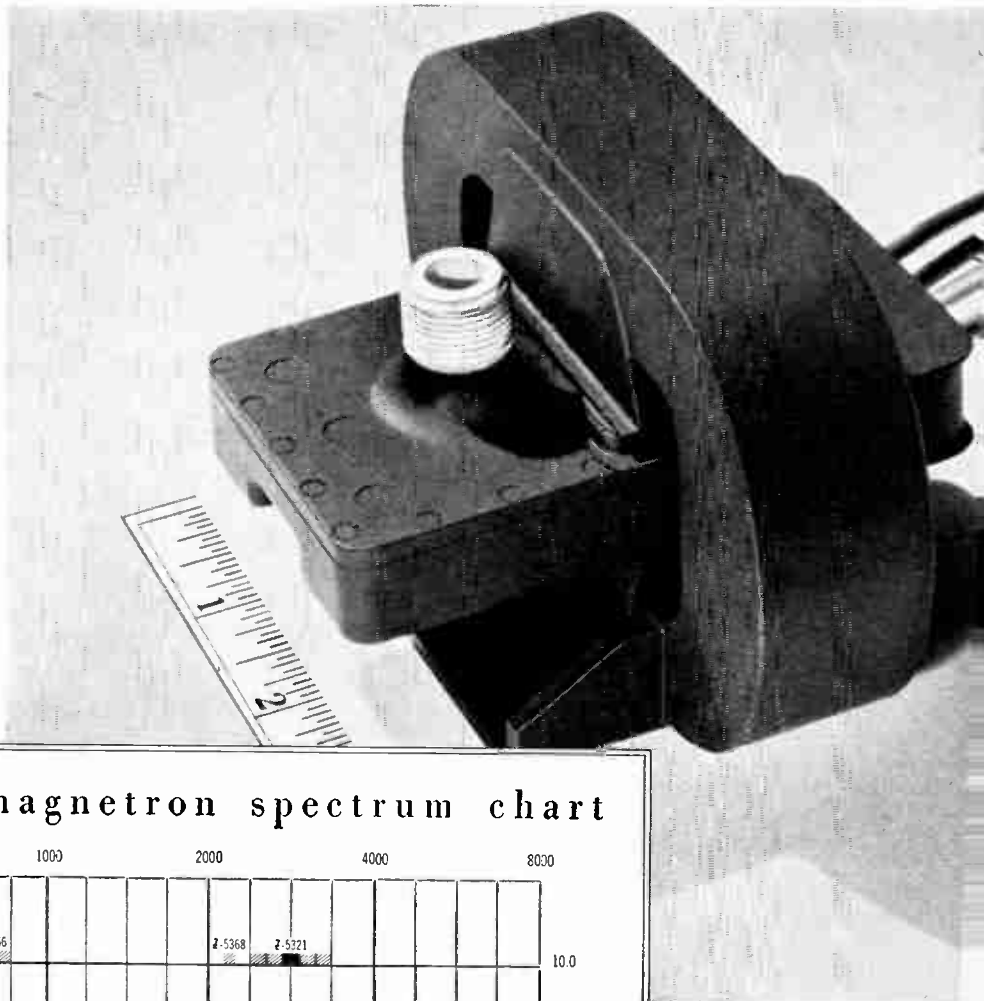
In answer to the criticism that small business does not always get its share of the business, NASA recently announced the appointment of Jacob M. Roey as small business adviser. "We want to locate small research organizations, for example, and catalog their interests and capabilities," he said.

Tests for Space

Full-scale antenna test mockup of Project Mercury capsule is being used in developing communication systems for the manned space capsule. Systems, designed by Collins Radio, will aid in putting such a capsule into orbit and recovering it

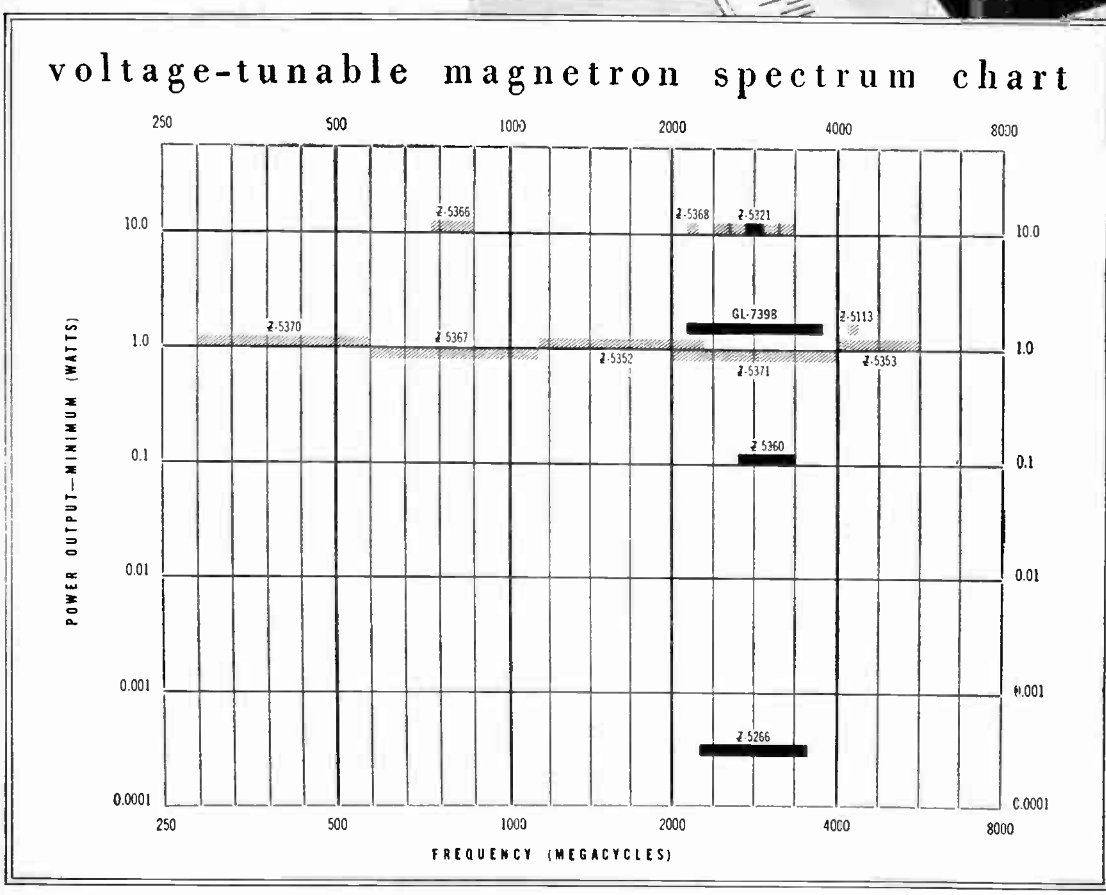
GENERAL ELECTRIC GL-7398*
VOLUME PRODUCTION, AVAILABLE

**formerly designated Z-5300*

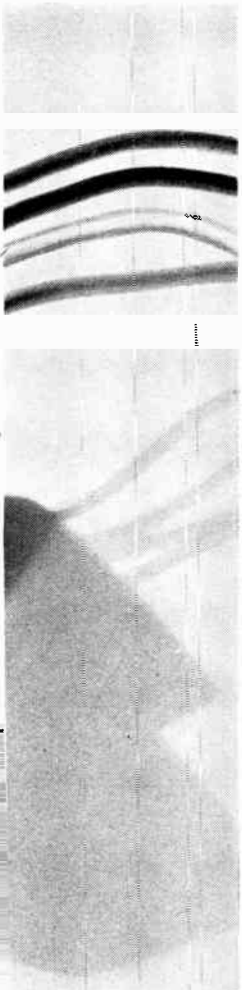


Voltage-tunable magnetrons now available are indicated by solid areas. Other developments are shown by cross-hatched areas.

▼



VOLTAGE-TUNABLE MAGNETRON IN FOR IMMEDIATE DELIVERY!



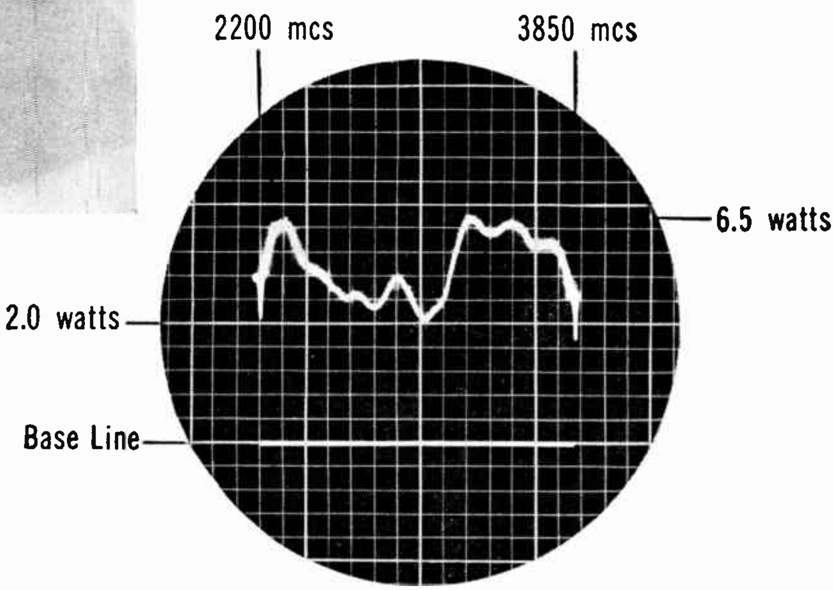
The General Electric GL-7398 voltage-tunable magnetron, a complete RF power source ideal for FM modulation, is now in volume production and available for immediate delivery. Moreover, samples are currently available or can be developed by use of proved technology to meet any need within the frequencies charted on the opposite page. The GL-7398 is designed for use in many applications, such as:

- **FM telemetering or video transmission**
- **Beacon transmitters**
- **Local oscillators in electronically tunable radars**
- **Drivers in pulse-to-pulse frequency-shift radars**
- **FM altimeters**
- **Broad-band signal generators**
- **Countermeasure transmitters**
- **Drivers for countermeasure amplifiers**

Output frequency can be varied linearly over a range of nearly 2 to 1 by sweeping the anode voltage. Power output is relatively flat at a minimum of 2 watts. The GL-7398 is a rugged, compact, packaged unit with these characteristics:

Anode voltage at 3 kmc	**— 1250 volts**
Anode current	**— 10-20 ma**
Frequency range	**— 2200-3850 mcs**
Tuning rate	**— approx. 3 mcs/volt**
FM rate	**— 10 mcs or higher**
Weight	**— 3.1 lbs.**

By use of internal narrow-band circuits, a variation (Z-5321) is available which gives a minimum of 10 watts power over a 200 mc bandwidth at a factory-predetermined centerpoint in the 2 to 4 kmc band. Other variations with built-in attenuators for local oscillator applications can be supplied (Z-5360 and Z-5266). *Power Tube Department, General Electric Company, Schenectady, New York.*



◀ Typical power – frequency of the GL-7398 shows power constant over the full band to within plus-or-minus 3 db.

Progress Is Our Most Important Product

GENERAL ELECTRIC

9545-8481-22

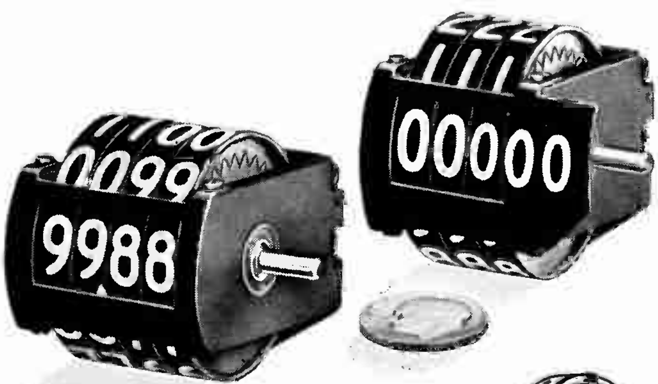
Men who Count KNOW

it pays to give their customers Veeder-Root Counting Precision

If you need ultra-precision counters to build into your product as an added service to your customers, then take a long look at Veeder-Root Instrument-type Counters, like those shown below. You'll see craftsmanship that measures up to ultra-precision standards. And you can count on it that Veeder-Root precision remains a constant quantity under highest speeds and toughest operating conditions.

Veeder-Root can bring to your counting problem the longest experience in precision counter-making of anyone in this business. Give your customers the advantages of built-in counters, give them the lifetime assurance of Veeder-Root precision.

You always "Know the score" when you count on Veeder-Root!



NEW VEEDER-ROOT MINIATURIZED COUNTERS

These Internal Pinion Counters have ⅞" wheels on which the figures are a full ¼" high, combining minimum size with maximum readability. Runs at continuous speeds of 400 rpm, and intermittent speeds of 750 rpm. Torque 1.5 oz. Meets military specifications. Originally built-in parts of navigational instrumentation, these counters are applicable to many other uses.

Everyone can Count on

Veeder-Root INC.

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New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

Files Tell Cold War Story . . .

(Continued from p 22)

ceivers or tape recorders were in use at the time of the attack. Reconnaissance planes often carry several panoramic intercept receivers for scanning the radar portions of the electromagnetic spectrum. Received signals are recorded and analyzed for frequency, pulse repetition frequency (prf) and pulse width.

A direction finder provides the bearing and the prf gives the range, thus revealing the location of radar. Once the positions and effective ranges of a group of radar installations are plotted, the perimeter of radar surveillance is determined.

With the various types of ecm devices undoubtedly carried on these planes, enemy radar could be jammed or else the pilot could keep out of radar sight.

The crew of the P4M numbered fourteen: five officers and nine noncoms. Five of the noncoms were Aviation Electronics Technicians. The others were: an Aviation Ordnanceman; an Aviation Machinist's Mate; an Aviation Fire Control Technician; and an Aviation Electrician.

WHAT NAVY'S FILE REVEALS

DATE	TYPE PLANE	NO. PLANES	RESULT	WHERE	COMMENTS
Apr. 8, '50	PB4Y Privateer	1	shot down	Baltic Sea	patrol/recon plane*
Nov. 6, '51	Neptune	1	disappeared	near Siberia	weather recon
Jul. 31, '52	PBM Mariner	1	damaged	Yellow Sea	patrol/recon plane*
Jan. 18, '53	P2V-5 Neptune	1	ditched	Formosa Straits	patrol/recon plane*
Mar. 12, '54	Skyraiders	2	attacked	near Czech border	....
Jul. 25, '54	Skyraiders	2	attacked	....	....
Sept. 4, '54	P2V Neptune	1	shot down	near Siberia	patrol/recon plane*
Feb. 9, '55	AD Skyraider	1	shot down	near Tachen Islands	....
June 22, '55	P2V Neptune	1	crash landed	St. Lawrence Island	patrol/recon plane*
Aug. 22, '56	P4M Mercator	1	shot down	near Communist China	recon flight
June 12, '57	Navy plane?	1	attacked	Formosa Straits	....
June 16, '59	P4M Mercator	1	attacked	Sea of Japan	infrared recon flight

*Denotes plane's usual mission. Specific duties on day of incident not stated by Navy

WHAT USAF's FILE SHOWS

DATE	TYPE PLANE	NO. PLANES	RESULT	WHERE	COMMENTS
June 8, '51	F-80	2	lost, landed	Czechoslovakia	....
Nov. 19, '51	C-47	1	forced down	Hungary	....
June 13, '52	RB-29	1	disappeared	Sea of Japan	classified recon flight
Oct. 7, '52	RB-29	1	disappeared	Japanese territory	routine recon flight
Oct. 8, '52	C-47	1	attacked	near Berlin	....
Mar. 10, '53	F-84	1	attacked	near Czech border	....
Mar. 15, '53	RB-50	1	attacked	100 mi N.E. of Siberia	recon flight
July 29, '53	RB-50	1	shot down	off Russian coast	recon flight
Jan. 27, '54	RB-45 F-86F	1 16	attacked	Yellow Sea	recon flight
July 23, '54	rescue plane (?)	1	attacked	South China Sea	....
Nov. 7, '54	B-29	1	shot down	Japan	photo-mapping recon flight
Feb. 5, '55	RB-45 F-86F	1 12	attacked	Yellow Sea	recon flight
May 10, '55	F-86	8	attacked	coast of N. Korea	....
Aug. 18, '55	T-6	1	shot down	near N. Korea	....
Mar. 6, '58	F-86	1	shot down	between N. and S. Korea	....
June 27, '58	C-118	1	shot down	Soviet Armenia	....
Sept. 2, '58	C-130	1	shot down	Soviet Armenia	....
Nov. 17, '58	RB-47	1	attacked	Baltic Sea	recon flight
Nov. 17, '58	RB-47	1	attacked	Sea of Japan	recon flight

Eight Planes Vanish

This attack marked the twelfth such incident (involving 15 planes) for the Navy since April 1950. Eight of the 15 were shot down or disappeared.

The Air Force has had 18 incidents since June, 1951, involving a total of 65 planes. Reports show nine were shot down or disappeared and two more landed in Czechoslovakia.

Guarding Arctic

One of six new DEWline radar stations just completed by USAF along the Aleutian Island chain. Purpose is to prevent Soviet bombers from making an undetected end run around the northern DEWline

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HFE (I_c = 0.5A) (Range)	40-100	40-100	40-80	40-80
HFE (I_c = 2A) (Min.)	20	20	20	20
I_{co} (2 volts, 25°C) (Max.)	200	200	50	50 μa
I_{co} (30 volts, 71°C) (Max.)	6	6	2	2 ma
F_{ae} (Min.)	5	5	20	20 kc
T (Max.)	95	95	95	95°C
Therm Res. (Max.)	2	2	2	2° C/W

*Mil. T 19500/36 (Sig. C.)
**Mil. T 19500/58 (Sig. C.)

NOTE: Military Types pass comprehensive electrical tests with a combined acceptance level of 1%.

Delco Radio announces new PNP germanium transistors in 2N553 series — the 2N297A and 2N665, designed to meet military specifications. These transistors are ideal as voltage and current regulators because of their extremely low leakage current characteristics. All are highly efficient in switching circuits and in servo amplifier applications, and all are in *volume* production! Write today for complete engineering data.

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Editorial Conference: Friday 9:30 AM

Bill MacDonald, 33 years an Editor, Feeds a Growing Boy

Electronics, like a growing boy, has a voracious appetite — an appetite for information about technical developments, new markets, business potentials . . .

electronics magazine has the job of feeding information to the industry in a balanced editorial diet so that the quality and quantity of editorial will more than meet industry requirements.

Editor W. W. MacDonald inspires respect from his 26-man editorial staff, and justly so. Mac has been, successively, an Associate Editor, Executive Editor and then Editor of *electronics*. Before joining *electronics* he had been Managing Editor of "Electrical Merchandising" and Editor of "Radio Retailing." A senior member of the Institute of Radio Engineers, he has devoted 33 years to editing McGraw-Hill publications.

Mac is responsible for *electronics* editorial. True, he has far more assistance from his highly trained, professionally mature staff than do most business publication editors. Fifteen members draw upon direct engineering experience in the electronics field. Four editors gained electronics experience in the armed services. Four others came to *electronics* with backgrounds in journalism, finance, and marketing. The balance of the staff comprise the Art Director and his assistants.

But the Editor of *electronics* is a perfectionist and never satisfied. He is constantly raising the standards by researching his readers, going into the field, sounding out his staff.

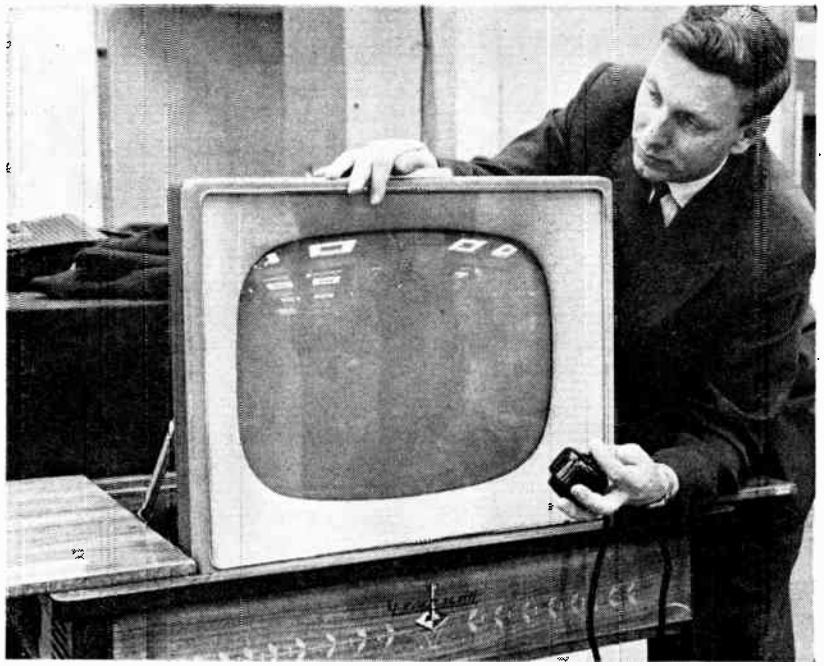
And what does Mac's editorial contribution mean?

That the reader of *electronics* is kept best informed about his industry, and is therefore most apt to progress in it. If your subscription to *electronics* is expiring, if you're not a subscriber, fill in the box on the Reader Service Card. It's easy to use. Postage is free.

electronics / A McGraw-Hill Publication • 330 West 42nd Street, New York 36, N. Y. ABP ABC

Exhibit Shows USSR

Soviet engineers in New York give data on communications gear, analog computers and various entertainment products



Soviet tv engineer Anatoly Chuev shows 21-in. set that folds away under chess table top. Left hand holds remote control device

NEW YORK—TECHNICAL STRIDES in Soviet consumer goods, computers, communications equipment and components were in evidence as the USSR's science, technology and culture exposition opened here last week.

Eye-catcher among the home television sets on display in the Radio-Electronics section is a 21-in. screen that is pulled up into viewing position when the two leaves of a chess table are raised from the center and flipped outward. A device for remote control of volume and channel switching is shown.

Several transistor radios of high sensitivity are displayed, including one that operates from solar power.

Transistorized Computer

A transistorized universal analog computer highlights the computer exhibit of seven analog computers. Soviet engineers say digital computers could not be shipped to New York because of their size and complexity.

The transistorized unit on display is basically a research tool used in studies of automatic systems. Some of its components are similar to parts of other analog computers used in industrial process control.

Other Analog Units

Another analog computer using tubes handles integrated equations, boundary conditions of equations and initial conditions, and is used in solving mechanical problems in building construction. Another unit, used in the metals industry, can collate 23 parameters. An Academy of Medical Sciences analog computer simulates the electrical process of the human heart, nervous system and other physical sources of excitation.

A multichannel telephone and telegraph cable system, said to be used widely in Siberia, is completely transistorized and uses printed circuits containing miniature transformers and other miniature components. System is designed to provide three or four telephone channels over a distance of 50 km.

Gains

New transistorized telephone crossbar switch, a number of which are reported to be in regular operation already, handles 20 telephone lines but only two at one time. Soviet engineers say it can be used for close-range ship-to-shore telephone communications and in metropolitan and rural locations.

Progress in Facsimile

Soviet engineers report advances in facsimile or "phototelegraphy," which they say is used extensively in the Soviet Union. A standard phototelegraphic blank is about 9 by 12 in. and can be transmitted at three drum speeds: 60 rpm and 120 rpm by radio and 250 rpm by cable. The latter takes six minutes to transmit.

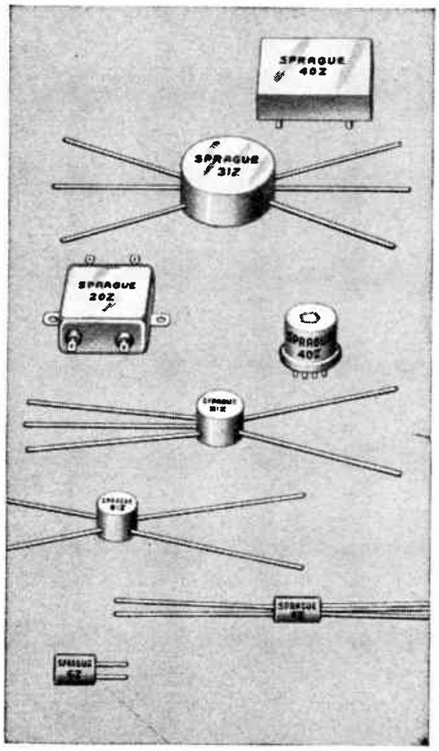
Among the units of medical electronic equipment shown at the Soviet exposition is an eight-channel radiograph which makes use of short-lived radioisotopes in measuring the speed of human blood flow.

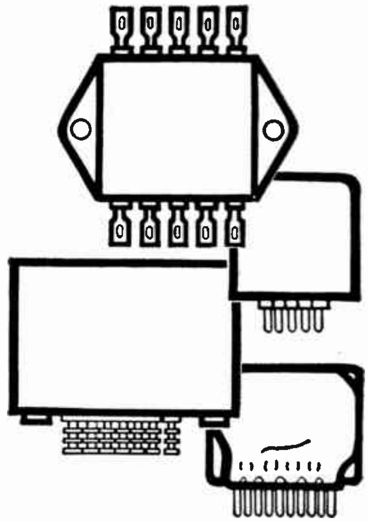
Produces Drawing

Another piece of equipment is used in connection with the injection of radioisotope material into the spinal column to locate a tumor. A recording instrument produces a scale drawing of the path of the radioactive material. Physician can then place the entire paper recording along the patient's backbone and find the precise spot where the in-

(Continued on p 35)

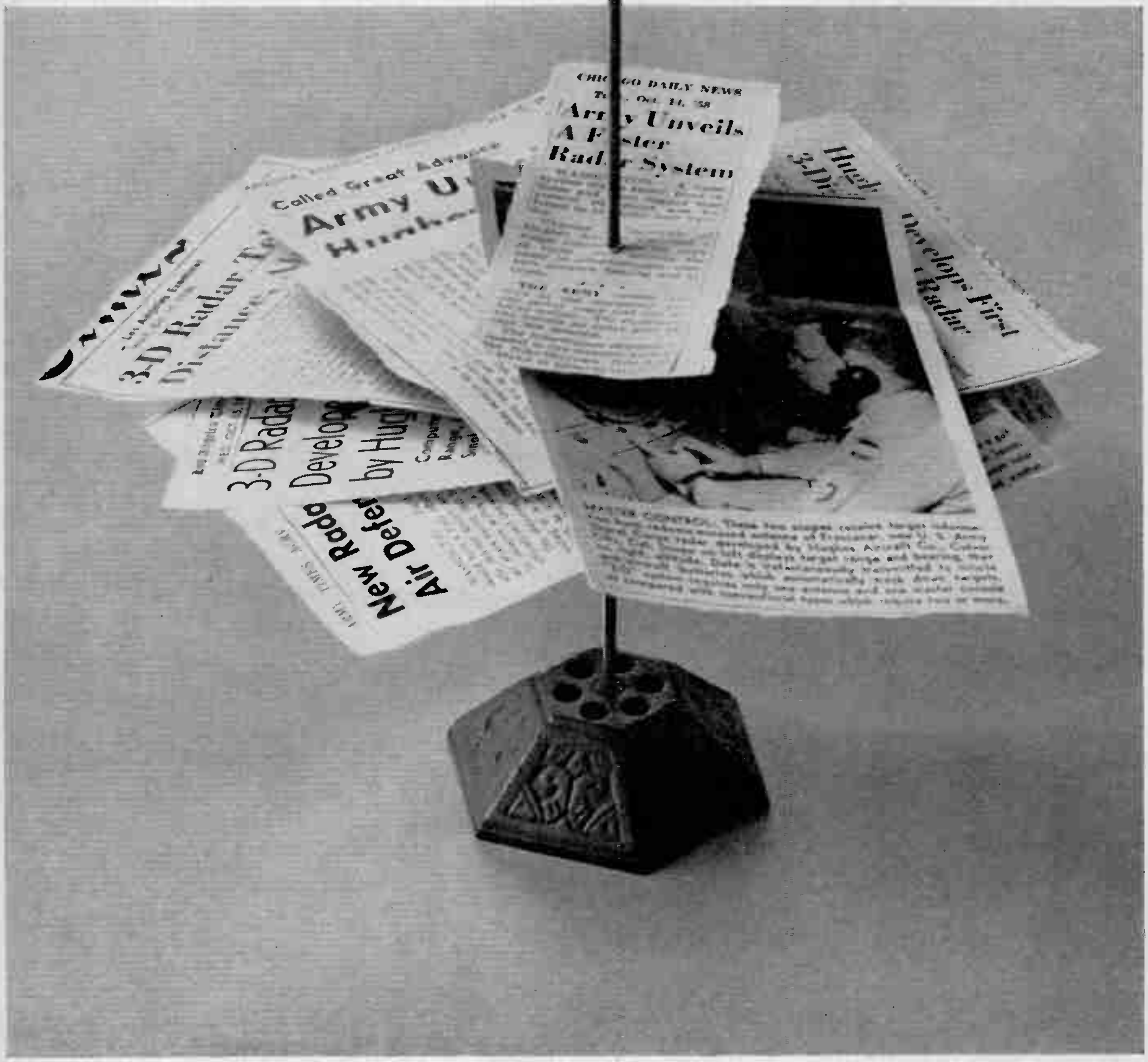
Engineer Yuri Danilevsky shows plug-in component of 4-channel telephone system that contains printed circuit, miniature components





WANTED:

Engineers who can top these stories



Hughes new frequency scanning radar has been called the most important new development in the art since radar itself was conceived. Mechanical antenna movement has been largely eliminated. The radar beam is positioned in space by varying the frequency of the electromagnetic energy applied to the antenna.

Already, this new principle has proved its mettle. The Army's new Frescanar radar handles a large number of targets with great accuracy and presents all information with three-dimensional realism.

Obviously this is but one step in the evolution of this new radar principle. Hughes Fullerton needs engineers who can exploit this breakthrough and go on to discover new commercial and military applications as yet undreamed of.

Hughes Fullerton is now rapidly expanding. While the main emphasis is on advanced Research and development work, there are positions open in a variety of engineering activities.

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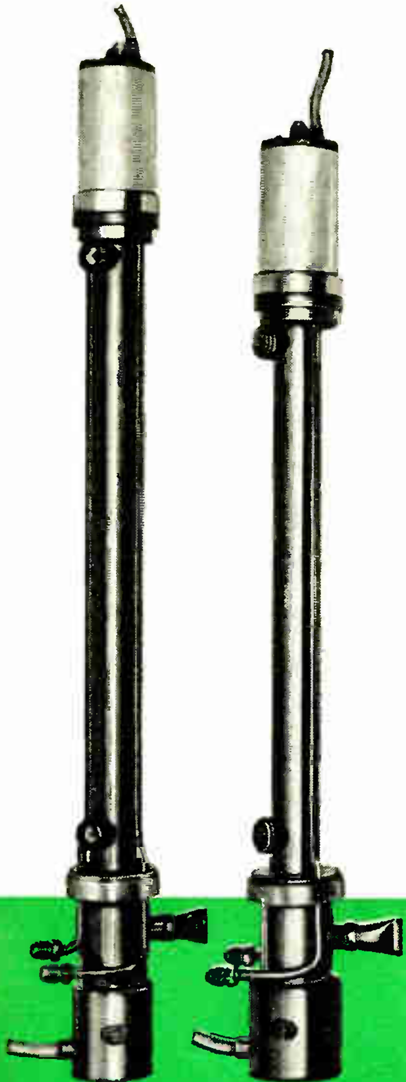

STX-104 STX-105

NOW AVAILABLE New X-Band TWT Amplifiers from Sperry...for missile guidance, air navigation systems, and other CW applications...combining

Broadband response... high power...high gain... rugged long life construction

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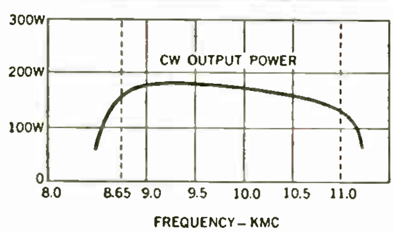
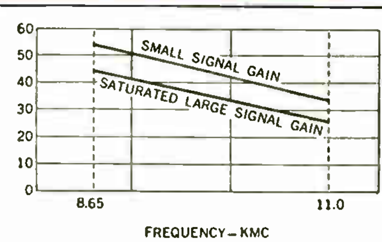
SPECIFICATIONS

Frequency Ranges:....................STX-104, 7.00-8.75 kmc; STX-105, 8.65-11.0 kmc
Small Signal Gain:..40 db nom
Output Power CW:.........................100 w min, 150 w min avg over frequency range
Gain at Rated Output Power:..30 db nom
Input Power at Rated Output Power:..630 mw max
MAXIMUM RATINGS: Beam Voltage, 8 kv; Body Current, 100 ma; Collector Voltage, 2660 v min (with respect to cathode); Operating Temp., 150°C

(1)



(2)



(3)

(1) Loaded waveguide structure and tough metal envelope of STX-104 and 105 provide high vibration and shock resistance, as substantiated by this and many other environmental tests conducted in Sperry labs. Quality components and integral input-output connections contribute to high performance reliability and long life. (2) Output Power vs. Frequency (3) Small and large Signal Gain vs. Frequency.

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$2 Billion for Space in '70

Government's two space agencies, NASA and ARPA, now have budgets totaling $790 million

WASHINGTON—The entire National Aeronautics and Space Administration-Advanced Research Projects Agency budget of $790 million will increase to more than $1.5 billion during fiscal year 1965 and $2 billion during fiscal 1970, says William F. Long, Electronic Industries Association's marketing data department manager.

General trends in all expenditures, not just for NASA and ARPA, during the next years were summarized by Long:

Period	Total Expend. for Missiles Aircraft, NASA, ARPA	Electronics Portion	Electronics Percent
Currently	$11 billion	$3 billion	27
Mid-1960's	13 billion	5 billion	38
1970	14 billion	6 billion	43

The "electronics portion" of the space-aircraft missile program, as shown in the table above, relates to industry totals as follows (in billion of dollars)

Period	Space Aircraft-Electronics Missile	Total Electronics Military	Total Electronics Industry*
Currently	$3	$4.95	$9.12
Mid-1960's	$5	9.00	15.25
1970	$6	12.05	19.72

* Includes consumer products, replacement parts, industrial-commercial products, and military products.

USSR Show . . .

(Continued from p 31)

cision should be made.

A sizable display of television equipment, including a complete broadcast studio, 20 types of home tv sets, closed-circuit tv gear and an underwater tv camera are exhibited. (Technical details of the broadcast equipment will appear in the July 24 issue of ELECTRONICS.) In addition, stereophonic hi-fi sets, record players and tape recorders are on display.

The Soviets also show a model of an automatic traffic control system for railroads. A Soviet engineer says the system is used on many rail lines in the Soviet Union, including the Trans-Siberian Railroad.

The show is in the Coliseum and runs through Aug. 10.

Recording Blast Vibrations

Battery-powered, portable Blastcorder by Geotechnical Corp. has fixed scale for immediately measuring peak accelerations from 0 to 1.1 g's. Device, usable with one, two, or three pickups, weighs 20 lb and provides permanent record on 4 x 6 transparent film

MEETINGS AHEAD

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

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

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

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

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

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

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

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

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

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

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

Sept. 23-25: Non-Linear Magnetics and Magnetic Amplifiers, AIEE, ISA, PGIE of IRE, Shoreham Hotel, Wash., D. C.

Sept. 28-30: Telemetering, National Symposium, PGTRC of IRE, Civic Auditorium & Whitcomb Hotel, San Francisco.

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

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

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 74.

Weather or not . . . here they come

Mobility is essential to the mission of the Tactical Air Command. Whenever or wherever trouble strikes, TAC must be capable of moving men and materials with speed and safety, regardless of weather or landing conditions. The AN/TPN-12 Ground Control Approach Radar System, now in production at LFE, assures all-weather mobility for the Air Force on virtually any landing strip in the world. Lightweight; portable (by land, sea or air); simple to set up and operate; this highly reliable GCA System has progressed from proposal-to-prototype-to-production in only 10 months time . . . another outstanding example of *Leadership from Experience* by LFE.

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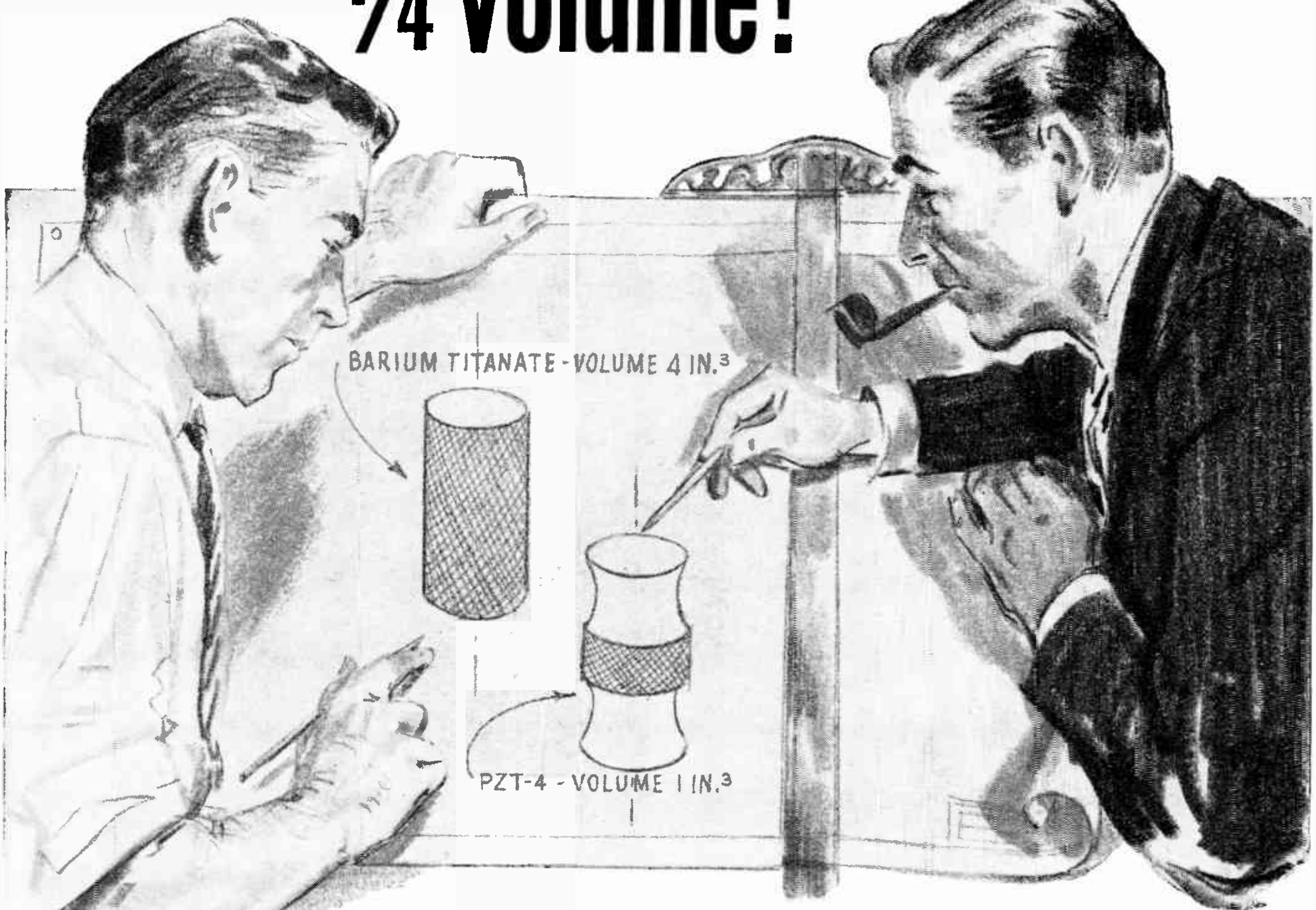

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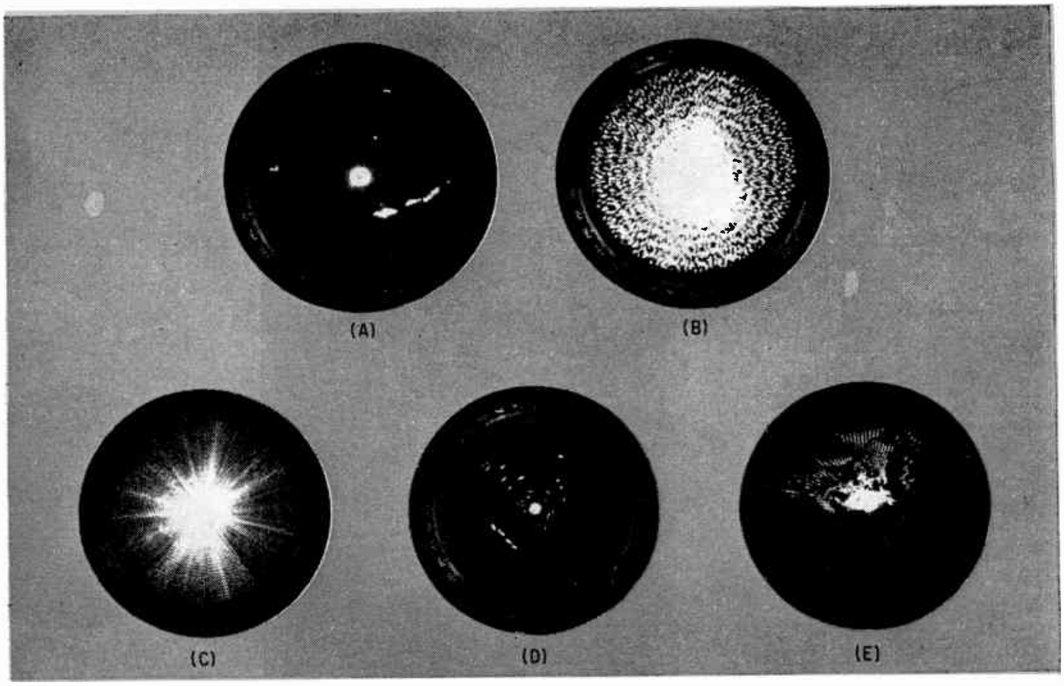


FIG. 1—Normal display shown in (A). Display obliterated by radar interference (B). Display (C) is obscured by interference and after integration appears as (D). Display (E) shows same area as (D) on shorter range scale without integration

Reducing Mutual Radar Interference

Little attention has been paid to the effects one radar produces on another. Higher transmitter power and more sensitive receivers now make the mutual interference problem more acute

By K. H. CHASE and J. L. PIERZGA,
Sperry Gyroscope Co., Sperry Rand Corp., Great Neck, New York

RAPIDLY INCREASING RADAR POPULATION will eventually cause friendly jamming far more serious than that transmitted by enemy jammers, unless corrective measures are applied. The radar-interference problem has already far exceeded the means for suppressing the interference. This article will show some of the methods by which relief can be achieved. At best, however, the result is only a reduction in the problem. Considerable effort is still necessary to allow radars to operate in their own environment.

As a result of the interference problems, attention was placed on the reduction of pickup due to radiation and conduction of undesired signals. Shielding and filtering were employed wherever necessary in the radar. However, the largest single source of radiation interference was virtually overlooked. This source is the radar antenna itself.

The greatest factor in producing interference from the antenna is the broad frequency spectrum of the transmitted signal which often extends far beyond its useful bandwidth, thereby being seen by a receiver far removed from the carrier frequency.

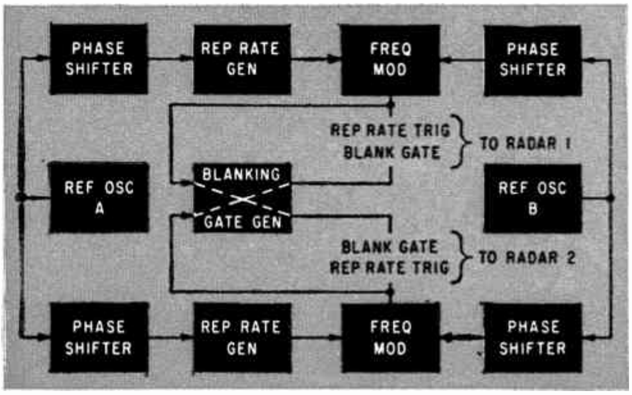


FIG. 2—Time-gated tracking system for use with intensity-modulated displays

To better understand the nature of radar interference, it becomes necessary to divide the problem into time domain and frequency domain subdivisions. In certain cases an overlap may exist (for example, frequency modulation on a pulse); however, such a case will appear in each subdivision.

GATING—Interference in the time domain has not been neglected to the same extent as in the frequency domain. From the interference standpoint, many interference remedies have resulted from other system requirements. One such case is the use of gated receivers or detectors in a tracking radar. Signal gating makes a tracking radar far less vulnerable to pulsed interference occurring at ranges outside the range of the target being tracked provided the interference is random in nature and pulses do not occur repetitively within the gate.

Intensity-modulated displays are extremely vulnerable to pulsed interference. Such interference can increase target detection time, and if very intense, can completely blank out a display. In the case of a search radar presentation as shown in Fig. 1, the target may never be seen. Tracking radars must be operated in an acquisition mode before the target can be tracked. In this mode, the target is often presented on an intensity-modulated display, and pulsed interference will either increase acquisition time or make target acquisition impossible. If the target is never acquired, the target gating circuit is of little or no use and the radar is rendered tactically inoperative.

SYNCHRONIZATION AND BLANKING—Two of the primary tools for reducing interference in the time domain are synchronization and blanking. In its simplest form, a group of radar transmitters which can be operated at the same repetition frequency may be synchronized by firing them simultaneously. If this is feasible, and if sea or ground clutter and signal ambiguity are not objectionable, this can be a simple and useful approach. In many cases, other considerations make this approach impractical and other synchronization methods are required. One type of synchronization involves modulation of the pulse repetition frequency, so that interference from one radar runs through the display on another radar at a rate great enough to avoid contamination of the tracking circuit and deflection displays.

Intensity-modulated displays which must operate in a pulsed interference environment lend themselves particularly to the use of blanking techniques. By putting a hole in a display during the firing of any offending transmitter and causing the blanked region to constantly move on the display, virtually all of the interference can be removed at very little cost in loss of useful information. Where a number of radars are located in the same vicinity, this blanking can be accomplished by direct interconnection. A system of synchronization and blanking, where the proximity of radars allows a direct interconnection to be made, is shown in Fig. 2. Reference oscillator *B* supplies a low-frequency sine wave output which after passing through phase shifting networks is applied to the frequency modulators as the modulating frequency. The phase shifters will allow the frequency modulators to produce pulses which have an instantaneous frequency difference. Reference oscillator *A* supplies a higher frequency sine wave at approximately the frequency necessary to supply the radars with repetition triggers. The output of this oscillator also passes through phase shifters before being transmitted to the repetition rate generators. These generators merely supply a chain of triggers which have a fixed period. The outputs of the repetition rate generators are fed to the frequency modulators and combined with the low-frequency signals from reference oscillator *B*. The mixing of the signals produces a chain of triggers whose period varies with the modulation index and the modulating frequency from reference oscillator *B*. With reasonable repetition frequencies, modulating frequencies and modulation indexes, one radar can be made to appear as a target to another radar moving at velocities on the order of 100,000 mph. It would be exceptionally unusual for one radar to break track on its target in favor of another with such a rate. With a time-gated tracking system, as shown in Fig. 2, one radar never fires at the same time as the other. This type of synchronization can be extended to a much greater number of radars with some slight degradation. It would take many radars, a dozen or so, to reach a point where the effects of one radar on another will be bothersome.

Blanking triggers are supplied from each radar to a blanking gate generator as shown on Fig. 2. The resultant blanking gates will be fed to the other radars (other than the one supplying the trigger) to blank out acquisition or search displays which are usually not time gated. This technique can be extended to cover a much greater number of radars than shown. The limit is reached when the scanning loss caused by too many holes in a display exceeds the scanning loss caused by interfering signals.

In installations where direct interconnections cannot be made, such as adjacent ships or widely separated field installations, other blanking techniques have been developed. One such system involves the use of a separate radar receiver at the offended site to determine when the level of interference exceeds a threshold value. This receiver would require a bandwidth in excess of the normal radar receiver, thus providing the ability to measure spectrum components outside the half-power bandwidth of the normal receiver. Figure 3 shows a block diagram of such a system. A sample of the input signal is coupled to the wide-band receiver where it is amplified, detected, and limited and then applied to a blanking gate generator. The wide-band receiver passes spectrum components outside the pass band of the normal receiver. Centered about the normal receiver frequency, the side band amplifiers develop guard bands on both ends of the pass band of the normal receiver. If interfering signals are detected by these amplifiers and following circuits, a blanking gate will be generated. The path through the normal channel incorporates a delay line to allow the blanking signal to block the interfering signal. The desired return signal will not have sufficient energy outside of its designed pass band to develop a blanking signal, and passes through to the radar displays. This method would allow radars to operate with reduced frequency separation if there is a time drift between the pulse-repetition rates of the radars. Without this drift, the same time or range interval may be continuously blanked.

Blanking can only be a useful tool up to the point where the number of interfering sources causes a prohibitive scanning loss in the offended system. Beyond this point, other techniques must be employed.

PULSE-WIDTH DISCRIMINATOR — Where the radar population is high, or when the offending radars have a high duty cycle, a composite blanking signal produced by the offending radars would result in a prohibitive scanning loss. The scanning loss, which is

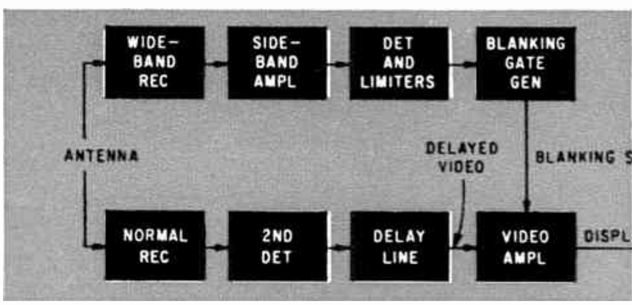


FIG. 3—Blanking technique used with no direct connection between radars

a product of the duty cycle times the number of offending radars, is further magnified by a factor of at least two. This factor is the result of the system designers requirement that the blanking period be longer than the transmitter pulse plus all the various delays anticipated in the various installation configurations.

The radar which is subjected to this interference will receive a composite blanking signal from all of the anticipated interference sources of at least twice the duty cycle necessary. A pulse-width discriminator will reduce this scanning loss by one-half, and will generate a blanking signal only when the offending signal is present in the system video.

The width of signal return is directly related to the transmitted pulse width and to the length of the target. For conventional aircraft, a target length of 150 ft or 0.3 μsec may be expected. An approximation of the duration of the signal return from an aircraft on this basis would result in a signal duration of $T_{xmitter} + T_{target} \pm 20$ percent. The increment of 20 percent gives a wide safety factor and allows for signal perturbations. The circuits to be discussed sense pulse durations and blank pulses of all other durations.

The discriminator circuit shown in Fig. 4 will blank a video signal if it falls within the notch developed by the gating circuits. Incoming video is clipped by diodes D_1 and D_2, at both the bottom and the top, to eliminate stretching of the incoming video due to overloading and to prevent noise at the base line of the video from activating the circuit. The remaining signal is amplified, limited and differentiated. The negative differentiated pulse produced by the leading edge of the incoming video is coupled to V_3 by coupling diode D_3. The function of multivibrator V_3 is to prevent the following circuits from being influenced by the input video during its sensing period. The leading edge of the positive pulse from V_3 triggers V_4. The positive pulse from V_4 which is amplified, inverted and differentiated, is impressed on V_{5A}, whose output triggers V_6 with a positive differentiated signal. The output of V_6 is coupled through cathode follower V_{5B}, to apply an enabling voltage on the suppressor grid of gate tube V_7.

The input to the control grid of V_7 is the differentiated trailing edge of the amplified video. An output will appear at the plate of V_7 whenever the trailing edge of the video occurs within the time of the enabling-gate signal from V_6. The time of the leading edge of the gate is determined by V_4, and the duration of the gate is determined by V_6. The output of V_7 is amplified, inverted and used to trigger V_8. The duration of multivibrator V_8 pulse is set by R_1 to coincide with the width of the pulse to be blanked. The output of V_8 is used as an *off* gate and turns off V_{11} whenever a video pulse of incorrect width occurs. Unprocessed video is amplified by V_{10}, a grounded-grid amplifier-cathode follower, and applied to the delay line. The output of the delay line is applied to the gated amplifier V_{11}. Clamper tube V_{12} removes the gate from the processed video.

Evaluation of the pulse-width discriminator when incorporated in a system resulted in a marked improvement in the acquisition capability of the system.

FREQUENCY DOMAIN—The greatest source of interference lies in the frequency spectrum of a radar transmitted pulse. Radar designers have been striving to produce a narrow, fast-rise-time pulse. Each of these pulse qualities has broadened the frequency spectrum. In so doing, little attention was paid to the end result of such an ideal transmission. An irregular target reflects the pulse with considerable distortion and the receiver response further degrades the pulse. Investigations have shown that pulses with envelopes shaped like a cosine-squared function produce a narrower frequency spectrum than rectangular pulses.

Klystron tubes lend themselves readily to pulse shaping since the shaping can be accomplished in either the r-f drive signal or by a modulating voltage pulse. One of the advantages of shaping the pulse with a modulating anode is that relatively small currents are required in producing the desired shape. When such a device is used in the power amplifier stage of a klystron chain, less distortion will result in the desired characteristic. When a modulating anode proves impractical for certain cases, the r-f drive can be shaped at any point in the klystron chain. The problem associated with this method is that of maintaining the pulse shape through the amplifiers. All stages following the shaping stage must be operated in their linear region, thereby reducing the available bandwidth of the chain and the power out.

COSINE-SQUARED PULSE GENERATOR—Investigation of frequency spectrum utilized by a radar using shaped transmitter pulses resulted in developing the cosine-squared generator shown in **Fig. 5.** The approach outlined below is by far the least complex, and yields a distortionless cosine-squared pulse.

The trigonometric identity $\cos^2 \omega t = \frac{1}{2}(1 + \cos 2\omega t)$ indicates that the desired $\cos^2 \omega t$ waveform is the result of a d-c shift of one-half the amplitude of a cosine wave, which is twice the frequency of the cosine-squared wave.

A sine wave from an audio oscillator is applied to a count-down circuit consisting of a series of blocking-oscillator frequency dividers (tubes V_5 through V_8), which divide by 320. The output of the count-down circuit is a positive pulse, which is synchronized to the original sine wave. The positive pulse synch output triggers a pulse generator, (not shown in Fig. 5), which in turn develops a rectangular, positive *on* gate pulse. The width of the gate pulse is adjusted to be equal to the duration of one cycle of the input sine wave. The pulse generator delay control allows the correct portion of the sine wave to be gated out. The *on* gate is applied to the input of cathode-follower gate-driver V_1. The positive gate developed at the output of the cathode follower is applied to box-car detector V_2. The *on* gate overcomes the back bias developed by the voltage dividers R_1-R_2 and R_3-R_4, allowing the diodes to

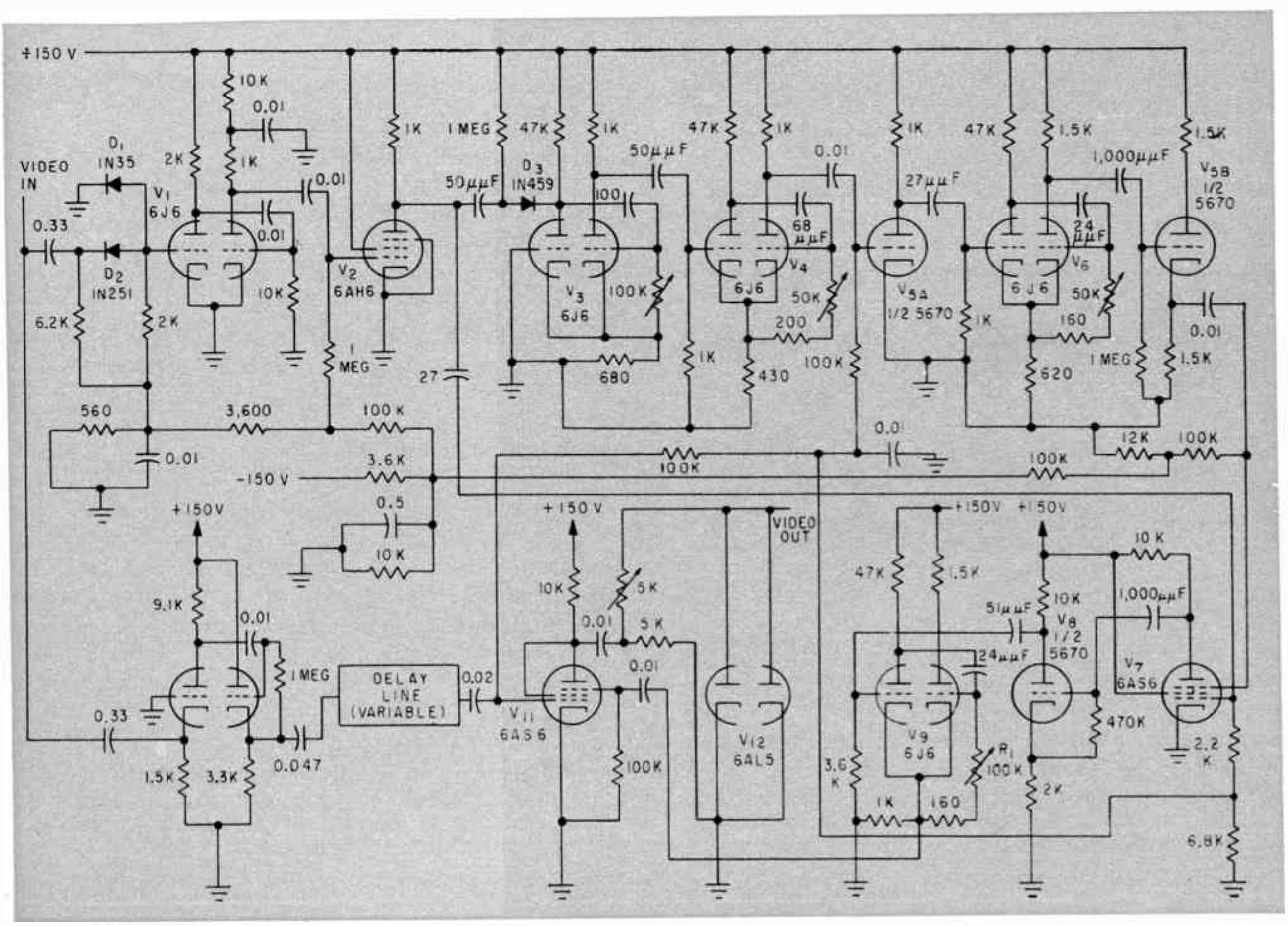


FIG. 4—Pulse width discriminator gates output video off whenever a signal which has the wrong width occurs

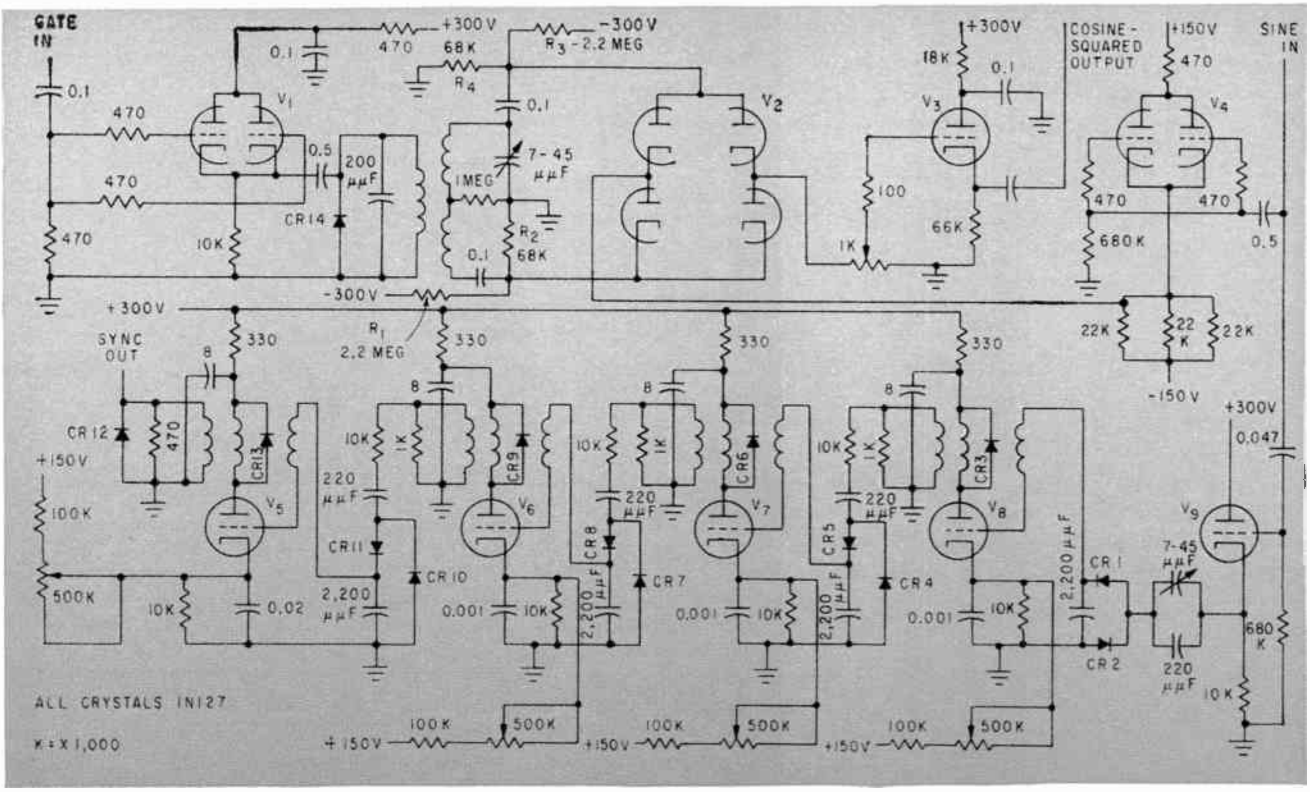


FIG. 5—Cosine-squared pulse generator generates a pulse whose width is half duration of one input sine wave cycle

conduct thereby passing the portion of the sine wave occurring during this interval. The resulting output from cathode follower V_3 is a cosine-squared pulse, whose width measured at half amplitude is half the duration of one cycle of the input sine wave.

The cosine-squared pulse output is fed into a balanced modulator (not shown in Fig. 5) in conjunction with a 30-mc signal. The output of the balanced modulator is a cosine-squared pulse whose carrier frequency is 30 mc. This burst is used as an input to a synchrodyne klystron. The duration of the gated beam voltages of the klystron chain are adjusted so that they will straddle the cosine-squared pulse.

There will be a marked reduction in the available output from the klystron chain, because to minimize amplitude distortion the klystrons in the chain are restricted to the small signal region of their operating characteristics. No deteriorating effect on ranging accuracy and on target discrimination was noticed. By utilizing a shaped pulse in the transmitter, the frequency spectrum will be considerably narrower, thus allowing radars to operate much closer in frequency than would be possible with a rectangular pulse.

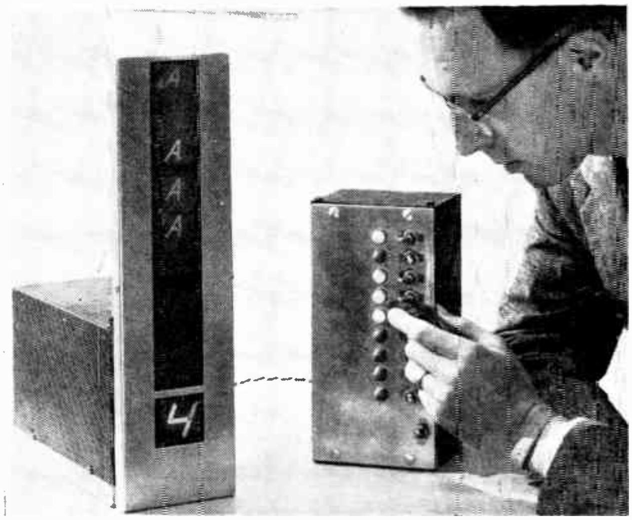
Magnetron devices do not allow the same flexibility in pulse shaping. Networks capable of handling very high power are required to shape the output pulse of a magnetron and considerable power is wasted when the shaping follows the power amplifier.

Magnetrons also have proven to be rich in harmonics. Unless adequate filtering is provided after the magnetron, these radiations will hamper the operation of other nearby radars. Klystrons, when used as oscillators, also tend to generate some harmonics. However, when followed by an amplifier chain, these harmonics are usually filtered out by the limited bandwidths of the klystrons.

Another area of interest generally overlooked is the radar receiver. The receiver bandwidth is usually specified at the 3-db points. While for system considerations this bandwidth definition is adequate, for interference considerations receiver gain is of interest in regions well beyond this 3 db point. Most radar receivers normally have significant gain at a frequency as much as 100 mc away from their center frequencies.

In determining the extent of interference in a given system, the characteristics of pulse spectra and receiver bandpass well beyond their respective center frequencies must be combined.

RECENT TECHNIQUES—Two new aspects of the radar field should be mentioned since these will have some impact on the interference problem. A recently developed f-m pulse technique uses what may be considered coding of the transmitted signal. The radar receiver associated with that transmitter contains a special decoder which reforms the pulse. The second technique of increasing importance will be the use of frequency diversity, that is, a constant shifting of the radar frequency. By this technique, interference from an offending radar will appear at random thereby reducing the number of occurrences.



Operator throws toggle switch number five to light corresponding panel in display unit and increase total to four

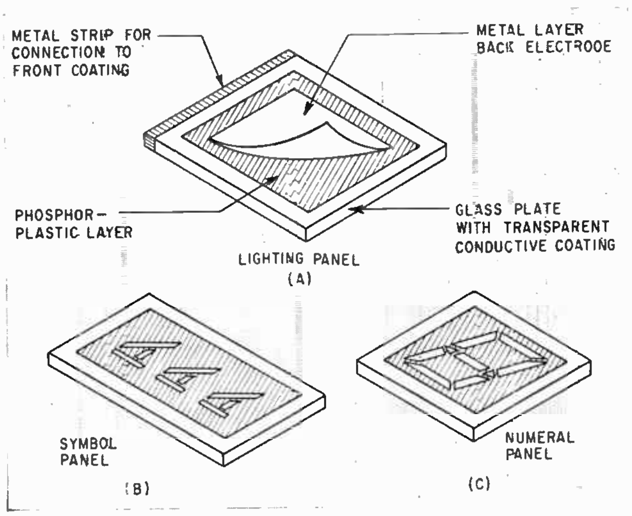


FIG. 1—Construction methods for EL panels used for lighting (A), symbols (B) and numerals (C)

Electroluminescent Panels

SEVERAL ADVANTAGES are derived by using electroluminescent panels in place of present indicators for the display of numerical and symbolic information.[1,2] Some of the advantages of these self-luminous panels are related to the solid-state nature of electroluminescence. Since the panels require no evacuated envelopes or heated filaments, the possibility of failure is exceedingly small. This is of special importance where numerals are formed by many separately lighted segments; failure of a single segment can result in misreading several numerals.

Because the electroluminescent plate is thin, it forms a truly planar indicator and is readable over an exceedingly wide viewing angle. It requires negligible panel depth. The plates can be made in a wide range of sizes, from a fraction of an inch to several feet in height. Electroluminescence is an area source of light and only the desired shape need be excited. Thus, all the light generated is useful and, for a given display brightness, less heat is dissipated in these panels than in other indicators.

Brightness of these self-luminous indicators is more than sufficient for operation in adequately illuminated areas. Future advantages include the additional flexibility of change in emitted color with change in excitation frequency.

Plate Construction

The construction of an electroluminescent (EL) plate used for lighting is shown in Fig. 1A. Phosphor is mixed with a plastic dielectric and sandwiched between a glass plate with an electrically conductive, but transparent, coating, and an evaporated metallic layer. An a-c voltage applied between the conductive transparent coating and the metallic layer of this capacitor will excite the phosphor and cause light to be radiated through the glass side.

For the display of symbols and numerals, the back layer is evaporated through a stencil (Fig. 1B, 1C). The a-c voltage is applied between the desired evaporated segments and the conductive transparent coating. The symbol *A* is an arbitrary choice; any letter, numeral or pictorial outline can be used.

Figure 2 shows how excitation of the proper segments of a nine segment numeral pattern can show all 10 numerals in easily recognizable form. The segment pattern shown is one of several possible arrangements.

The photograph shows a digital display system that uses electroluminescent indicators. Such a system could be used by the dispatcher of a fleet of cargo planes to keep track of the availability and activity of his fleet stationed at a distant airfield. The encoding unit (with the toggle switches) would be located at the airfield and the decoding and display unit would be located in the dispatcher's office.

Each position on the display would correspond to a particular plane and would show if it were ready for assignment. The display would also show the total number of planes available at that time.

This illustrates the two functions of the system: remote reproduction and summarization of the input information on the display board. By

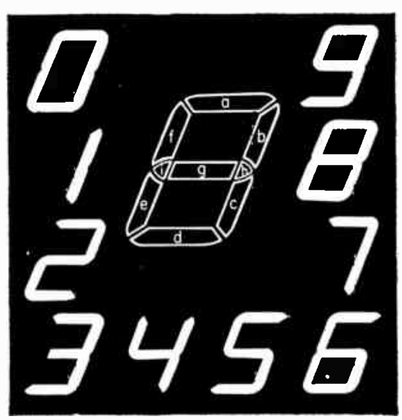


FIG. 2—Use of nine-segment pattern gives any number from zero to nine

Today visual display systems are being constructed entirely of solid-state elements by using electroluminescent indicators. These systems can be used to telemeter information, replace manually posted displays, summarize information and operate as input or output accessories for a computer

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for Automatic Displays

expansion of the circuitry and display panel, a multicolumn board could readily be built.

System Operation

Information is transmitted from the encoding unit to the decoding unit and display board in a series of pulse bursts. Each pulse burst contains the entire information to be displayed, making the system highly redundant. This results in rapid error correction should the information be garbled in transmission.

Figure 3 is a block diagram of the circuit used to obtain the pulse bursts. Assume the flip-flop to be initially ON. Because the flip-flop is ON, the clock gate conducts pulses to the ring counter, causing it to successively actuate each of the 10 gate circuits. If a particular toggle switch is thrown OFF, no pulse will be generated at the corresponding gate when the ring counter actuates that gate. Hence, the only pulse appearing at the output amplifier will be the clock pulse conducted through the clock gate and the OR circuit. This causes a negative output pulse to be transmitted.

If a switch is thrown ON, the coincidence of the ring counter and switch signals will generate a pulse at the respective gate. This pulse goes to the positive input of the amplifier and, by inhibiting the clock pulse appearing at the negative input, causes a positive output pulse to be transmitted. Operation continues until the ring counter has scanned all nine switches and reaches the tenth gate. It then turns the flip-flop OFF, disabling the clock gate and ending the transmitted pulse burst.

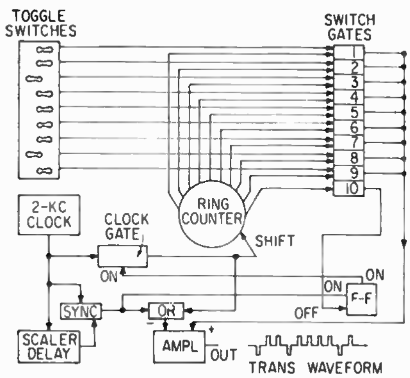


FIG. 3—Control and encoding circuit uses scaler delay to set repetition rate

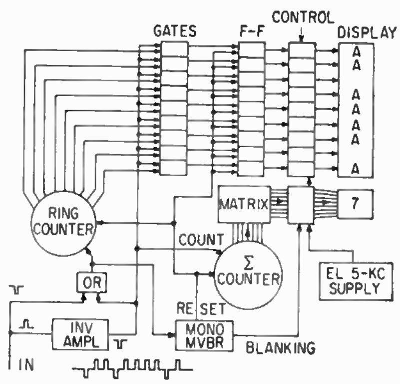


FIG. 4—Receiver decodes, totals and displays information

Clock pulses are also used to drive a scaler delay that sets the repetition rate of pulse bursts. The scaler generates an output pulse, resets and begins scaling again after each fiftieth clock pulse. Because its output pulse comes just after the clock pulse, the scaler delay is synchronized with the next clock pulse. It starts the transmission of another pulse burst by causing a negative pulse to be transmitted and by turning the flip-flop ON.

The flip-flop opens the clock gate and the ring counter again scans the input switches, beginning on the next clock pulse. The negative pulse is followed, therefore, by nine information pulses. Burst repetition rate is 40 cps.

Decoding

The decoding and display circuit is shown in Fig. 4. The first incoming pulse of the burst, being negative, triggers the monostable multivibrator. This action resets the ring counter, the summation counter and the memory flip-flops and blanks the numerical display for the duration of the pulse burst.

The remaining nine incoming

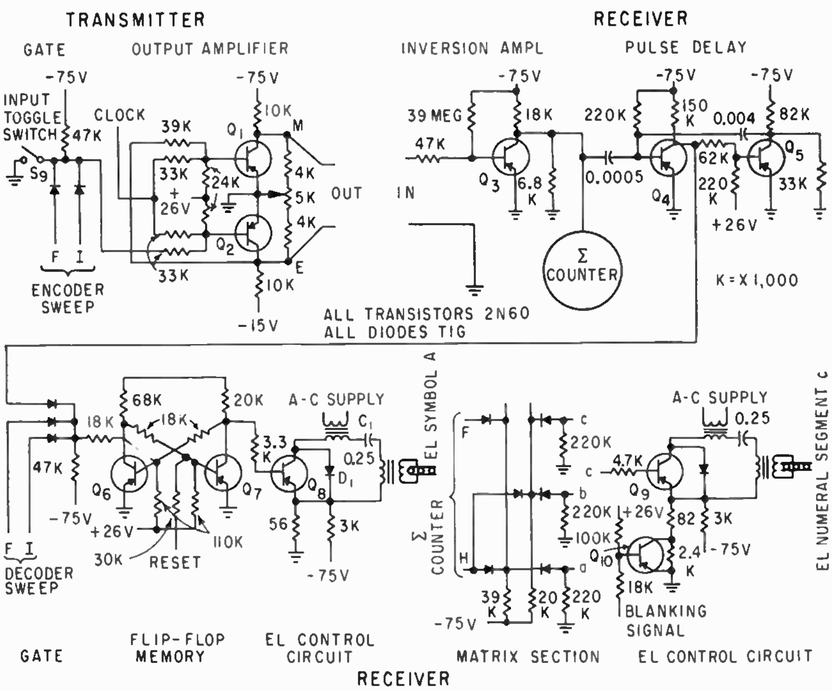


FIG. 5—System can use pair of wires for transmission or any single channel having sufficient bandwidth to pass the pulse burst

pulses serve three purposes. All are rectified and used to drive the decoding ring counter synchronously with the encoding ring counter. The positive pulses appear at the gate circuits and the coincidence of any positive pulse with its corresponding ring counter output produces an output pulse at the respective gate. This output pulse turns the flip-flop ON and the *A* symbol corresponding to the proper toggle switch is excited by the control circuit. Finally, the positive pulses also appear at the summation counter where they are totaled.

The state of this counter is translated to the required nine-segment code and actuates control of the numerical display. This translation is accomplished by an AND-OR diode matrix. Because the output of the translation matrix indicates zero when the summation counter is reset and then indicates each successive number as the counter totals the positive pulses, the display is blanked until the transmission is completed. Blanking is not readily noticeable because the transmission lasts only one-fifth of the 25-millisec repetition period.

Single Channel

Each binary unit of information follows the same general circuitry in its delivery to the display board. To illustrate the circuit, a binary unit will be followed through the system, shown in Fig. 5. The signal from the ninth toggle switch will be chosen and it is assumed this raises the total in the summation circuit to seven.

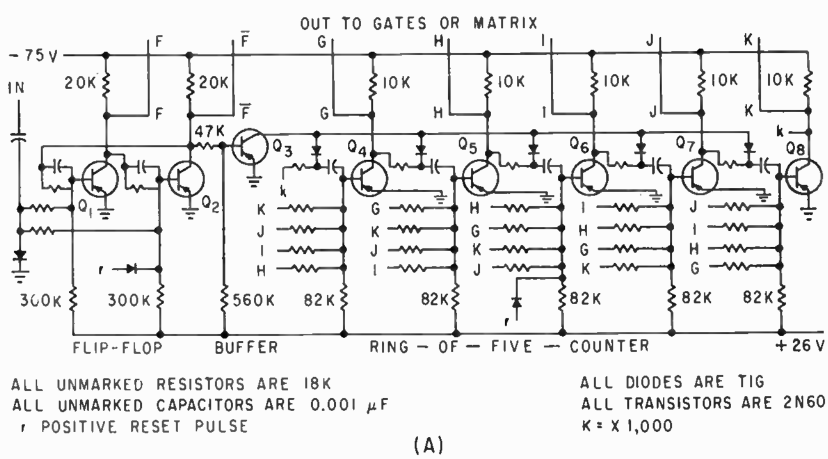
Information is introduced into the system by opening toggle switch, S_9, in the transmitter. With S_9 open and when the outputs *F* and *I* of the encoder sweep circuit are both ungrounded, a negative pulse is generated in the gate circuit. This pulse goes directly to the output amplifier. During this pulse, a clock pulse also arrives at the base of Q_2. The coincidence of these two pulses causes Q_2 to become saturated, grounding point *E*.

Because *E* and *M* are normally at —30 v, this grounding of *E* is effectively a positive pulse on *E* with respect to *M*. Had the information pulse not been generated by the gate, the clock pulse would have caused Q_1 to be saturated, grounding *M* and giving an effective negative pulse on *E* with respect to *M*.

Receiver

The output amplifier pulses are transmitted to the receiver, which has a separate ground and power supply. Here the inverting amplifier selects each positive pulse from the pulse burst and delivers a negative pulse at its output. This output goes to both the summation counter, which counts all positive pulses in the pulse burst, and through a pulse delay to the common input of all the receiver gate circuits.

The ninth gate circuit gives an output pulse when a positive input occurs in coincidence with the outputs *F* and *I* of the decoder sweep. The pulse from the gate goes to the set side of the flip-flop composed of Q_6 and Q_7. Output power of the flip-flop is sufficient to drive the electroluminescent control circuit that delivers the power to the electroluminescent symbol *A*. The flip-flop is reset by the synchronizing pulse at



	J	K	G	H	I
F	1	3	5	7	9
$\bar{F}$	2	4	6	8	0

(B)

	J	K	G	H	I
F	0	1	1	1	1
$\bar{F}$	1	0	1	1	1

(C)

FIG. 6—All three counters use same circuit (A). Counter-number code (B) and map for segment a (C) simplify matrix

the beginning of each pulse burst.

Numerical Display

The output of the summation counter is fed directly to the diode matrix. According to the truth table of Fig. 6B, when outputs F and H of the summation counter are ungrounded, the numeral 7 should be displayed. Figure 2 shows that segments a, b, c and h must be excited. Segment h, since it is excited for all numerals, needs no control and is attached directly to the h-f power supply for the electroluminescent display.

Channels a, b and c are energized by outputs F and H of the summation counter acting upon the portion of the diode matrix shown in Figure 5. Each of diode matrix outputs a, b and c goes to an electroluminescent control circuit. These control circuits are supplied with a biasing arrangement that permits the numeral to be blanked while the summation counter is changing. Blanking is accomplished with Q_{10} which blocks during the pulse burst.

Ring Counters

All ring counters (sweep circuits and summation counter) have 10 stable states. The same circuit, Fig. 6A, is used for all three counters and it departs from the common practice in that a flip-flop driving a ring-of-five is used rather than either a ring-of-ten or a four-stage binary counter. More recent designs do not require the buffer. A reset pulse, r, is used in the decoder to reset the ring counter and summation counter before the information pulses are received.

The 10 states of the counter are defined as the coincident ungrounded states of 10 pairs of outputs. Each pair is composed of one output from either the F or $\overline{F}$ (not F) side of the flip-flop and one output from one of the five-ring counter stages. These 10 states are plotted in a two by five table in Fig. 6B.

Translation Matrix

Use of this circuit as a summation counter requires that the number of transmitted ON pulses be stored and used to drive a translation matrix. The matrix must translate each stored decimal number from the flip-flop and ring-of-five code to the electroluminescent display segment code.

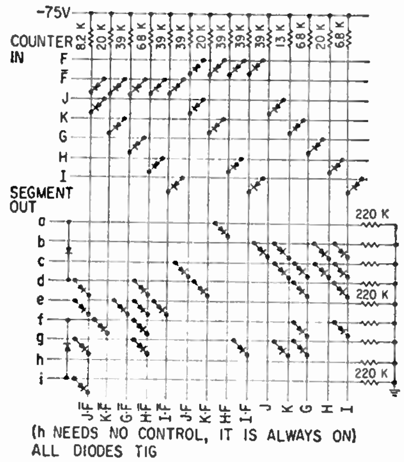


FIG. 7—Diode matrix translates decimal number to segment code

The relation between the counter code and the decimal number is the same as that used to define the ring counter states (Fig. 6B). The relation between the segment code and the numeral to be displayed is shown in Fig. 2. These two codes are combined to give the required translation function.

To derive and show the translation function in simplest form, a set of nine maps are used, one for each segment. The map for segment a is shown as Fig. 6C. Each map shows, by ones and zeros in the proper squares, which combinations of flip-flop and ring-of-five ungroundings should cause that segment to be ON or OFF. Expressed in Boolean algebraic terms, the map describes the relation:

$$a = J \cdot \overline{F} + K \cdot F + G + H + I$$

Inspection of the maps facilitates simplification of the AND-OR function and reduction of the number of diodes required.[3,4]

The resulting AND-OR diodes matrix requires 54 diodes and is shown in Fig. 7. The upper half of the circuit forms the AND terms on the vertical lines. The lower half forms the OR combinations. Values of the resistors in the AND circuits are chosen according to the number of segments driven by each.

EL Control Circuit

The intrinsic electroluminescence utilized by this system requires alternating field excitation. Typical operation for display purposes is at 400 cps and 230 v. In this system, a frequency of 5,000 cps is used because the electroluminescent indicators are not standard. A special circuit is needed to gate this audio-frequency, high-voltage power to the electroluminescent segments in response to the d-c, low-voltage logic signals. An a-c switch requiring only one transistor is used for this purpose.

A-C Switch

Most transistors switch efficiently for only one polarity; however, by adding D_1 and C_1 in Fig. 5, conduction and blocking are obtained for both polarities. When Q_8 is biased ON, current from emitter to collector passes through Q_8 while current from collector to emitter passes through D_1.

When Q_8 is biased OFF, Q_8 and D_1 both block during the half cycle when the instantaneous polarity is positive at the emitter. On opposite half cycles, C_1 charges through D_1 to the peak value of the supply voltage and no further current flows. Although Q_8 and D_1 must each block twice the peak supply voltage, the load current is divided between the two. The step-up transformer is required because presently available transistors do not have the necessary voltage rating.

Scaler Delay

Rectangular loop magnetic cores and switching transistors are combined in the scaler delay circuit.[5,6,7] The scale factor of about 50 is accomplished by one pulse generator core and one counting core, together with three transistors.

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Basic Optical Data for

Key formulas and definitions will assist preparation of imaging systems, flying spot scanners and other arrangements using lenses

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SIMPLE OPTICAL systems must frequently be set up by electronic engineers, especially in connection with photosensitive devices and cathode-ray-tube displays where light must be transferred efficiently and images formed.

The formulas given will supply the imaging performance of any object-lens arrangement at small aperture and field conditions, where lens abberations are negligible. First, effective focal length and principal plane locations are determined from Table I. Then, object distance, image distance and magnification are determined from Table II.

When object and image distances are large with respect to lens thickness, the thin lens formula provides a good first approximation. When a single lens of known focal length is used, Table I need not be used. Formulas needed for aperture considerations are given below Table II. Terms are defined in Table III and symbols and sign convention are identified in Table IV.

LENS ARRANGEMENTS—Two basic lens arrangements are given in Fig. 1. Figure 1A is fully covered by Tables I and II. Figure 1B illustrates a situation in which all light from the image must be collected onto the cathode of a phototube. Another lens is required following the image plane, to form an image of the first lens on the phototube cathode at an appropriate magnification. A ray emanating from the axial point of each object is shown to illustrate the interleaved imaging systems.

APERTURES—In addition to image location, another serious consideration is the amount of light going into the image. With an incorrect lens arrangement, the image may be too dim or brightness may fall off too rapidly for points away from the

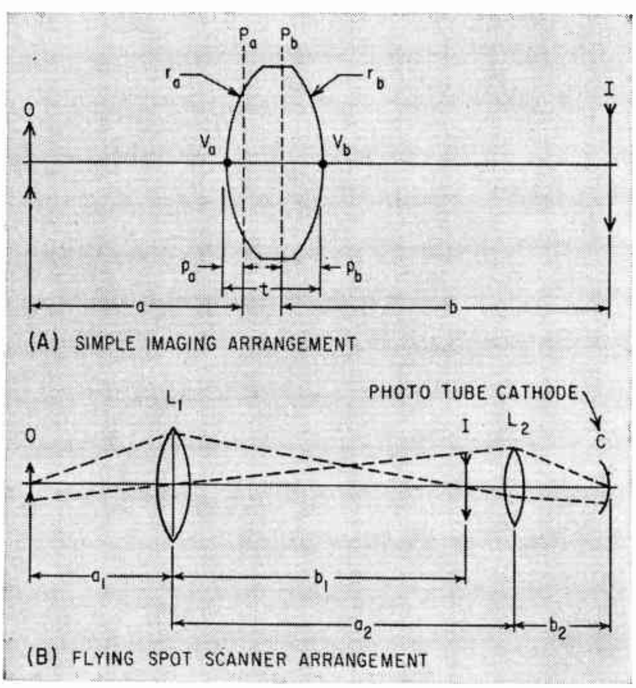

FIG. 1—Basic lens arrangements, identifying terms used in formulas

Table III—Common Optical Design Terms

Entrance Vertex: Intersection of the up-light lens surface with the optical axis

Collimated Light: (Referred to certain source or object) All light originating at any one point in source is a bundle of rays parallel to each other, but not necessarily parallel to the optical axis

Focal Point: When an object is at a lens focal point, the lens collimates light from this object into a bundle parallel to the optical axis

Focal Plane: Plane, normal to the optical axis, passing through the focal point

Principal Planes: Hypothetical planes at which the lens or lens combination is considered to be located for purposes of lens system design

Effective Focal Length: Distance from exit principal plane to focal plane. When two bundles of parallel rays, making a small angle of A radians with each other, enter a positive lens they will be imaged in the focal plane as two points separated by a distance D. The effective focal length of the lens is D/A

Electronics Engineers

Table I—Formulas for Effective Focal Length and Principal Plane Locations

	Thin Lens	Thick Lens	Combination (for 2 lenses)
$\frac{1}{f}$	$(N-1)\left(\frac{1}{r_a}+\frac{1}{r_b}\right)$	$(N-1)\left(\frac{1}{r_a}+\frac{1}{r_b}-\frac{N-1}{N}\cdot\frac{t}{r_a r_b}\right)$	$\frac{1}{f_1}+\frac{1}{f_2}-\frac{s}{f_1 f_2}$
p_a	0	$\frac{N-1}{N}\cdot\frac{tf}{r_b}$	$\frac{sf}{f_2}$
p_b	0	$\frac{N-1}{N}\cdot\frac{tf}{r_a}$	$\frac{sf}{f_1}$

center (vignetting). This aspect of image formation is controlled by the apertures investigated as follows:

Locate the image of every lens opening and diaphragm as seen in the object space and determine the diameter of each image. The image whose diameter subtends the smallest angle at the object is the entrance pupil. The sine of the angle subtended by the entrance pupil radius at the object is the numerical aperture, a measure of the light collecting power of the system. The image subtending the smallest angle at the entrance pupil is the field stop and the angle subtended is the maximum angle the object may subtend at the entrance pupil, if there is to be no significant vignetting. The image of the entrance pupil in the image space is termed the exit pupil.

Table II—Formulas to Obtain *a*, *b* and *m*

	f	a	b	m
Given a and b or f	$\frac{ab}{a+b}$	$\frac{bf}{b-f}$	$\frac{af}{a-f}$	$\frac{b}{a}$
Given c and m	$\frac{cm}{(m+1)^2}$	$\frac{c}{m+1}$	$\frac{cm}{m+1}$	m

Aperture Formulae

f/number $\quad f.n. = a/\phi$

numerical aperture $\quad n.a. = \sin[\tan^{-1}(\phi/2a)]$

$n.a. = \sin[\tan^{-1}(\frac{1}{2}f.n.)]$

$n.a. \doteq \phi/2a = \frac{1}{2}f.n., \quad \phi \ll a$

Table IV—Definitions of Optical Symbols and Sign Convention

N	Index of refraction of lens material
I	Image
O	Object
$L_{1,2}$	First and second lenses
a	Object distance (object to entrance principal plane)
b	Image distance (image to exit principal plane)
$P_{a,b}$	Entrance and exit principal planes
p_a	Entrance principal plane distance (measured from entrance vertex in thick lens and from entrance principal plane of first lens in lens combination)
p_b	Exit principal plane distance (measured from exit vertex in thick lens and from exit principal plane of second lens in lens combination)
$V_{a,b}$	Entrance and exit vertices
$r_{a,b}$	Radii of entrance and exit surfaces
f	Focal length of single lens or lens combination
$f_{1,2}$	Focal lengths of first and second lenses of a lens combination
t	Thickness of lens between the vertices
s	Separation between lenses (measured from exit principal plane of first lens to entrance principal plane of second lens)
$c \equiv a + b$	Distance from object to image
$m \equiv \frac{b}{a}$	Magnification of the arrangement
$f.n.$	f/number, conventionally used in photography, usually given for object at focal point
$n.a.$	Numerical aperture
ϕ	Diameter of entrance pupil

Note: f/number and numerical aperture may also be defined for the image plane. In that case, a must be replaced by b and ϕ represents the diameter of the exit pupil in the aperture formulas

Sign Convention: The sign convention used here is the simplest one for the novice. Others are also used by lens designers. All of the quantities given below are positive in Fig. 1A

a, p_a, c	Positive in the "down-light" direction
b, p_b	Positive in the "up-light" direction
r	Positive for a convex surface
f	Positive for a collecting lens (a lens which can form a real image of a real object)

Photoelectric Scanners

To reduce bunching and irregular running of London's buses, scanning units at several checkpoints detect the passage of a bus and relay the running number in binary form to the route display panel at control center

By **T. S. PICK,** Chief Electrical Engineer, **and A. READMAN,** Testing Superintendent,
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TRAFFIC CONGESTION is a problem in most major cities. Today, more than ever, electronics is being called on to solve it. What's being done in London is one example.

That city's traffic congestion is complicated by the fact that the London Transport Executive operates 500 bus routes with a fleet of 7,000 buses. The resultant congestion manifests itself in buses of the same route becoming bunched together and also becoming considerably delayed with respect to scheduled time.

Automatic Indicator

The bus electronic indicator to be described gives the bus operators a picture of bus distribution at a central control point, thus permitting early action in the event of service irregularities.

Equipment in current use is illustrated in block form in Fig. 1. Basically, a single modulated beam of light is reflected from a two-color binary coded reflector plate mounted on the side of the vehicle and detected by color-discriminating photoelectric cells. The two outputs from these cells are amplified at the modulation frequency and the signals so formed are compared and stored by a cold-cathode trigger tube circuit.

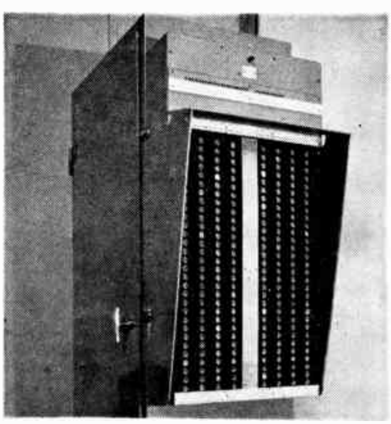
The stored information is then transmitted over telephone lines to the control center using conventional relay techniques. The binary information is decoded to decimal form and presented as an illuminated number on a section of a route display panel.

In traversing its route, each bus passes a number of check points and at each point its running number is registered at the control center in the appropriate display section and cancelled out of the preceding section. The display panel therefore shows the number of buses between check points, their running number and the pattern of movement along the route. Display panel data are also available for recording in permanent form for subsequent analysis.

Identity Plates

The reflector plate is designed to clip in a cradle attached to the front near side of the bus above the cab. Reflector buttons are of the type normally used in road signs and are arranged in vertical rows of three buttons at $\frac{5}{8}$-in. centers to give some degree of compensation for vehicle loading. The horizontal spacing of each vertical row of reflectors is 2 in., which gives a pulse rate of 350 pps when the vehicle is traveling at 40 mph.

Clear reflectors are used to make up the binary number and the interdigital spaces are marked by red reflectors; with 30 buses operating on the route selected for the pilot trials, only five digits are required in the code.



Display panel at control center presents bus movement pattern in digital form. A recorder also maintains permanent record for analysis

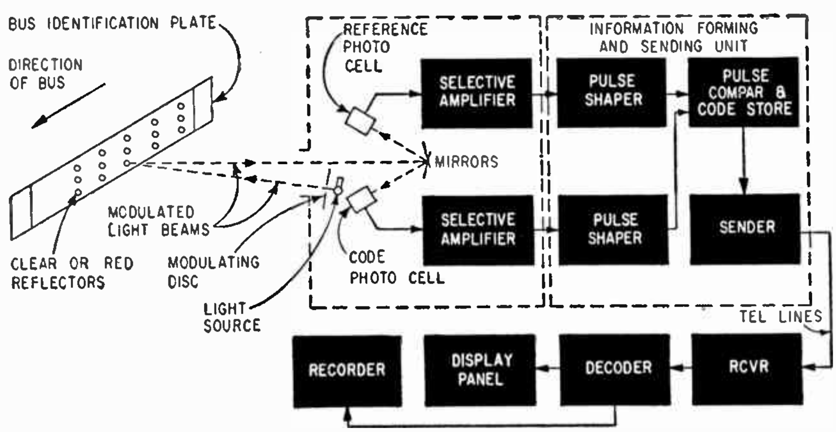


FIG. 1—System block diagram of bus scanning system. Data from bus identification plate on side of vehicle is detected by scanner unit and converted to binary form before transmission

Control Bus Traffic

Scanning units are provided at selected checking points along the route; they are erected on the pavement at the same height as the identity plates and as near as possible to the roadway. The light source is a standard prefocus transverse-filament, 48-w automobile headlamp bulb operating at 90 percent of its rated voltage.

Reflections from the bus identity plates are accepted at the scanning unit by a lens and mirror arrangement which directs these reflections simultaneously onto the photosensitive surfaces of two photoelectric cells; one cell responds only to the reflections from the clear reflectors and the other to both clear and red reflections.

The modulated light reflections from the identity plate are thus converted into two trains of electrical pulses modulated at 5 kc by a motor-driven slotted disk. One photocell is particularly sensitive to daylight radiation with a blue predominance and produces binary information; the other cell provides the reference pulses necessary to establish the zero level. This arrangement gives adequate separation (a discrimination ratio of 30:1 is possible) and also perfect synchronism between code and reference signals.

Two-stage tuned amplifiers within the scanner casing amplify the modulated signals and effectively reject the effect of extraneous light on the photocells. The signals are then demodulated to provide an output of two trains of negative d-c pulses of 100 v in amplitude from the scanning unit.

Information and Sending Units

The information and sending unit, which accommodates a regulated power supply, pulse shaping circuits, pulse comparator and code store, is enclosed with the sender. They are either packaged in a weatherproof case for pole mounting or placed within a street pillar.

The circuit for comparison and storage is shown in Fig. 2.

Square wave outputs from the pulse shapers supply the common trigger lines of two chains of five cold-cathode trigger tubes; V_2 through V_6 respond to the timing reference signals and V_8 through V_{12} respond to the code signals. Tube V_1 acts as a primer to raise the trigger potential of both V_2 and V_8 and thus prepares the circuit for the receipt of incoming signals. The plates of V_1-V_6 are coupled with commutating capacitors which produce a transfer from tube to tube, in step with the incoming timing reference pulses; at the completion of a total count of five, V_6 energizes relay K_1, which then initiates the line sending circuits.

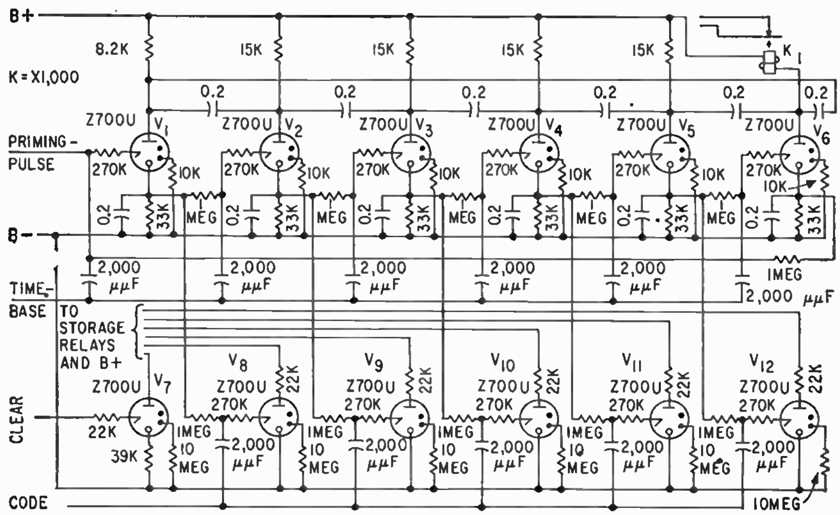


FIG. 2—Comparison and storage circuits. Coincidence of incoming code with reference pulse causes code tubes to fire in accordance with binary number present

Since the bias is sequentially applied to V_8 through V_{12} as V_1 steps to V_6, the coincidence of a code signal with a timing reference pulse causes the code tubes to conduct and either fire or not fire according to the digit or zero of the binary number present. Tubes V_8 through V_{12} actuate relays in their anode circuits which store the data until the sending sequence is completed; V_7 in association with another relay acts as a clear-down timer so that spurious information and incomplete counts are dispensed with after a preset time interval.

Sender

Standard relays are used in the sender circuit and arranged to transmit the stored binary data as a series of 50-v positive and negative pulses at a constant speed of 10 pps. The pulse train consists of six pulses; the first five contain the identity information and the last is a resetting pulse.

Receiver and Decoder

Ordinary telephone lines connect the checkpoint equipment to the control center. Rectifier polarized relays connected across the incoming line are operated in accordance with the polarity make-up of the pulse train. They are arranged to switch in sequence a chain of timing reference relays in such a manner that any positive pulses occurring in the signal operate the appropriate relay in the code chain relays.

The display panel contains eight sections each having 30 miniature fluorescent lamps. If two lamps are excited at the same time, as when a bus passes from one check point to another, the current demand causes the voltage to fall and the previously illuminated lamp is extinguished.

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Constant-Current Technique

Completely transistorized measuring system detects and responds with 0.1-percent linearity to core displacement in a differential transformer. Low-level, a-c transformer output is converted to 10- to 50-ma d-c transmission signal of one watt maximum by high input impedance feedback amplifier

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DIFFERENTIAL TRANSFORMERS have come into wide use in the process industry as the primary element in motion measurement systems. The device discussed here converts the small a-c voltage produced by displacement of a differential transformer core to a d-c voltage large enough to drive a standard high-accuracy measuring instrument or to control a d-c operated control device.

Measurement Techniques

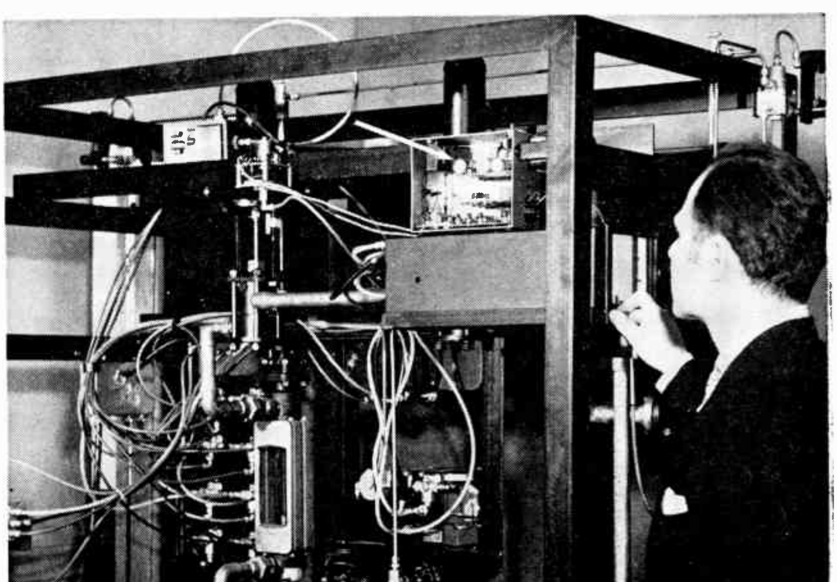
Conventional systems for measuring core displacement in a differential transformer consist of an error amplifier, servo motor and a reference differential transformer. The error amplifier drives the servo motor positioning the reference transformer core to compensate for unbalance caused by core movement in the measuring transformer. Since both transformers are excited in series by the line, voltage shifts introduced by the power source are automatically eliminated. However, response time is poor and care must be taken with phase relationships to preserve accuracy.

It is also possible to rectify the output of the differential transformer directly with diodes. If high-frequency excitation is used, the response time limitation of conventional methods can be overcome; however, the nonlinearity and temperature sensitivity of practical diodes leave much to be desired.

In the system described here diode rectification is used, but only after the signal has been brought to a satisfactory output level by a linear amplifier. Use of a precision exciter and —60 db current feedback from the output rectifier to the amplifier maintain system linearity at 0.1 percent over a 20 to 55 C temperature range. Local a-c and d-c feedback within the amplifier assure stable operation.

System Operation

As shown in Fig. 1, a precision one-kilocycle exciter provides ex-



Output current of experimental core displacement measuring unit (arrow) controls an electric-to-pneumatic converter and valve assembly

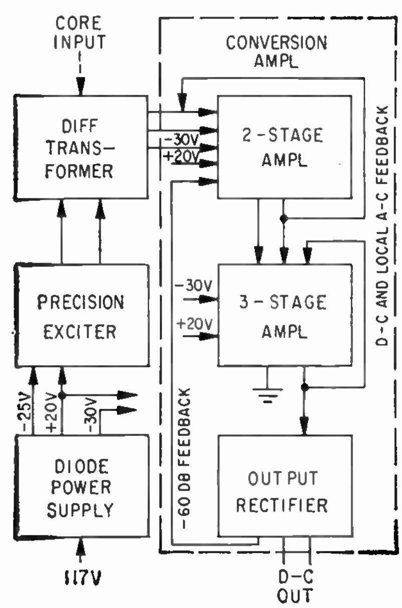


FIG. 1—Negative current feedback eliminates amplifier loading errors resulting from temperature variations

Cuts Servo Response Time

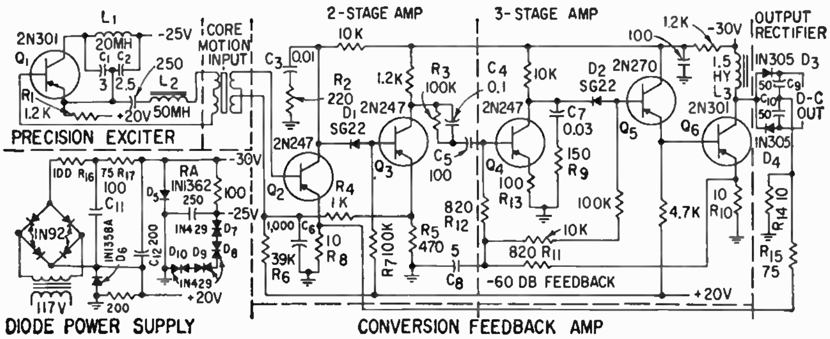


FIG. 2—Operating voltages of measuring unit are regulated by Zener diodes in power supply. Filter network of resistors R_{16} and R_{17} and capacitors C_{11} and C_{12} set regulating point for diodes D_5 and D_6. Zener diodes D_7, D_8, D_9, and D_{10} are temperature compensated

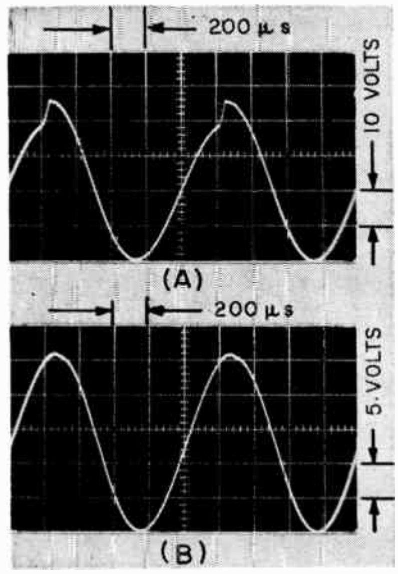


FIG. 3—Bottoming voltage waveform (A) at oscillator collector and excitation voltage waveform (B) at oscillator emitter

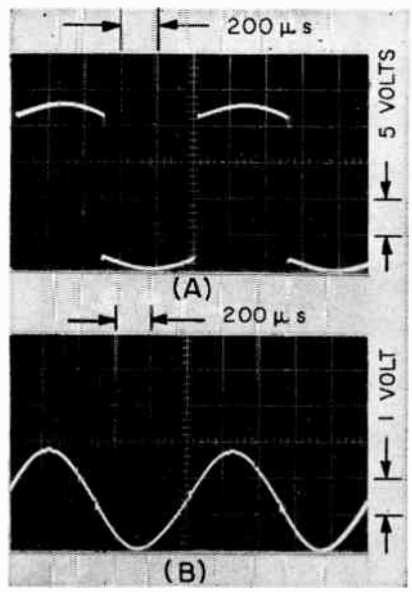


FIG. 4—Output voltage waveform (A) at Q_6 collector and feedback current waveform (B) generated across R_{10}

citation for the differential transformer and compensates for d-c resistance changes in the transformer primary resulting from temperature variations. Since the oscillator output is directly dependent on the amplitude of the d-c voltage from the source, temperature compensated Zener diodes used in the power supply are operated at 7.5 ma to provide an accurate and stable reference level.

The voltage produced in the secondary of the differential transformer as the transformer core moves is sensed, amplified and then rectified by the conversion amplifier. System output is made to provide feedback that is proportional to the current in the load, increasing input impedance and providing excellent linearity.

Use of d-c constant current varying from 10 to 50 ma as the transmission medium allows accumulation of d-c resistance in long lines without degradation of accuracy. Filtering can be employed at the input to sensitive readout equipment to eliminate hum and noise picked up on the lines.

A schematic diagram of the core displacement measuring system is shown in Fig. 2.

Precision Exciter

A constant-voltage, one-kilocycle oscillator and a high-Q swamping choke constitute the precision exciter. Selection of the one-kilocycle operating frequency was based on Q and output variations with frequency for the particular differential transformer used.

The Colpitts-type oscillator is formed by transistor Q_1, capacitors C_1, and C_2, and choke L_1. Operating bias established by R_1 produces 5-percent bottoming of the collector waveform shown in Fig. 3A. Since the internal collector resistance of Q_1 is low, the oscillation amplitude is determined by the Q of the L-C components and the accuracy of the negative supply voltage.

Output at the emitter Q_1 is a sine wave as shown in Fig. 3B. Waveform distortion is reduced when driving low-impedance loads by the energy storing action of capacitor C_2.

Compensation Circuits

Swamping choke L_2 provides constant-current output to correct for d-c resistance changes in the differential transformer primary as the temperature varies. High inductance of L_2 at 1 kc as compared to that of the primary winding permits the choke to swamp the current changes in the circuit. The d-c resistance of the swamping choke, which is only 8 ohms at room temperature, is compensated for along with the 22 ohms present in the differential transformer primary.

If the negative supply voltage is held to 0.01-percent variation for each deg C temperature change, the final exciter amplitude stability is 0.3 percent between temperature limits of 25 to 55 C. The exciter produces a 110-mv rms output across the secondary of the differential transformer for a core displacement from the null position of 0.088 inch.

Conversion Feedback Amplifier

Loading errors caused by temperature-induced changes in the d-c resistance of the transformer secondary are prevented by providing 625,000 ohms impedance at the input to the two-stage amplifier. This impedance is obtained at the

1-kc operating frequency by applying 60 db of negative feedback to the amplifier from the output rectifier.

To avoid amplifier instability resulting from variation in feedback phase with frequency, the amplifier transmission curve is shaped from 5 cps to 220 kc. This is done with local a-c feedback loops and shaping networks, and by using wide-range components.

Good gain stability requires that operating points of all transistors be stabilized. This is done by using a separate d-c feedback loop for each group of d-c coupled transistors.

The two-stage amplifier circuit uses high-frequency drift type transistors for Q_2 and Q_3. These transistors have an alpha cutoff frequency of 30 mc. Since a grounded-emitter connection is used in the circuit, the actual high-frequency cutoff is approximately equal to 30 mc divided by the beta of the transistor. Collector load magnitude and the values of C_1 and R_2 shape the high-frequency response for the transistor pair.

A low-frequency step is produced by the C_4-R_3 coupling network to the three-stage amplifier. Capacitor C_5 blocks d-c while maintaining a low reactance relative to the output impedance of Q_3 throughout the passband.

Current Feedback

Current feedback from the emitter of Q_3 is applied through R_4 and the secondary of the differential transformer to the base of Q_2. A change in the collector current of Q_2 is transferred by coupling diode D_1 to Q_3 where it appears as a current change through R_5. The resulting voltage swing is applied to the base of Q_2 at proper polarity to correct for the initial shift in collector current.

Resistors R_6 and R_7 return to a positive bias to establish the operating points of Q_2 and Q_3, respectively. This resistor pair is stable within two percent over the temperature range from 20 to 65 C.

Most of the a-c feedback is removed from the loop by C_6 whose capacitive reactance rises at frequencies below the passband of the amplifier. Unbypassed emitter resistors R_5 and R_8 provide a-c feedback at all frequencies.

Power Amplifier

The three-stage amplifier is a direct-coupled power amplifier. High-frequency response of the stage using drift transistor Q_4 is shaped by C_7 and R_9. This stage is directly coupled to Q_5 by forward-biased diode D_2 which maintains the required voltage difference between stages.

A transistor with a 150-mw collector dissipation rating is used for Q_5 to permit generation of adequate power to drive Q_6. Transistor Q_5 employs a grounded collector connection to more nearly match the low impedance of Q_6. Germanium output transistor Q_6 is biased for linear operation.

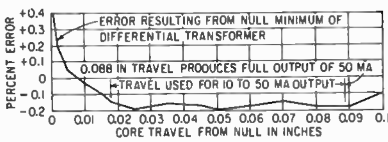


FIG. 5—Linearity curve for system and core displacement measuring unit

The signal applied to the output rectifier is shown in Fig. 4A. Choke L_3 is used instead of the transformer usually required to obtain true a-c feedback through the load. A suitable transformer having the necessary low d-c resistance, high current capacity, low leakage reactance and the like is expensive.

The d-c feedback signal from the emitter of Q_6 shown in Fig. 4B is picked up at emitter resistor R_{10} and applied to the base of Q_1 through R_{11} and R_{12}. This technique holds the operating point within 5 percent over a 20 to 65 C temperature range.

Alternating current feedback below 30 cps resulting from rising reactance in capacitor C_8 compensates for phase shift caused by rapidly falling reactance in choke L_3. The a-c feedback and unbypassed emitter resistor R_{13} determines input impedance of Q_1.

Output Circuit

The output rectifier consists of diodes D_3 and D_4, capacitors C_9 and C_{10}, and current feedback resistor R_{14}. Capacitors C_9 and C_{10} couple the a-c signal to current flowing through the load. Thus, feedback is present around diodes D_3 and D_4 to correct for changes in their characteristics with ambient temperature variations.

Resistor R_{15} couples the feedback voltage to the emitter resistor of Q_2. This system generates a total of −60 db of current feedback at 1 kc. Final power gain of the entire amplifier with all feedback circuits in operation is 73 db.

Output d-c is true constant current for load values from zero to 400 ohms. Maximum output power of one watt is developed into a 400-ohm load.

With reduced input levels to the amplifier, loads up to 5,000 ohms can be used before distortion becomes pronounced. To limit errors resulting from leakage in C_9 and C_{10}, high-quality aluminum foil capacitors are used.

Performance

For full d-c output of 20 volts across a 400-ohm load, the a-c ripple is 82-mv rms. Response time for 0.1-percent accuracy is under 20 millisec with filtering action of C_9 and C_{10} introducing most of the delay. Stability checks made on the laboratory model indicate a repeatability of 0.05 percent for an input signal from 10 to 110-mv rms.

Maximum output of 50 ma is provided for 0.088 in. of core travel from null. A minimum transmission signal of 10 ma which corresponds to 0.0176 in. core travel establishes transmission zero thereby voiding null problems.

Linearity curve for the experimental model, shown in Fig. 5, was checked using highly accurate core positioners. Error given is in percent of core setting and is −0.1 percent maximum down to residual null voltage. Linearity is maintained within runs taken at any temperature in range of 20 to 55 C.

The author acknowledges the assistance of J. Franklin who built the experimental models and obtained the performance data.

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Temperature Detectors

Operating principles and ranges of detectors generally used with industrial and laboratory temperature indicators, recorders and controls

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RADIATION PYROMETERS, thermocouples, resistance thermometers and filled thermometers are transducers widely used in industry and laboratories for accurate temperature measurement. They are known as servo detectors since their output can be transmitted to a remote instrument.

As temperature indicating, recording and control instruments are closely associated with detectors, manufacturers should be consulted on the best combination of detector and instrument for specific applications. Temperature ranges and operating principles are described in Fig. 1 and below.

RADIATION PYROMETERS—Radiant energy from the target on which the pyrometer is focused produces a millivoltage proportional to the target's temperature. Copper wires carry the output to a potentiometer or calibrated galvanometer. These instruments can accurately gauge the temperature of moving surfaces. Although radiation pyrometers are comparatively expensive and require periodic maintenance under some conditions, the wear out usually associated with thermocouples at elevated temperatures is absent. The target must have adequate sighting area and emissivity.

THERMOCOUPLES—Two dissimilar wires welded together at one end form the versatile and familiar thermocouple. The weld point is the temperature sensing portion, or hot junction. The opposite ends of the wires are the reference junction. Output is a millivoltage proportional to the temperature difference between the hot and reference junctions. Compensated (not copper) wires transmit the output to a potentiometer or calibrated galvanometer. When the hot junction's temperature falls below the reference junction's temperature, the emf reverses in polarity.

Practically any two dissimilar wires will serve. However, only a few combinations meet the standards of accuracy, reproducibility and reliability required by modern instrumentation. Five standard calibrations (there are two platinum vs. platinum and rhodium) are recognized by the Instrument Society of America and are generally available. Thermocouples are primarily immersion or insertion detectors. Some are surface-temperature detectors, but these may sacrifice accuracy.

RESISTANCE THERMOMETERS — These are usually a temperature sensitive winding on a bobbin or form, encapsulated in a protective metal sheath. The circuit generally is extended over three copper wires to a Wheatstone bridge. Since full length of the winding must be influenced by the temperature medium, insertion or immersion types are preferred. Tip-sensitive and flat-grid types are also made. Copper, nickel and platinum windings are often used because of favorable resistance coefficients, reliability and reproducibility.

FILLED THERMOMETERS—A closed container is filled with a gas, vapor or mercury, which expands with temperature. The expansion influences a hollow spiral or helix connected to the container by capillary tubing. The helix or spiral actuates a pointer on a calibrated scale. These also are basically immersion detectors.

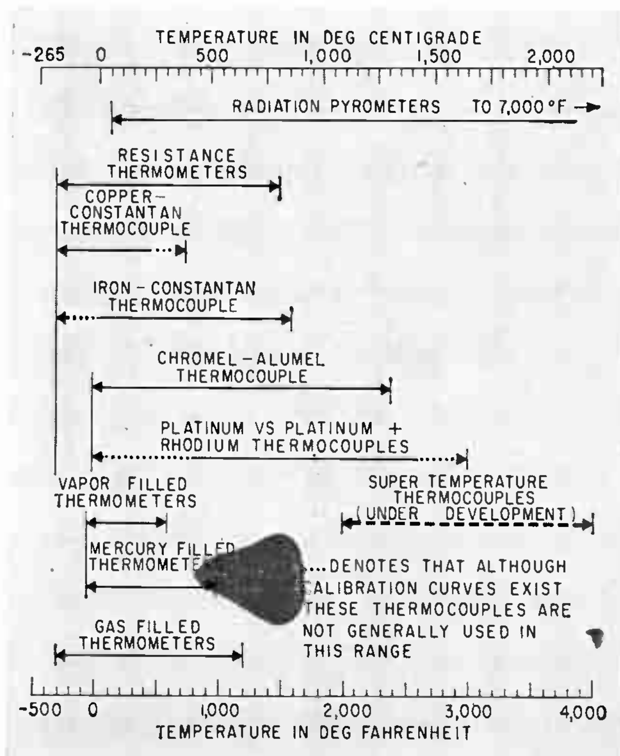


FIG. 1—Normal temperature ranges of transducers which will provide proportional signals to remote instrumentation

New type of crossed-field device uses magnetron structure to provide reflex action. Magnetron frequency is a function of magnetron current and may be varied by changing relative electrode voltages. Up to 18 mc frequency shift at 800 mc is obtainable

By C. LOUIS CUCCIA, Electron Tube Division, RCA, Harrison, N. J.

Voltage Control of

MAGNETRONS ARE EFFECTIVE small-size high-efficiency oscillators and much effort has been directed toward the development of methods of electronically frequency-modulating their output power. These methods have included the use of auxiliary electric beams within the basic magnetron structure[1,2] or in a coupled structure,[3] or have involved a structure which represents a departure from conventional magnetron structure.[4,5,6]

The reflex magnetron is a unique type of crossed-field device employing a modification of the conventional anode-resonator and cathode structure to introduce a third electrode, drawing negligible current, which not only provides frequency modulation and frequency control but also provides effective control of the magnetron pushing characteristics. A feature of the reflex magnetron is that the device functions without sacrifice of the high power, high efficiency and small size characteristic of the conventional magnetron and with frequency deviation greater than two percent of the center frequency possible.

The reflex magnetron has many potential uses. As an f-m magnetron, this new device is suited for use as an f-m transmitter in telemetering and f-m communication systems where not only small size and high efficiency and output power are important, but where low modulator power is also prescribed. The reflex magnetron is also suited for use in frequency-locked amplitude-modulated magnetron[7] arrangements where the substantial reduction in frequency pushing made possible by the reflex action enhances the frequency locking of the system, and in mti radar systems where reduced frequency change during each pulse results in improved readability.

Conventional Magnetron

The conventional magnetron is an oscillator consisting of a high-Q anode resonator capable of producing an azimuthal traveling electric field and a cathode which is capable of producing electrons. As illustrated in Fig. 1A, the anode provides vane tips which form a cylindrical interaction space wherein the traveling electric wave is formed. The cathode is supported concentric with the vane tips in the cylindrical interaction space. A magnetic field passes axially through the interaction space and electrons attracted from the cathode to the vane tips form space-charge bunches, or spokes, which give up energy to the anode resonator.

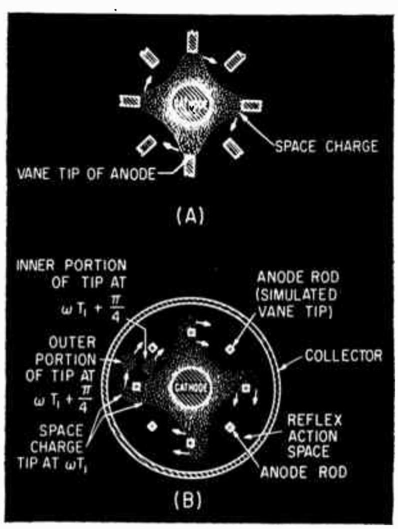


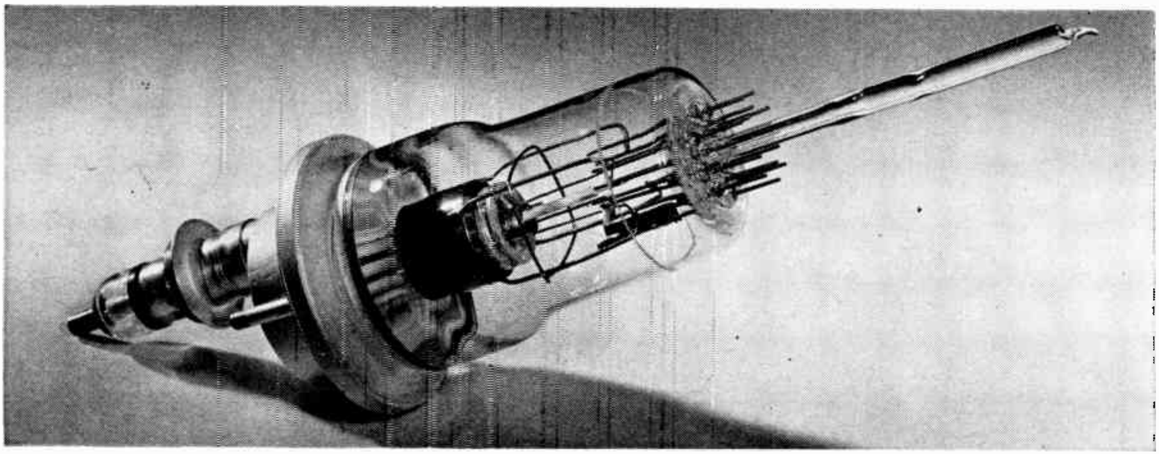
FIG. 1—Space charge configuration of normal magnetron (A), space charge configuration of reflex magnetron (B)

Reflex Magnetron Operation

Reflex-magnetron operation is introduced into a magnetron by producing a reflex-action space behind the resonator vane tips, into which space charge can pass from the anode-cathode interaction space into the reflex-action space and then return to the vane tips.

Figure 1B illustrates a typical reflex-action space which is formed between anode rods, forming simulated vane tips, and a collector, which is provided with a positive potential with respect to the anode rods to attract space charge through the anode rods into the reflex-action space.

The electrons which reach the anode rods form the tips of the space-charge spokes; these space-charge spokes are properly phased by the magnetron operation. Parts of the tips of the space-charge spokes, instead of being collected by the anode rods, are attracted



Experimental reflex magnetron; r-f and coolant connections are at left while electrical connectors surround exhaust tip

Magnetron Frequency

through the anode rods into the reflex-action space. In this outer space they encounter a traveling wave, formed by the anode rods, which is characteristic of electric fields normally found in inverted magnetrons.

The electrons of the space-charge spokes in the inner interaction space have been attracted toward the anode rods by a radial d-c field between the cathode and vane tips which forms a radial potential gradient. The potential between the anode rods and the collector is substantially less than that between the cathode and the anode rods. The phased electron bunches attracted through the anode rods from the tips of the space-charge spokes then follow along the outer faces of the anode rods and fall out of phase with the traveling electric fields in the reflex-action space. As shown in Fig. 1B, the inner and outer portions of the spoke tip at $\omega T_1 + \pi/4$ will have different azimuthal positions, although they had the same relative azimuthal position at ωT_1. Since the traveling electric fields in the spaces within and without the anode rods are of the same phase, reactive currents will be induced in the anode resonator by the electron bunches in the reflex-action space, and the frequency or phase of oscillation will be accordingly altered.

If the collector is biased to cause the electron bunches attracted into the reflex-action space to be returned to and collected by the anode rods rather than the collector, optimum reflex action will take place. One of the features of the reflex magnetron is as follows. The electron bunches in the reflex-action space represent a small amount of space charge relative to the space charge produced in the spokes within the anode rods. But these bunches represent substantial bunched energy and can cause large excursions in the frequency or phase of the magnetron oscillations. This reflex action also provides the advantage of causing the collector to collect negligible current.

The collector performs the double function of acting as both a collector and a reflector, with the reflector action producing a unique crossed-field type of interaction wherein bunched space charge travels on both sides of an array of electric-field pole faces producing a traveling wave. The space charge is produced from one side of the array with the spaces between pole faces forming windows for electrons to pass through. Some electrons will actually traverse a slalom type of trajectory, passing through more than one space between pole faces in succession.

Reflex Magnetron Structures

Figures 2A and B illustrate how a conventional magnetron resonator structure can be modified to allow for reflex action. In the structure of Fig. 2A, the magnetron vane tips at one end of the resonator block are extended to provide an array of anode rods[8] through which space charge from the magnetron cathode can pass. The collector is positioned concentric with the extended vane tips. Figure 2B illustrates a magnetron resonator block wherein deep slots have been cut axially into the vane tips to form a reflex action space in which the reflector is positioned. Other variants include a magnetron resonator block wherein slots are cut radially in the vanes from the cathode-vane-tip interaction space outward, and an appropriate collector electrode or electrodes is positioned at the outer edges of the space thereby produced.

In the interdigital-rod structure, alternate rods acting respectively as inner and outer conductors of a quarter-wave line are interleaved to form a coplanar anode-rod structure. The cathode is positioned within the coplanar anode-rod structure. When a magnetic field is introduced to the tube parallel to the axis of the cathode and the rod structure is provided with a sufficiently positive potential relative to the cathode, the tube will behave as a magnetron.

A collector is positioned outside of the coplanar anode-rod structure concentric with this structure. A reflex-action space is therefore formed between the collector and the anode rods. A positive potential relative to the potential of the rods placed on the collector will attract space charge through the rods from the space-charge spokes and produce reflex action.

Experimental Performance

The tube was operated with the collector tied to the anode so that c-w operation of the tube as a magnetron could be determined and with cathode-anode voltages in the 600-to-1,100-v range and magnetic fields of 350 to 900 gauss as derived from an electromagnet whose current was varied from 0.75 to 1.1 amperes.

Continuous-wave-power outputs from 20 to 130 watts were obtained with anode current between 100 and 500 ma. Efficiencies as high as 40 percent were obtained.

When the collector was operated with a negative potential with respect to anode potential, a small change in power was realized. With the collector voltage negative by 1,500 v with respect to anode voltage, only a 10 percent decrease in output power occurred. This is due to the fact that no reflex action takes place, and what amplitude control is produced is realized only as a result of the limited penetration of lower voltage from the collector into the cathode-anode space.

When the collector was operated at a positive voltage relative to anode, two modes of operation were found possible. With anode-cathode voltage held constant and the collector voltage increased relative to anode voltage, the frequency of operation changed as a function of collector voltage. With the collector provided with a fixed positive bias relative to the anode, the pushing of the reflex magnetron, which occurred during charges of anode voltage relative to cathode voltage, was a function of the magnitude of the fixed positive bias.

Frequency deviation of the order of 10 mc with a collector current of 10 ma was obtained with a magnetic field of 400 gauss. With a magnetic field of 600 gauss, the frequency deviation of the order of 5 mc was obtained, with a corresponding reduction in collector current. This performance is to be expected since for higher magnetic fields the constraint of electron motion into azimuthal trajectories becomes stronger, and it becomes more difficult to attract space charge through the anode rods into the reflex-action space.

In most reflex magnetrons operated in the 750- to 850-mc frequency range, frequency deviations as great as 18 mc were realizable at lower magnetic fields.

At collector potentials above those at which stable maximum frequency deviations occurred, an interesting phenomenon was observed. As the collector potential was increased beyond a certain point, the spectrum indication of frequency as viewed on a spectrum analyzer was observed to move rapidly in the direction it had been moving while the collector voltage was increased and then to disappear with concomitant stopping of oscillation by the reflex magnetron. In this collector-voltage range, the space charge in the reflex-action space produced induced currents in the resonator which substantially cancelled the induced currents produced there by the space charge in the anode-cathode space, thereby setting up a condition whereby oscillations could not be sustained. This transition from oscillation to no-oscillation occurred in a slow enough time interval to be followed on the spectrum analyzer.

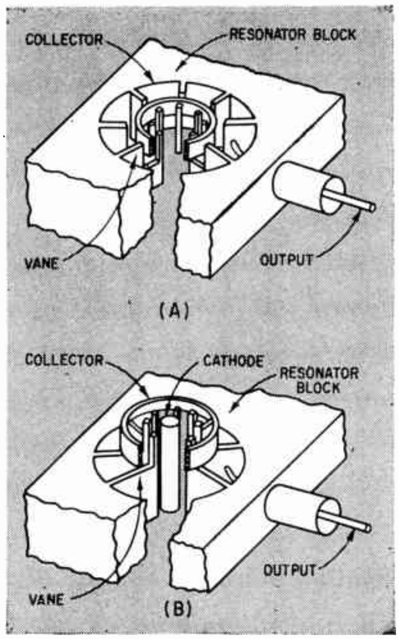


FIG. 2—Reflex magnetron using extended vane tips to form reflex action space (A), slotted vane tips structure (B)

The frequency pushing of the reflex magnetron was controlled by biasing the collector potential to some fixed potential relative to the anode potential, while the anode potential was varied with respect to the cathode potential.

Reflex Action Limits

It would seem that the extent of frequency control could be increased greatly by the expedient of enlarging the space between the rods and allowing more space charge to flow into the reflex-action space. This does not necessarily follow.

When the spacing between anode rods is relatively small, the intensity of the traveling electric fields produced by the resonator vane tips in both the anode-cathode space and the anode-collector space is maximum, insuring optimum operation of the magnetron as a result of these fields producing well-defined electron spokes. These electron spokes have narrow tips which, upon passing into the reflex-action space, produce well-defined bunches of electrons which provide the interactions and induced currents necessary for frequency control.

When the space between vane tips is enlarged in a peripheral circumference which provides both optimum magnetron and reflex action, the intensity of the traveling electric fields decreases and the space-charge spokes become less defined. The magnetron efficiency becomes reduced and the electron bunches in the reflex-action space take on a randomness which adversely affects the reflex action.

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Fail-Safe Circuits for Conveyor Systems

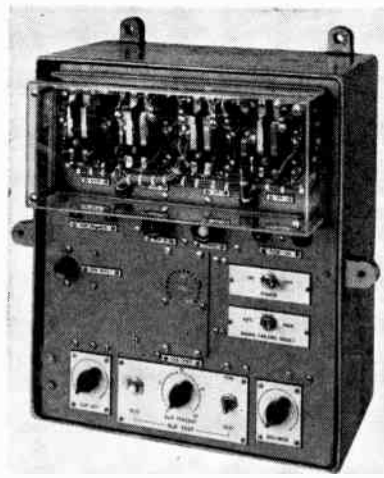
Unique magnetic amplifier provides protection against fire hazard caused by belt slip from overloading. Device requires no warmup time and exhibits negligible long-term drift

By **FRANK R. HULSCHER,** Electric Control and Engineering Ltd., Camperdown, N. S. W., Australia

WITH MOST UNATTENDED conveyor systems some type of protection equipment is desirable. Belt slip caused by overloaded or wet belts can create a serious fire hazard, particularly in enclosed places such as mines. Failure of a belt in a conveyor system can result in a dangerous pile-up of material.

Protection equipment for such applications should be reliable, rugged, fail-safe, be easy to install and provide a means of checking the operation. The magnetic interlock described here meets these requirements and overcomes the disadvantages of thyratron, frequency-sensitive or differential relay units.

Magnetic amplifiers with four legs[1,2] on the core can be made which will operate differently than conventional units. The amplifier in this conveyor guard circuit[3] has maximum output with zero control signal. Furthermore, the output decreases symmetrically for either a positive or negative control signal. Such characteristics are adaptable to fail-safe relaying.



Conveyor guard unit with cover removed

Bridge Circuit

Figure 1 shows the bridge circuit with the magnetic amplifier controlling interlock relay *K* in the conveyor drive circuit.

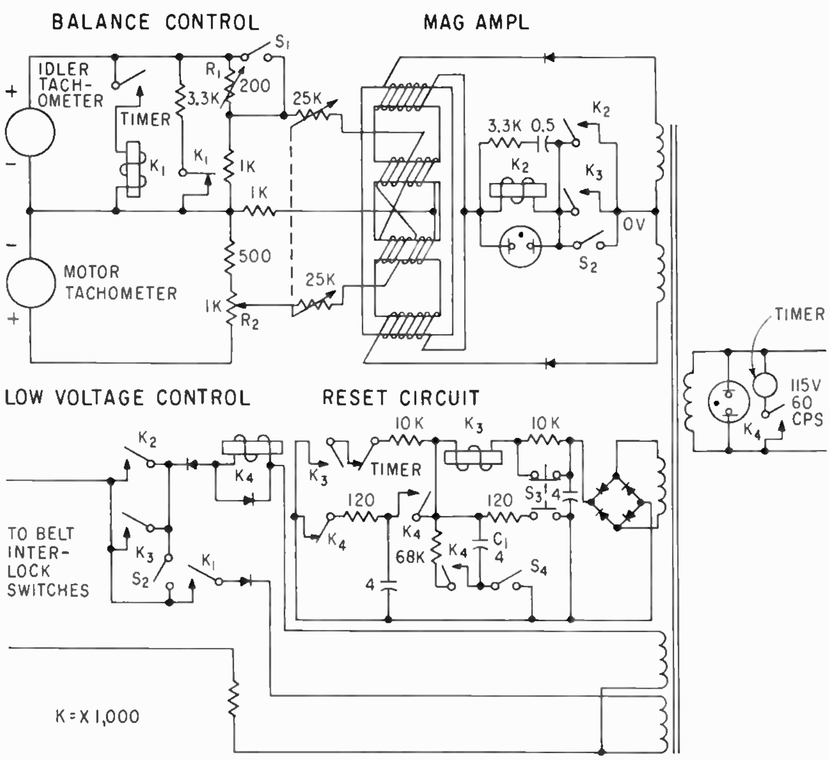


FIG. 1—Tachometers monitor conveyor belt slip. Bridge circuit feeds four-limbed magnetic amplifier to control interlock relay K_2

Outputs of motor and idler tachometers are fed into a differential network. Under normal running conditions the net control ampere-turns equal zero, the condition for maximum output. If tachometer outputs do not match for any reason, usually belt slip or failure, the bridge becomes unbalanced. Amplifier output decreases and relay K_2 drops out.

Potentiometers R_1 and R_2 are used to balance the bridge and set the release point of K_2. Range of control is from 3- to 20-percent belt slip, with ±2 percent. Magnetic circuit time-delays prevent trip-out on momentary overloads.

A reset circuit provides resetting after normal stops, and stops caused by belt slip or supply failure.

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Microphotometer Aids Biologists

By EDWIN GORDY, M. D., Instrument Design and Development Dept., Roswell Park Memorial Institute, Buffalo, N. Y.

ELECTRONIC instrument has been developed to aid biologists who are studying cell growth in tissue culture. The basic circuit designed for this application has also been used in three other instruments.

The biologists are measuring concentrations of intracellular materials. Staining the normally colorless materials with selected dyes causes them to have an optical density directly proportional to concentration of the compound under study[1]. Many of the tissue culture strains grow in monolayers on glass and are suitable for study under a microscope by transillumination.

The microphotometer to be described was constructed to permit direct measurement of transmittance (and therefore optical density) while the stained cells are being studied visually at a magnification of about 1,000 x. The small photocurrents are read on a line-operated meter having excellent long and short term stability. In addition, an eyepiece micrometer is incorporated to permit measurement of the length of objects in the microscopic field.

The instrument comprises a microscope, a light-tight housing containing a multiplier phototube and associated optical parts, and the line-operated meter. The microscope and part of the housing and optics were obtained commercially. The photometer was designed specifically for the application.

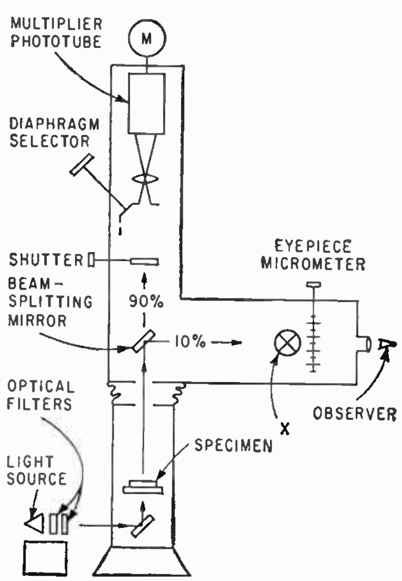

FIG. 1—Optical arrangement permits 10 percent of light to reach observer and 90 percent to reach multiplier phototube

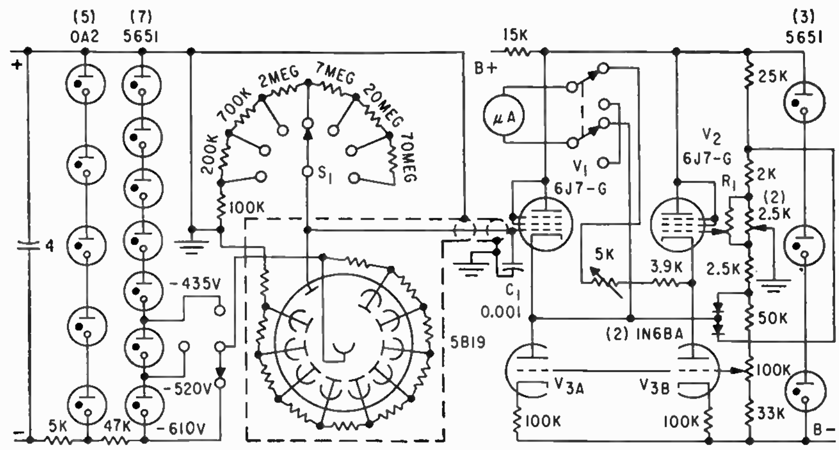

FIG. 2—Positive terminal of high voltage for multiplier phototube is grounded so that meter input circuit operates near ground

Optical Arrangement

In Fig. 1, the beam-splitting mirror sends 10 percent of the incident light to the observer and 90 percent to the end-window multiplier phototube after it traverses the diaphragm and its associated lens. This lens distributes light over the entire area of the photocathode to minimize effects of point-to-point variations in photocathode sensitivity[2]. The diaphragm limits the multiplier phototube field of view to a spot 1, 2, 3 or 4 mm in diameter, corresponding to a microscopic region in the specimen of 1, 2, 3 or 4 microns in diameter.

Circuit Description

The cascaded voltage regulator tubes in Fig. 2 regulate high voltage for the multiplier phototube. The positive terminal is grounded so the meter input circuit operates near ground. Tubes V_1 and V_2 are operated at low plate voltage and current so that net grid current is zero[3].

Constant-current tube V_3[4] and the three voltage regulators maintain the quiescent values of current and voltage of V_1 and V_2, keeping grid current at zero. This allows switching in any desired value of grid resistor (multiplier phototube anode resistor) without zero shift caused by grid current.

With the low voltage applied across the multiplier phototube, dark current is negligible and can be trimmed out using zero adjust control R_1. Fatigue effects are not evident since maximum photocurrent is 10 microamperes full scale using the 0.1-megohm grid resistor. Maximum current sensitivity is 0.01 microamperes full scale using the 100-megohm resistor.

Regulation

The meter shifts ±½ percent for a change of ±20 volts in the nominal 120-volt line. Capacitor C_1 removes line transient effects. Stability of meter readings is better than 1 percent full scale over several hours.

The filaments of the triode-connected 6J7-G tubes (V_1 and V_2) were operated at reduced voltage.

The photometer circuit has also been successfully applied to a spectrophotometer, a light-scattering apparatus and to a photofluorimeter.

The author acknowledges the as-

sistance of Dr. M. Goldstein, E. O. Ulrich, L. Muldrow and M. Contad.

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Accelerometers Effect Vertical Gyro Output

By F. V. SULMER Air Arm Div., Westinghouse Electric, Baltimore, Md.

VERTICAL gyros must be provided with means for aligning the spin axis with the local vertical. This spin axis erection must be done when the gyro is first activated and continuously thereafter to eliminate gyro drift errors, earth rotation errors and errors caused by the gyro's motion relative to earth.

The erection system uses a device for sensing the local vertical. This device detects displacement of the gyro spin axis relative to the direction of gravity. The intelligence is fed to precession motors (torquers), which drive the gyro gimbals to reposition the spin axis parallel to the direction of gravity.

The sensing device, a gravity-sensing element or a vertical reference mechanism, is pendulous in nature. If the erection signal is not cut out during aircraft maneuvers, a gyro error results because of the automatic erection of the spin axis.

To date, no known device can distinguish between the forces caused by other accelerations from those caused by gravity. For this reason, any conventional erection sensor will erect the gyro to the vector sum of gravitational and all other translational accelerations.

To achieve erection cutout at the desired time, a system is required to detect accelerations of the aircraft and differentiate between those accelerations and gravity.

If three accelerometers are oriented in space along three mutually perpendicular axes, the accelerometers will detect all accelerations to which they are subjected, regardless of orientation of the axes in space.

The outputs of the accelerometers are voltages that represent the magnitude of the acceleration vectors along their respective axes. If these voltages are called A, B and C, the resultant acceleration, R, to which the system is subjected is the vector sum of these voltages or $R = \sqrt{A^2 + B^2 + C^2}$.

If the system is subjected to the acceleration of gravity only, then $g = \sqrt{A^2 + B^2 + C^2}$, where g is a voltage proportional to the acceleration of gravity.

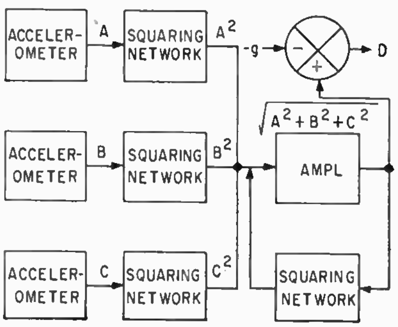


FIG. 1—One possible mechanization shows how a difference signal can be generated when vertical gyro is subjected to accelerations other than gravity

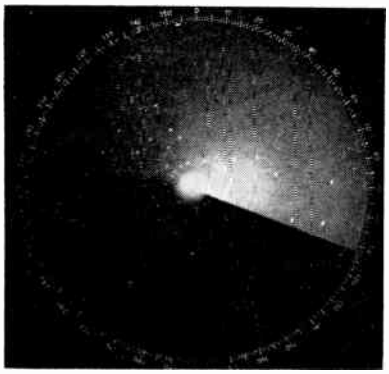
Since the objective of gyro erection cutout is to eliminate the erection of the spin axis whenever the gyro is subjected to an acceleration other than gravity, it is sufficient to ascertain that such an acceleration is present and it is unnecessary to know the direction of the acceleration vector. Therefore, if $g \neq \sqrt{A^2 + B^2 + C^2}$ the system is being subjected to an acceleration other than gravity.

Using this method of gyro erection cutoff, the equation is $D = \sqrt{A^2 + B^2 + C^2} - g$, where D is the difference in acceleration. If $D \neq 0$, the system is subjected to outside acceleration other than gravity.

The difference acceleration voltage can be applied to a switch to cut out erection whenever desired. In most applications, a bias voltage will be applied so that erection cutout is achieved when the difference voltage exceeds the bias voltage. The magnitude of the bias voltage will depend on the requirements imposed on the system.

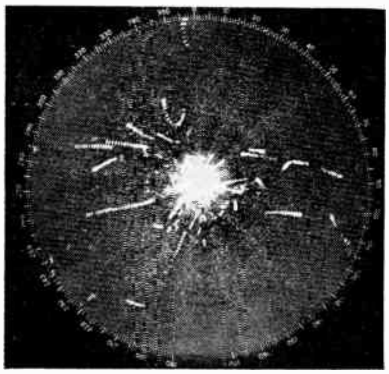
The possible mechanization in Fig. 1 assumes that output of the amplifier is a voltage proportional to $\sqrt{A^2 + B^2 + C^2}$. This assumption is correct (with negligible errors) when high-gain amplifiers are used.

Era of Storage Tube Just Beginning?



Traffic pattern of aircraft, above, as seen on a conventional radar scope, fades from view rapidly as operator sees pip showing plane's location with each sweep of the scanner

Traffic pattern of aircraft, below, as seen on the radar sky-writing system, shows plane's flight at a glance. Dual-gun storage tube saves pips with each sweep of the scanner and projects them on scope



IMPROVEMENTS in storage tubes are now being emphasized for use in air traffic control systems. Although the storage tube is over ten years old, continued improvements in resolution, or the amount of detail that can be stored, and the accuracy of reproduction of shades of grey, have increased the number of applications. And the era of the storage-tube seems to be just beginning.

Dual-Gun Tube

One of the latest radar systems, incorporating a new recording storage tube developed by Raytheon, Waltham, Mass., was demonstrated to Armed Force representatives in Washington. The system is scheduled for use soon by Canada's Department of Transport. For the vital air-traffic control applications, it is necessary to pick up target trails of several moving planes. Radar pictures from more than one source are stored simultaneously, the radar pictures are scan-converted into tv and the television image is displayed on a large number of monitors. One of the more dramatic performances of the new tube is to allow stored-image playback thousands of times without substantial deterioration.

The Raytheon tube, QK703, is a dual-gun cathode ray recording storage tube that is capable of simultaneous reading and writing. This development is an improvement in resolution of recording storage tubes from 600 lines per diameter to 1,000 lines per diameter, along with other improved characteristics such as background uniformity.

Stored signals can be held many hours or erased in a fraction of a second. Reading can be performed at all times, even when new video signals are being written. Moreover, it is never necessary to switch the storage screen potential. In single-gun types, a basic problem results from the fact that the switching of the storage screen voltage provides transients in the output electrode signal.

Components for a 100-mc Computer

THE CRYOSAR, (ELECTRONICS, p 11, May 22, 1959), a new component developed at Lincoln Laboratory, MIT, by A. L. McWhorter and R. H. Rediker, may make possible a 100-mc computer. Work at MIT is proceeding with this application in mind.

Reports indicate that the Cryosar will operate at pulse repetition frequencies well above 100 megapulses per second.

The computer element, which operates at liquid helium temperature (4.2 K), utilizes avalanche breakdown produced by impact ionization of impurities in switching from its high to its low-impedance state and returns to its high-impedance state by recombination of the carriers with ionized impurities.

Investigations are continuing towards understanding the negative resistance of the so-called bistable Cryosars, which are fabricated from *p*-type germanium purposely compensated with a donor impurity.

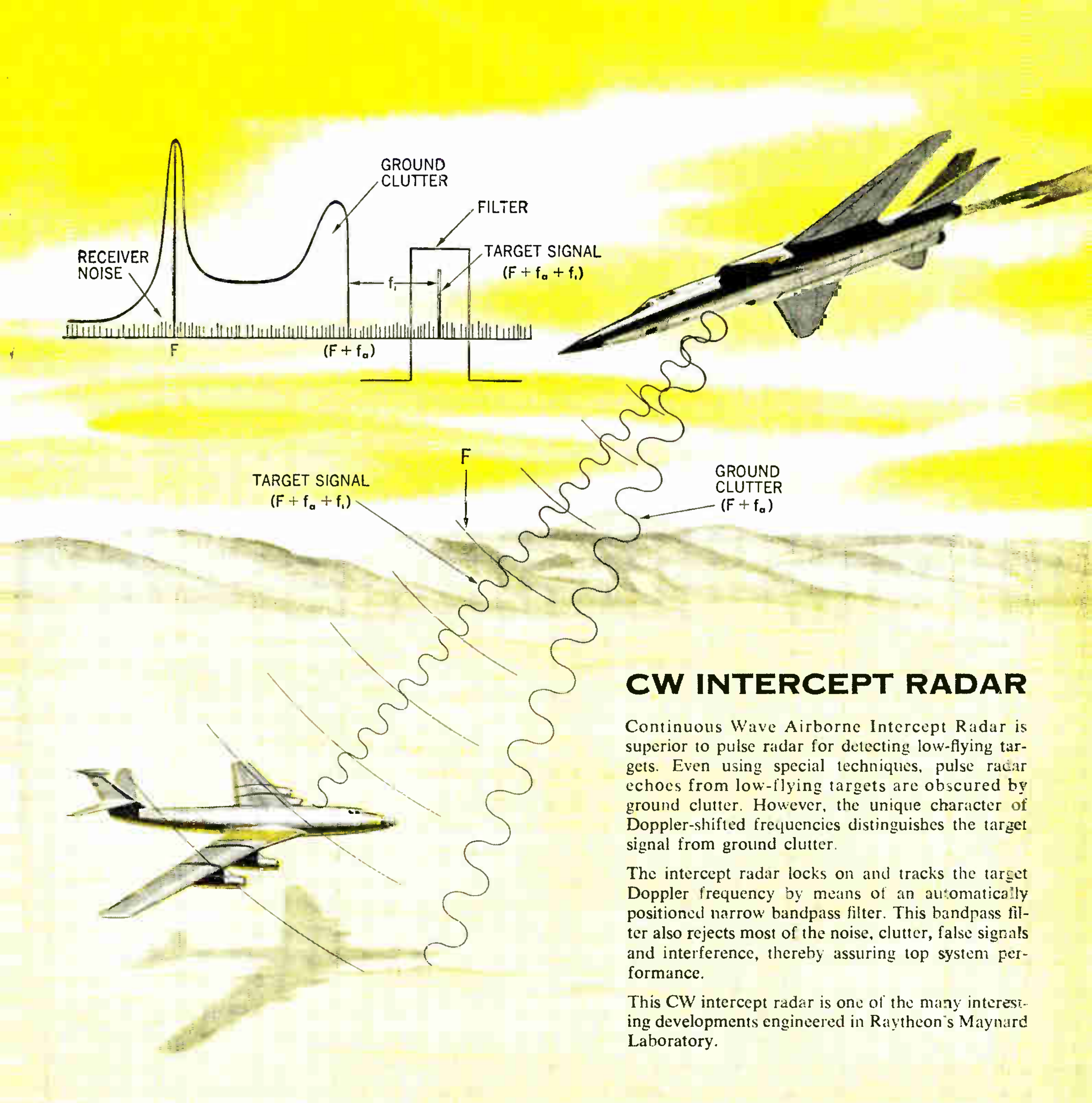
The bistable Cryosar can be used as a memory element, multivibrator or flip-flop. The speed is limited by the turn-on time of 10^{-8} seconds.

Flip-Flop

At Lincoln Laboratories, circuits have been developed to use Cryosars for logical operations in a computer. In negative-resistance two-terminal devices such as the Cryosar, if the applied voltage exceeds

Window-Frame Module Technique

Developed in Stanford Research Institute's Computer Techniques Laboratory, this window-frame module technique is an experiment in modular packaging. The design allows moderately high component density, good tolerance to vibration and shock, and accessibility to components for test. Small plug-in modules using repetitive circuitry require a low level of maintenance skills. Six or eight frames use small wired-in circuit boards with as many as 20 input connections on a 1½-in. board. The designer is J. L. Haynes, and assembly was by E. Fanjul



CW INTERCEPT RADAR

Continuous Wave Airborne Intercept Radar is superior to pulse radar for detecting low-flying targets. Even using special techniques, pulse radar echoes from low-flying targets are obscured by ground clutter. However, the unique character of Doppler-shifted frequencies distinguishes the target signal from ground clutter.

The intercept radar locks on and tracks the target Doppler frequency by means of an automatically positioned narrow bandpass filter. This bandpass filter also rejects most of the noise, clutter, false signals and interference, thereby assuring top system performance.

This CW intercept radar is one of the many interesting developments engineered in Raytheon's Maynard Laboratory.

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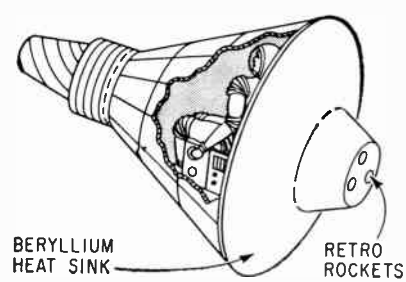
a critical amount, the voltage drop across the device changes to a lower value and remains there over a wide range of currents. Other examples of this are the neon bulb, the *pnpn* diode and the tunnel-effect diode.

The Shockley *pnpn* diodes tested appeared to be limited to a frequency of one-mc. The Cryosar was tried in a flip-flop circuit at 30 and 100 mc with promising results.

The flip-flop circuit, described by R. C. Johnston of Lincoln Labs, consists of the negative-resistance diode, a length of transmission line and a sinusoidal power source. The power source, or pump, fires the diode: a pulse is sent down a shorted half-wave stub and is reflected in the opposite polarity. It arrives back at the diode one cycle later and enables the diode to fire again. If a bilateral diode is used, such as the Cryosar, it is possible to store two bits since both half-cycles may be used.

Beryllium Dish to Shield Satellites



THE FIRST man-in-space may be protected by a six-foot diameter, five-inch thick heat shield, positioned behind the cockpit to absorb heat as the manned satellite enters the heat zone, orbits in space and returns to the earth.

The giant shield will be produced by Brush Beryllium, Cleveland, Ohio, manufacturers of beryllium metal and its alloys. The manned satellite capsule and its propulsion system, shown in the drawing, are being constructed by McDonnell Aircraft, St. Louis, Mo., for NASA's Project Mercury.

The successful production of such a large section of beryllium will herald a new phase in the role of beryllium in industry. Beryllium and its compounds are much talked about in nucleonics and electronics, and are performing as missile and reactor materials. Used as an ingredient in alloys, the metal lends high strength and elasticity to materials not normally possessing these characteristics. The cost of the metal will become more favorable as greater quantities of the beryl ore are made available, and new oxide processing plants are being built.

The Oxide

In spite of its highly desirable characteristics for the electronics industry, the development of beryllium oxide bodies has progressed very slowly. This has been because the material, in its unfired state, is highly toxic and the industries dealing with ceramics have not been geared to handling toxic materials. The National Beryllia Corp., North Bergen, N. J., has equipped itself to meet this demand, and their largest potential market for beryllium oxide is, at the moment, the electronics industry for design, development engineers and producers of electronic components.

New Tunnel Diode for 1,000-Mc Operation

MADE OF GERMANIUM, an experimental tunnel diode was recently described by Henry S. Somers Jr. of RCA. Now operating at frequencies higher than 1,000 mc, the device may have a potential range to beyond 10,000 mc.

The device employs negative resistance, well known, but not put to widespread practical application.

The new tunnel diode has been applied experimentally in a simple amplifier circuit developed at the David Sarnoff Research Center by K. K. N. Chang. According to reports, performance characteristics are similar to those of the parametric amplifier. But circuitry is far simpler.

Recalling that RCA had recently demonstrated an experimental tunnel diode made of gallium arsenide, Somers pointed out the natural advantages of germanium: standard material, readily available, low cost and a more familiar material.

Machine Assembles Circuit Modules

PROTOTYPE MACHINE for automatic or semiautomatic assembly of micromodules (ELECTRONICS, p 62, May 15) is in experimental use at Radio Corp. of America, Semiconductor and Materials Division, Somerville, N. J. The preliminary model is hand-operated.

The machine forms a continuous cage of the 12 riser wires which connects microelements, positions components in the cage, and solders the wires to the wafers.

Wire is fed from 12 bobbins and over triple pulleys placed 90 degrees apart on the top deck. The wires converge into a cage corresponding to the wafer notch positions. Wire ends are grasped and spaced by a pull-down arm located below the assembly section.

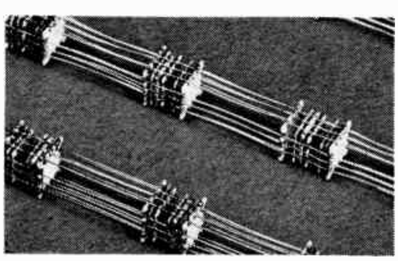
Cage Indexing

The pull-down is mounted on a vertical screw so that the wire cage can be indexed downward by turning a gear mating with the screw. The gear is provided with a dial indicator to measure the amount of cage travel required for spacing between component wafers.

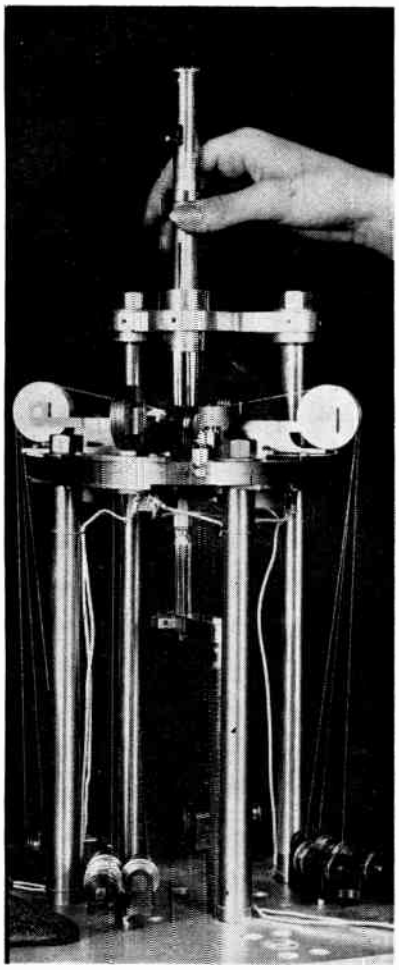
When several modules have been assembled, a second pull-down is placed on the cage at the starting position. Wire ends are clipped below the second pull-down. The first pull-down and modules are removed and the process repeated.

Components are loaded horizontally into 4 vertical fingers of a transfer device. The pickup is placed in the top of the machine and down inside the converging cage. The pickup releases the wafer and is retracted.

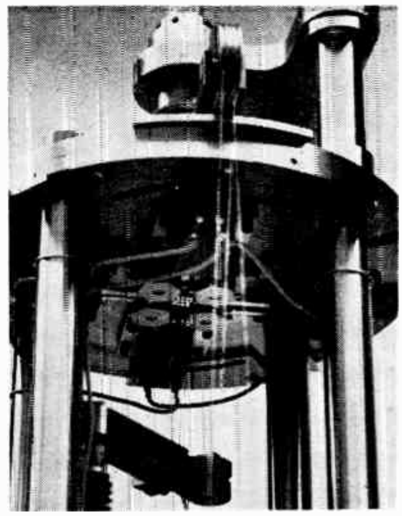
The wires fit into the wafer notches and are pressed just above the wafer by small resistance-



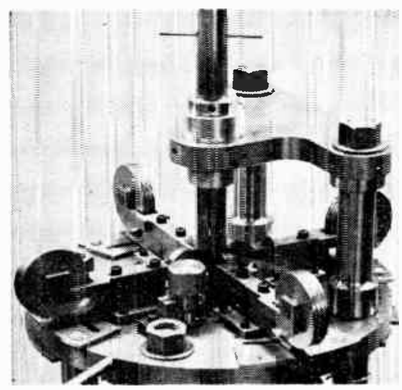
Assembled modules



Pickup being retracted from wire cage. Assembled module and pulldown are in center of photo



Underside of top deck showing a wafer in soldering position



Upper side of top deck with pickup fully inserted

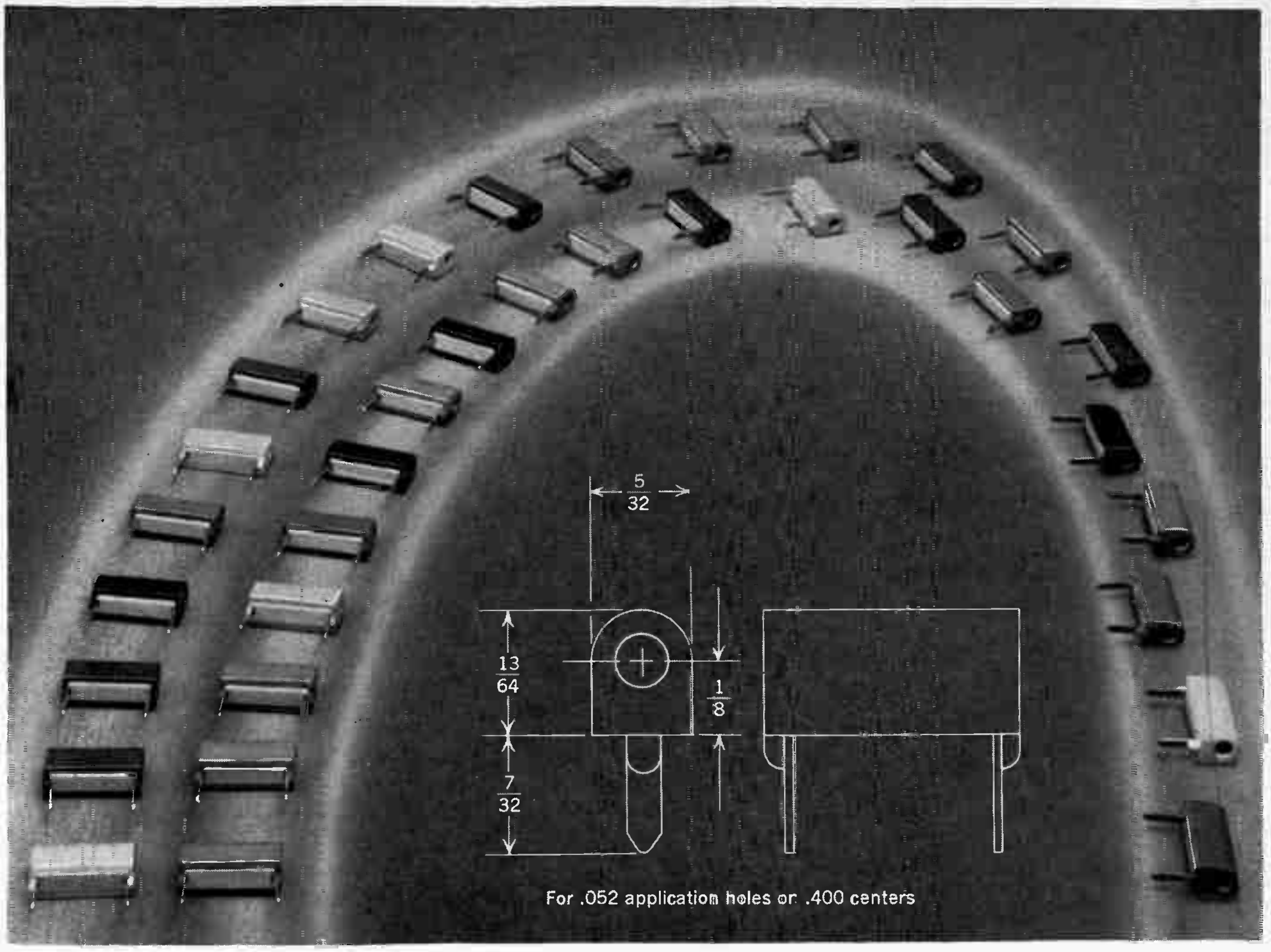
heater bars. The bars are energized briefly, hence soldering the tinned riser wires and notches together. The cage is drawn down and the cycle is repeated.

Pending regular use of the machine, hand assembly techniques produce the experimental modules required for engineering evaluation. Tested components are delivered to assemblers along with a worksheet which shows pictorially the arrangement of the components in the module.

Components are placed in a jig made of L-shaped metallic spacers. The spacers maintain relative position of the components while tinned riser wires are placed and soldered into the notches on the 2 exposed sides of the wafer. The partially completed module is then placed in a padded bench vise to attach the other 6 riser wires. Wire ends are placed in Teflon blocks which prevent dislodgement of wires during handling. The blocks also serve as part of the encapsulating mold and as test fixtures adapters.

Components are coated with a silicone gel which absorbs stresses. The module, with Teflon blocks in place, is placed in a mold. Epoxy is injected through a hole in the mold cap, passes through flues under the module and rises between components. Air escapes through ports in the mold cap. Another type of mold is shown in the photo.

Because the micromodules are undergoing intensive design and development study, production methods for microelement components are continually being modified and



New

Test Jacks for Printed Circuits

Designed for permanent assembly to printed circuit boards, these new test jacks by Ucinite are easily accessible to standard .080 test probes and eliminate the need for individual adaptor boards.

Simple, economical construction ensures reliability and reasonable cost. Gold-over-silver-plated beryllium copper contacts provide dependable, low-resistance connections. Nylon bodies are available in eleven standard code colors specified as follows: Part number (119437) plus letter suffix . . . A-Opaque White, B-Red, C-Black, D-Brown, E-Green, F-Orange, G-Blue, H-Yellow, J-Gray, K-Violet, L-White translucent.

With an experienced staff of design engineers plus complete facilities for volume production of metal and plastic parts and assemblies, Ucinite is capable of supplying practically any requirement for fasteners, connectors, switches and other small metal and metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

ELECTRICAL ★ DOT ★ ASSEMBLIES

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Division of United-Carr Fastener Corporation, Newtonville, Mass.

are too varied for full coverage here. A few of the specific techniques are described.

Coils are wound on miniature ferrite toroids. The shuttle of the winding machine is a circular tube, preloaded by the device shown schematically in Fig. 1. The wire is coiled on the mandrel and pushed into the shuttle by an oscillating sleeve. Minimum core i-d is 0.1 inch; wire sizes from 36 to 43 AWG. are normally used. Coils are connected to capacitor wafers (for tank circuits or similar components). The wire ends are then hand-soldered to the proper notches on the capacitor wafer.

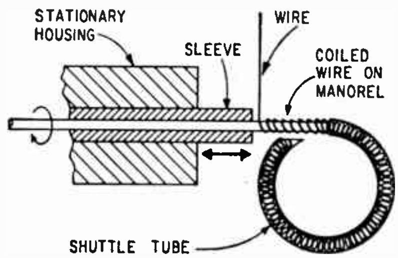
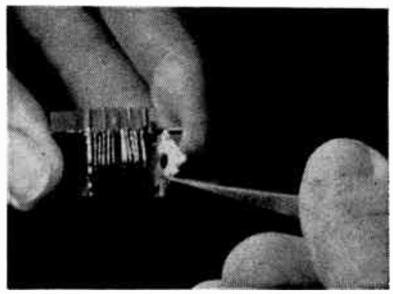
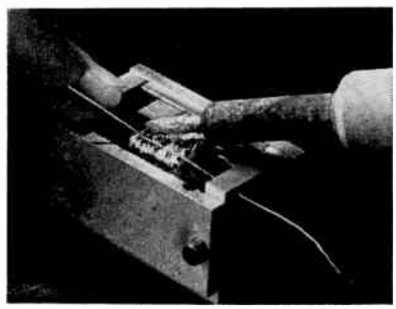


FIG. 1—Loading of miniature toroid winding shuttle

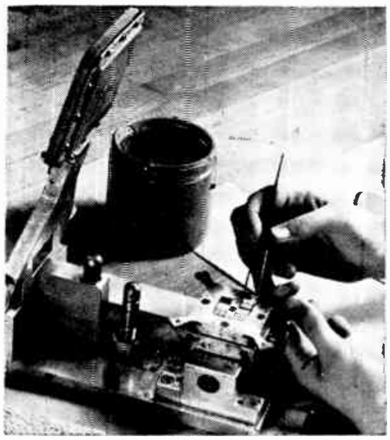


Components are placed in hand assembly jig

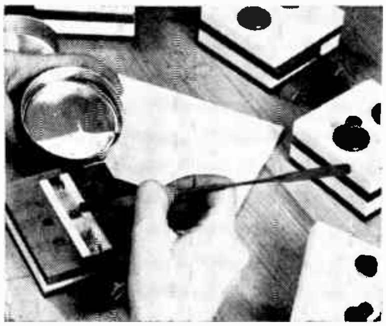


Hot iron solders tinned riser wire to tinned wafer notches

One type of multiple resistance microelement under study can have up to 4 strips of frit ink (of varied metallic dispersion) applied and terminated to the proper notches. Fine calibration is accomplished by abrading away a portion of each strip using an



Fixture used to screen component patterns on ceramic wafers



Encapsulation of assembled module

electronically monitored air-abrading tool. Other types used are thin metallic films applied to a wafer. The resistance is varied by scribing a meander path or with a pattern applied by a photo resist process.

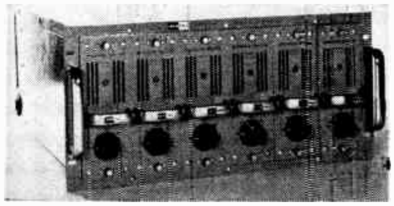
Also under study are film capacitors made by screening metallic electrodes on a wafer or by depositing and firing thin titanate films. Electrodes are screened over the film in alternate layers until the desired capacitance is achieved.

Transistor elements are mounted in a recessed wafer. Platinum paste is screened in a ring around the top of the recess and in the 3 lead pin holes in the bottom of the recess. After firing, the wafer is dip-soldered to coat the platinum. After the transistor elements are mounted in the recess, a metal cap is placed over the solder ring to hermetically seal the unit.

Conductive paths to component terminations and the land areas around the notches in the wafers are applied by screening. The metallic pastes and inks are loaded with glass frit so that a good bond with the ceramic wafer results from firing. Wafers are supplied by vendors as either pressed and fired ceramic or etched glass-ceramic.

On The Market

D-C Amplifier differential type

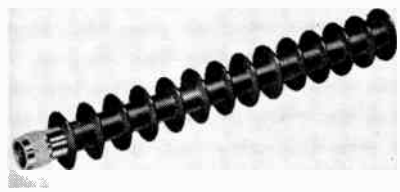


KIN TEL DIVISION of Cohu Electronics, Inc., 5725 Kearny Villa Road, San Diego 12, Calif. Model 114A differential d-c amplifier demonstrates a common mode rejection of 180 db, d-c, and over 130 db in the case of 60-cycle a-c noise with up to 1,000 ohms input unbalance. The input portion of the amplifier is completely isolated from the amplifier chassis. In effect, it floats with the transducer circuit itself. Output portion is also isolated from the amplifier chassis and floats with the output circuitry. Connection between the two portions is a complex transformer that incorporates the two isolating shields in its basic design.

CIRCLE NO. 201 READER SERVICE CARD

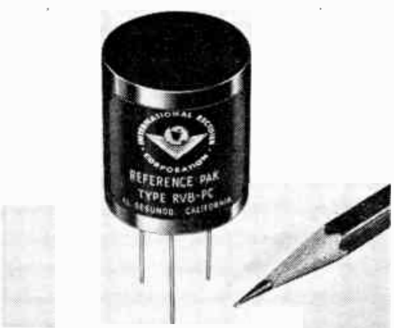
Terminations high power

MICROLAB, Livingston, N. J. A new line of terminations have a power rating of 150 w when operating in an ambient as high as +125 C. Frequency range is from 900 mc to 13,000 mc with a vswr of less than 1.2. The resistive element consists of a dissipative material evenly dispersed in a dielectric medium which is molded into a taper to provide a termination with minimum reflections and an optimum power distribution. Impedance of the terminations is 50 ohms; overall length, 11.2 inches; and weight,



8 ounces.

CIRCLE NO. 202 READER SERVICE CARD



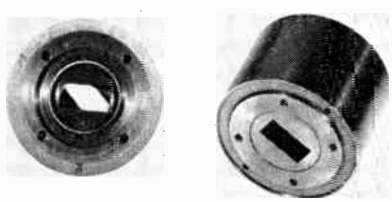
Reference Pack for p-c mounting

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Operable directly from unregulated 28 v d-c power supplies with a current drain of only 30 ma, these miniature voltage reference packs are designed specifically for printed circuit board insertion. They provide an output voltage of 8.4 v, ±5 percent, and will remain stable within ±1 mv over a line variation of ±10 percent in the 28 v supply. Units may be operated up to +125 C, and feature a temperature coefficient of ±0.001 percent/deg C from −55 C to +100 C. They use a self-contained Zener diode current regulator.

CIRCLE NO. 203 READER SERVICE CARD

Rotary Joint step twist

STAVID ENGINEERING, INC., Plainfield, N. J. A new step twist rotary joint provides a reliable means of transmitting Ku-band microwave energy at high-power levels through oscillating trunnions, such as those

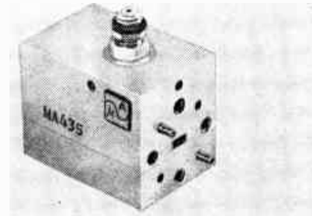


used in scanning radar antennas. Unit incorporates integral stops to eliminate the possibility of damage to the gear train from excessive angular rotation. Frequency range is 15.2 to 17.2 kmc; vswr, less than 1.09:1 over entire Ku band; peak power handling capacity (pressurized), 100 kw; insertion loss, 0.1 db maximum.

CIRCLE NO. 204 READER SERVICE CARD

Broadband Diode harmonic generator

MICROWAVE ASSOCIATES, INC., Burlington, Mass. Model MA-435 is a high efficiency millimeter wave harmonic generator diode. R-F input in the 26.5-40.0 kmc frequency range generates harmonic power over the 53.0-80.0 kmc frequency range. Minimum conversion efficiency measured at 70 kmc is 20 db. Fifty milliwatts of r-f drive has produced 1 mw output at 70 kmc. The extremely broadband response of the MA-435 is



PRECISION GYROS

A Proven Kearfott Capability. The increasing use of Kearfott gyros and gyro platforms in today's missile programs, underscores the company's leadership in gyro design and production. Such missile projects as the Atlas, Bomarc, Polaris, Snark, Subroc and Talos rely on Kearfott gyros or gyro platforms, as do the majority of manned aircraft now in service.

FLOATED RATE INTEGRATING GYROS. High accuracy miniature gyros specifically designed for missile use. The performance characteristics of these gyros are superior to any comparably-sized units available today. Hermetically sealed within a thermal jacket and ruggedly designed for adaptability to production methods. These gyros operate efficiently at unlimited altitudes. More precise performance characteristics can be provided in the same dimensions.

TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/hr maximum untrimmed
Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr
Drift Rate Due to
Anisoelasticity: Steady Acceleration: .015°/hr./g² maximum
Vibratory Acceleration: .008°/hr./g² maximum
Damping: Ratio of input angle to output angle is 0.2
Characteristic Time: .0035 seconds or less.
Weight: 0.7 lbs.
Warm-up Time: 10 minutes from −60°F
Life: 1000 hours minimum

VERTICAL GYROS. Provide accurate vertical reference in the form of two 400 cps synchro signals proportional to the sine of gimbals' displacement about pitch and roll axes. Gravity-sensitive vertical reference device provides electrical signals directly to torque motors which maintain gyro spin axis perpendicular to earth's surface. Hermetically sealed, they are unaffected by sand, dust, sun, rain, salt spray, humidity or fungus conditions as specified in MIL-E-5272A.

TYPICAL CHARACTERISTICS

Repeatability to Established Vertical: To within a cone of half angle equal to 15 minutes of arc (± 8 minutes typical).
Free Drift Rate in 5 minutes Time: 2.5° maximum at room temperature. 3.75° at −54°C and + 71°C.
Erection Rate: 2.5°/Min.
Initial Erection: The gyro will erect to within ± 1° of established vertical in 60 seconds time after application of power at room temperature.
Vibration and Shock: The gyro will meet above characteristics after vibration of 0.060" total excursion cycling between 10 CPS and 55 CPS for 4.5 hours. Shock test in accordance with MIL-E-5272A Procedure 2.
Operating Life: 1000 hours minimum.

FREE GYROS. Provide extremely accurate reference in the form of electrical output signals proportional to displacements about outer axes. With 360° of freedom about outer axes (inner axis freedom depends on the unit involved), these gyros may be mounted to give output signals of either pitch, roll or yaw. Shock and vibration resistant, they are equipped with quick-starting motors for applications in high performance missiles and aircraft.

TYPICAL CHARACTERISTICS

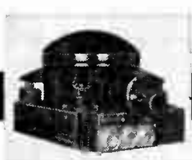
Free Drift Rate: Within 0.5° in one minute time.
Shock: The gyro operates satisfactorily without damage after 60g shock of .015 seconds duration.
Hermetically Sealed: These instruments are hermetically sealed and are not affected by sand, dust, sunshine, rain, humidity or fungus conditions.
Operating Temperature Range: Gyros operate in ambient temperatures below −20°C to + 100°C. A maximum of 3 minutes of operation at 400°F will not damage these gyros nor impair their accuracy.
Weight: 5.5 lbs. approximately.

SPRING RESTRAINED RATE GYROS. Almost universally applicable in missile and aircraft designs demanding precise angular rate measurements in environments of extreme shock and vibration. Fluid filling provides added immunity to shock and vibration, reduces bearing friction in AC types and potentiometer wiper friction in DC types. Kearfott design advances permit 30 second warm-up, overcome fluid viscosity variations resulting from ambient temperature change. These gyros are single-degree-of-freedom, viscous damped, spring restrained, with gimbals supported by precision bearings. Compensatory damping mechanisms eliminate need for accessory heaters.

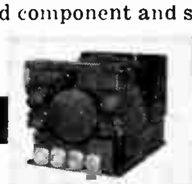
TYPICAL CHARACTERISTICS

Maximum Rate (°/sec.): 45-1000
Natural Undamped Frequency (cps) (± 10%): 16
Damping Ratio (of critical) over Temperature Range: .35 to .80
Operating Temperature Range (°F): −65 to +185
Vibration: 12 g's @ 20-2,000 cps
Shock (Motor Running): 60 g's for 6.5 milliseconds
Warmup Time (Sec.): 30
Weight (lbs.) (max): 1.5
Gyro Time Constant (Sec.): .012

Engineers: Kearfott offers challenging opportunities in advanced component and system development



Roll Stabilized Directional Gyro



3 Gyro—4 Gimbal Gyro Reference

25 Pound Inertial Platform

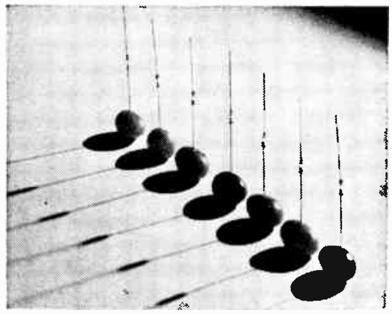
Kearfott | A GENERAL PRECISION COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation

Sales and Engineering Offices: 1500 Main Ave., Clifton, N. J.
Midwest Office: 23 W. Calendar Ave., La Grange, Ill
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

achieved by mounting the diode across a section of ridged RG-98/U waveguide. Integral tapers match the ridged section to the input and output for coupling to UG-600/U (RG-96/U) and UG-385/U (RG-98/U) flanges respectively.

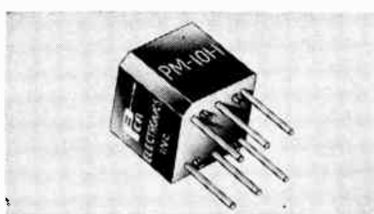
CIRCLE NO. 205 READER SERVICE CARD



Crystal Diodes all-glass

SYLVANIA ELECTRIC PRODUCTS INC., Semiconductor Div., Woburn, Mass., announces a versatile line of all-glass, subminiature crystal diodes for use in radio, tv, data processing and other military and commercial electronic applications. Maximum body length is 0.265 in., and maximum diameter 0.105 in. The line includes computer types, gold bonded types, point-contact types, and silicon junction types.

CIRCLE NO. 206 READER SERVICE CARD



Pulse Transformers varied applications

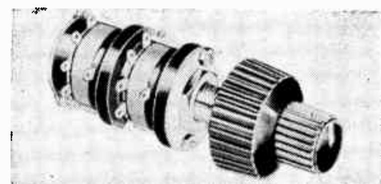
PCA ELECTRONICS, INC., 16799 Schoenborn St., Sepulveda, Calif., has developed a new series of PM pulse transformers applicable as blocking oscillators, in triggering, low voltage and counting circuits, for d-c isolation, pulse shaping and for use as wide band input and output transformers, among other applications. They are available in three sizes: 0.400 by 0.400 by 0.400 height; 0.562 by 0.562 by 0.500 height; 0.700 by 0.700 by 0.650 height.

CIRCLE NO. 207 READER SERVICE CARD

Silicon Rectifier high power

WESTINGHOUSE ELECTRIC CORP., Semiconductor Dept., Youngwood, Pa. Type 300 rectifiers are hermetically sealed silicon rectifying cells for all types of power applications. The cells may be used to provide forward currents up to 70 amperes per cell (with proper heat radiation) with maximum piv ratings up to 500 v. The rectifier case is the metallic rectifier positive (cathode terminal). The device has been specifically designed for high current applications with minimum space and weight requirements.

CIRCLE NO. 208 READER SERVICE CARD



Rotary Tap Switch concentric shaft

GRAYHILL, INC., 561 Hillgrove Ave., LaGrange, Ill., announces a new miniature concentric shaft rotary tap switch. The fully enclosed switch, only 1 in. in diameter, allows two switches to be mounted in the space normally occupied by one. Each shaft controls from one to three decks, with two to ten shorting or non-shorting positions per deck. Units are available as standard in over 6,500 various combinations of decks and positions.

CIRCLE NO. 209 READER SERVICE CARD

Servo Amplifier tiny, rugged

BELOCK INSTRUMENT CORP., 112-03 14th Ave., College Point, N. Y. A new transistorized 6 w 400 cps servo amplifier occupies a space of only 9 cu in. Its operation is instantaneous and it plugs into a standard octal type socket. It is available in completely encapsulated form or in a form suitable for quick repair. Voltage gain is greater than 4,500 and input impedance is greater than 70,000 ohms at 27 C. It has a variable gain control and

FROM DESIGN TO PRODUCTION

Stock Reflectors — solid spun, 4 in. to 10 ft. in diameter • mesh, 4 ft. to 18 ft. in diameter • larger sizes or special shapes on request.

Antennas — up to 10,000 mc

Large Waveguide Components

Prompt Delivery of any type antenna or reflector — precision built to your specifications. Write for technical data.

Ainslie CORPORATION

312 Quincy Ave., Quincy, Massachusetts

CIRCLE NO. 99 READER SERVICE CARD

MEET ROLLY CHAREST

Associate Editor electronics

RESUME:

Charest, Roland J., Boston University, BS in Journalism. Formerly New England editor for **electronics**. Navy sonarman. Writer, reporter, editor for Lynn Item, Boston Globe, Boston Traveler. Won a New England Associated Press (AP) award in 1955 for writing feature articles in the major city newspaper class.

PRESENT OCCUPATION:

Rolly Charest supports Managing Editor Jack Carroll for editorial content accuracy and expediting putting each weekly issue to bed. Rolly reworks headlines for greater readability, is involved in makeup, and helps polish editorial content. Rolly's across-the-board background assures you accuracy in the face of journalistic pressures; articles in this week's issue that could be held over to the next deadline, but are not. The readers' interests come first!

REFERENCES:

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electronics

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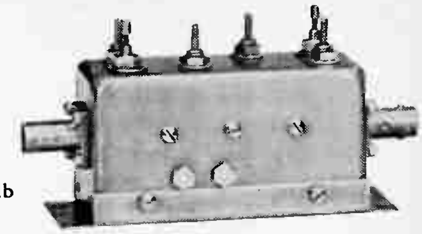
the ultimate in bandpass filters

Model HFF-4
(Quadruple Tuned)

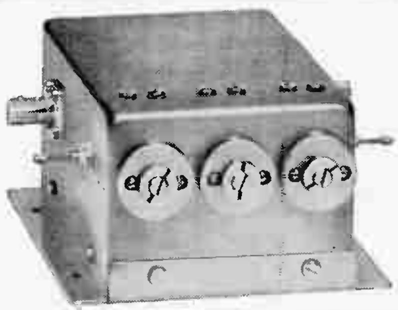


$f_0 = 400$ mcs
B.W. = 45 mcs
Insertion loss = 0.9 db

SPECIFICATIONS

MODEL HFF BANDPASS FILTERS

Center Frequency:	30 to 1000 mcs (factory preset to customer specifications)
Bandwidth:	5% to 25% of center frequency (factory preset)
Impedance:	50 ohms
V.S.W.R.:	≦ 1.2 in pass band (consistent with peak to valley ratio)
Insertion Loss:	≦ 1 db
Peak to Valley Ratio:	≦ .5 db
Selectivity:	Defined by number of resonant elements Doublets to sextuplets available
Power Rating (CW):	25 watts
Connectors:	BNC or Type N
Finish:	Silver Plate; Rhodium Flash



Model HFF-T-3
(Triple Tuned)

$f_0 = 425$ mcs
B.W. = 50 mcs
Insertion loss = 0.15 db

SPECIFICATIONS

MODEL HFF-T BANDPASS FILTERS

Center Frequency:	200 to 2000 mcs (factory preset to customer specifications)
Bandwidth:	1% to 15% of center frequency (factory preset)
Impedance:	50 ohms
V.S.W.R.:	≦ 1.2 in pass band (consistent with peak to valley ratio)
Insertion Loss:	≦ 1 db
Peak to Valley Ratio:	≦ .5 db or less
Selectivity:	Defined by number of resonant elements Doublets to sextuplets available
Power Rating:	100 watts
Connectors:	BNC or Type N
Finish:	Silver Plate; Rhodium Flash

Model HFF and Model HFF-T bandpass filters are available at other frequencies, bandwidths, power ratings and to customer specifications. Also available are temperature compensated filters for maximum stability.

SEND FOR BROCHURE

Applied Research inc.

76 S. Bayles Avenue Port Washington, N. Y.

is constructed to withstand vibration in accordance with MIL-E-5272.

CIRCLE NO. 210 READER SERVICE CARD

Analyzer pulse height

ELDORADO ELECTRONICS, 2821 Tenth St., Berkeley 10, Calif. Model 4100 multichannel pulse height analyzer features double pulse resolution of better than 0.5 μsec and a fixed dead time of less than 0.1 μsec. It accepts average count rates greater than 10^5 counts per sec without baseline distortion or use of temporary storage. Channel width is stable to better than 1 percent of a channel per week. Base line shift is less than 0.1 percent per week. Channel triggering levels are unaffected by changes in input pulse width.

CIRCLE NO. 211 READER SERVICE CARD

Tape Control for broadcasters

COLLINS RADIO CO., Cedar Rapids, Iowa, announces an automatic tape control designed for broadcasters to facilitate instantaneous and efficient play-back of recorded commercial announcements, programs and production aids. It records and plays back on magnetic tape enclosed in a plastic cartridge. In control room operation, one commercial announcement or production aid is recorded on each cartridge. An operator can place the cartridge in an automatic tape control unit and activate the mechanism for reproduction many times faster than he can cue-in and play back an electrical transcription on a turntable.

CIRCLE NO. 212 READER SERVICE CARD

Literature of the Week

MATERIALS

Magnetic Laminations. G-L Electronics, 2921 Admiral Wilson Blvd., Camden 5, N. J. Precision-made, high permeability, transformer laminations, magnetic head laminations, servo motor rotors and stators and special shape laminations are illustrated and described in bulletin TB104.

CIRCLE NO. 200 READER SERVICE CARD

COMPONENTS

Subminiature Indicator Lamps. Circon Component Corp., Santa Barbara Airport, Goleta. Calif., has available a series of data sheets on its subminiature neon indicator lamps which feature high intensity with integral internal ballast.

CIRCLE NO. 213 READER SERVICE CARD

Pulse Transformers. Sprague Electric Co., North Adams, Mass. Eight recent engineering data sheets contain technical information on a wide variety of miniature and subminiature pulse transformers.

CIRCLE NO. 214 READER SERVICE CARD

Microwave Tubes. Varian Associates, 611 Hansen Way, Palo Alto, Calif. A 36-page catalog illustrates and describes a line of klystrons, bwo's, twt's and related components.

CIRCLE NO. 215 READER SERVICE CARD

Square-Loop Tape Cores. Dynacor Inc., 10431 Metropolitan Ave., Kensington, Md. Three new engineering bulletins give a complete set of current data on the company's square-loop tape cores for magnetic amplifiers and specialty transformers.

CIRCLE NO. 216 READER SERVICE CARD

Transistor Voltage Breakdown. Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif. Voltage breakdown, the major cause of transistor failures, and leakage currents are discussed in

Transistor Kinks, Vol. 1, No. 1, a four-page publication.

CIRCLE NO. 217 READER SERVICE CARD

Switching Transistors. Bendix Aviation Corp., Red Bank Division, Long Branch, N. J., has available data sheets on the new 2N1136, 2N1137 and 2N1138 high gain power switching transistor series.

CIRCLE NO. 218 READER SERVICE CARD

EQUIPMENT

Computing Galvanometer. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Basic theory, application and specifications of the type 7-370 computing galvanometer are described in a new 4-page brochure.

CIRCLE NO. 219 READER SERVICE CARD

Shock Machine. Barry Controls Inc., 700 Pleasant St., Watertown 72, Mass. Bulletin 57-06B discusses the type 15575 Varipulse shock testing machine which offers versatility, reliability and simplicity of operation.

CIRCLE NO. 220 READER SERVICE CARD

Panel Instruments. Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. Bulletin 01-112-A contains specifications, ranges and dimensions of the expanded Crown line of panel instruments.

CIRCLE NO. 221 READER SERVICE CARD

FACILITIES

Aircraft Systems and Components. Electronic Specialty Co., 5121 San Fernando Road, Los Angeles 39, Calif. A 40-page catalog, AV-100, describes the complete facilities and products of the company's Avionics Division. For a copy of the brochure write on company letterhead.

Mounting System Capabilities. Lord Mfg. Co., Erie, Pa. A 12-page bulletin, No. 714, describes the company's space-age capabilities in the field of engineered systems for shock, noise and vibration control.

CIRCLE NO. 222 READER SERVICE CARD

Vitro Occupies Plant Annex

VITRO LABORATORIES recently moved into the new $400,000 annex to its research and development plant in Silver Spring, Md. The annex (an extension of the wing at left in picture) increases the plant capacity by 30 percent to a total of more than 100,000 sq ft of floor space. The Vitro facility is engaged in weapon systems work for the Navy.

The basic plant was completed at a cost of $2 million in August, 1957, when the laboratory staff numbered 425. During 1958 the staff expanded to 630, and additional floor space was leased in the Triangle Building, in Wheaton. Construction of the annex was started last September.

Vitro will continue to lease 8,000 sq ft of floor space in the Triangle Building to provide for further expansion of its staff.

Sales by Vitro's Silver Spring Laboratory rose from $4.2 million to $6.3 million in 1958, and a further increase to $7 million is anticipated for the current year.

Vitro Laboratories is the research and development division of Vitro Corp. of America, New York. Parent company also owns the Nems-Clarke Co., Silver Spring, which is engaged in the production of electronic equipment.

Epsco-West Gets Senior Engineer

APPOINTMENT of Kartar Dhanjal as senior electronics engineer for Epsco-West has been announced by Wallace E. Rianda, general manager of the California division of the Boston data control firm.

Specializing in the design of transistorized circuitry, Dhanjal formerly worked for B-J Electronics Corp., International Telemeter Corp., and Lane-Wells Corp. At International Telemeter, he worked on a Russian-English language translator computer.

Victoreen Hires Ben Olson

APPOINTMENT of Ben Olson as chief engineer of the company's Components Division is announced by The Victoreen Instrument Co., Cleveland, Ohio.

Before coming to Victoreen, Olson was associated with National Union Electric Corp., Bloomfield, Ill., as director of research and engineering. Previous to this, he served as senior engineer in production engineering, Sylvania Electric Corp., Tube Division, Burlington, Iowa.

Sylvania Elects Senior V-P

HERBERT TROTTER, JR. was recently elected senior vice president—engineering and research, Sylvania Electric Products, Inc., with responsibility for the over-all engineering program and for the operations of Sylvania Research Laboratories.

Previously a member of the Sylvania organization from 1942 to 1945, Trotter served as assistant director of two Eastman Kodak Co. divisions until 1956, and has been executive vice president of the Sharples Co., Philadelphia, up to his new appointment.

Gimpel Steps Into New Post

DONALD J. GIMPEL has been selected as director of engineering at Arnoux Corp., Los Angeles, Calif. He

"We grew too fast for our bank"

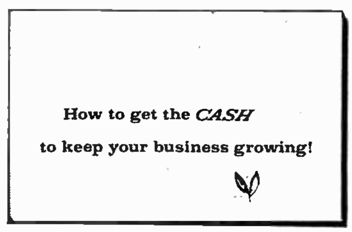
When he was fourteen years old, Jim McClain earned pocket money by rewinding motors and transformers. Thirteen years later James Ernest McClain, with very little capital but lots of know-how and drive, started his own business, specializing in the repair of distribution transformers.

In its first year, ESCO Manufacturing Company, of Greenville, Texas, consisting of 27 years old McClain and a hired mechanic, grossed $35,000, netted $7,000. Last year, gross was several millions, and net profit, correspondingly substantial.

In the early years the local bank was able and willing to supply all the credit that Esco needed. But the growth was so rapid and the matching need for working capital so great, the local bank wasn't quite able to go along. So Mr. James Ernest McClain, then head of a company grossing better than a half million dollars, and not willing to dilute his equity or surrender any voice in management, turned to Textile Banking Company for financing cooperation and advice.

Mr. McClain says: "In addition to the advantages we enjoy in using TBC's funds as equity capital, and the savings we effect in eliminating credit losses and the cost of a credit department, there is perhaps an even greater advantage. Though we are far away from the industrial and financial centers, we have the privilege of being able to call on TBC's experienced executives for advice in solving many problems, financial and otherwise. Their experience, their contacts, their ability to supply us with nation-wide credit information usually give us the right solution."

At TBC, we don't work miracles. We help growing companies, whose sales exceed $500,000 annually, meet all the capital needs of rapid expansion, without surrendering any management control, or without any dilution of profits. If you want to know more about how we do it, write for a free copy of our new booklet, "How to get the *cash* to keep your business growing."



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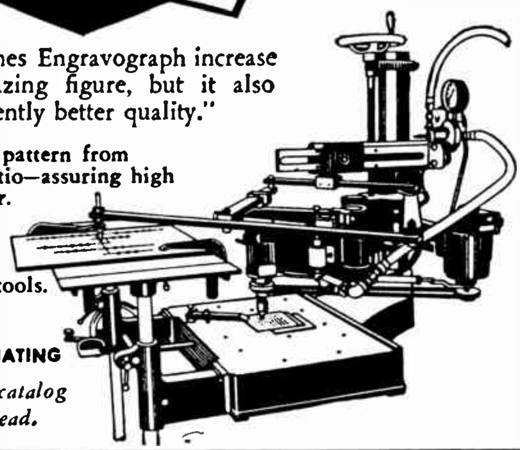

takes the new position after serving as director of research.

Through association with Panellit, Inc., the Aerial Measurements Laboratory of Northwestern University, and Armour Research Foundation, Gimpel had eight years' experience in the design of instrumentation and control systems and analog and digital computers.

Plant Briefs

Hermetic Connector Corp., Newark, N. J., announces formal changing of the company name to **Hercon Electronics Corp.**

Gray Instrument Co. of Philadelphia recently moved into a larger building in Andalusia, Pa.

New name for **Hycon Eastern, Inc.**, of Cambridge, Mass., is **Hermes Electronics Co.**

Accurate Specialties Co., Inc., Woodside, N. Y., has leased a 14,000 sq ft plant in **Hackensack**, N. J., to triple semiconductor component capacity.

Construction is under way on a new $200,000 plant for **Dynamic Gear Co., Inc.** of Amityville, N. Y.

Merging of Electralab Inc. of Needham Heights, Mass., and Printed Electronics Corp. of Natick, Mass., has resulted in the formation of a new company named **Electralab Printed Electronics Corp.** (E.P.E.C.). Main offices are located in Natick. E.P.E.C. is operating as a wholly owned subsidiary of the Farrington Mfg. Co.

News of Reps

The Vocaline Co. of America, Inc., Old Saybrook, Conn., names the following as their sales reps:

The Bilray Organization, for Indiana and Kentucky; **The Mel Foster Co.,** for North and South Dakota, Minnesota and western Wisconsin; **The W. R. Retzloff Co.,** for Texas, Oklahoma, Louisiana and

Arkansas; **L. E. Barnhart** for Mississippi, Tennessee and Alabama.

Radio Corp. of America recently named two rep firms for its mobile communications equipment. **Eastern Theatre Supply Co., Inc.** of Buffalo, N. Y., will cover the northwestern section of New York state. **Electronic Specialty Co.** of Charleston, W. Va., was assigned the western portion of West Virginia.

Jack Fields Sales Co. has changed its name to **Fields & Simon Sales Co.** in Montclair, N. J. **Marvin A. Schwartz,** formerly with Stavid Engineering Co., has joined the rep firm as a technical sales engineer and will cover the Metropolitan area territory.

Stanley B. Pierce of Norwood, Mass., announces the addition to his organization of **Laurence R. Berk,** as an associate. The Pierce organization is New England rep for The Daven Co. of Livingston, N. J., Augat Bros. of Attleboro, Mass.; and the James Vibrapowr Co. of Chicago, Ill.

Donald R. Warren, for the past eight years manager of the northern California branch of the Strassner rep companies, has resigned that post to become a principal in the Frank Lebell Co., San Francisco rep firm. Company's name has been changed to **Lebell-Warren Associates.**

Wayne Kerr Corp., Philadelphia designers and producers of electronic measuring instruments, has appointed the **Tiby Co.** of Cleveland, Ohio, as its new sales rep in Cleveland, Detroit and Dayton, to cover Ohio, western Pennsylvania and southern Michigan.

Two new midwest sales reps have been named by Daystrom Transicoil to handle the manufacturer's line of servos, synchros and precision rotating assemblies:

Whitmore & Associates of Chicago will cover Wisconsin, Illinois, Indiana and western Kentucky; **R. G. Ragon, Inc.,** of St. Paul will handle Minnesota and North and South Dakota.

COMMENT

Microwave Hazards

Like many others, I have followed with interest your reports and the ensuing correspondence on microwave health hazards . . .

Publications pertaining to the pearl-chain effect go back as far as 1935. It seems that the first one to observe chain formation in blood under the influence of high-frequency fields was Denier, who reported about this phenomenon in *Archives d'Electricite Medicale* in March 1935. The Viennese experiments referred to by Dr. Tomberg in his letter (p 102, May 1) must be the ones carried out by Liebesny and Pace in the First University Clinic of Vienna in 1936.

The late '30s were quite a fertile time for ultra-shortwave research in the biophysical field. One of the best publications written is a monograph *Ultrashortwaves in Biology and Medicine* edited by Dr. B. Rajewsky (at that time director of the Kaiser Wilhelm Institute for Biophysics in Frankfurt) and published in 1938. This book also contains references to the chain-formation phenomenon.

It is interesting to note that chain formation takes place, not only at high frequencies, but also at low frequencies down to 60 cps.

Generally, one can say that there is a threshold value of electrical field strength at which chain formation begins, corresponding to sufficiently high ponderomotoric forces which overcome the forces due to the Brownian movement; and an upper limit of the field strength where the chain formation suddenly disappears. This upper limit corresponds to a stage where the energy absorption due to the presence of the high-frequency field is just sufficient to again increase the Brownian movement, indicating the initial period of temperature rises.

One of the most recent publications is that by Dr. John Heller of the New England Institute for Medical Research, reported in one of the last issues of *Nature*.

The independent rediscovery of work already done by others, of course, is a common phenomenon. It is not always easily understood why the pertinent literature was not known to the later workers. The fact that work was done previously by others does not deduct from the accomplishment of the latecomers.

EUGENE MITTELMANN
CHICAGO

Designing for Reliability

Have just seen your special article "Designing for Reliability" (p 65, May 29).

The idea and approach are sorely needed. However, I feel that your choice of treatment of the statistical aspects of testing is unfortunate. Although I am not especially familiar with electronics industry practice, I do not think it is generally acceptable to advise use of Latin-square experimental design exclusively. To do so is equivalent to claiming that the use of litmus paper is the way to perform chemical analysis, or that running a test for high blood pressure will tell us all we need to know about medical diagnosis. The Latin square arrangement is but one of many experimental layouts that may be used in the conduct of an investigation, and it can only be used when there is no interaction between the variables being investigated. This is not an inconsequential limitation and should be clearly recognized by all.

In addition, citing the use of random-balance polyvariable analysis as a powerful tool is a confusing reference to a technique which is not only highly specialized but also quite controversial as to its applicability.

In short, there is one crucial omission from your article—namely, that do-it-yourself techniques without knowledge of the significance of the operations involved is very dangerous; for the novice to embark on such ventures solo is foolhardy.

S. M. SELIG
ARMY CHEMICAL CENTER
EDGEWOOD, MD.

We cited the two techniques as examples, neither expressing nor implying that they were exclusive recommendations. In the electronics industry, it is not customary for novices to be given solo responsibility for reliability efforts; and most electronics engineers recognize the advantages and limitations of various experimental methods.

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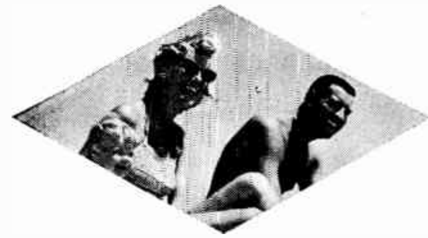

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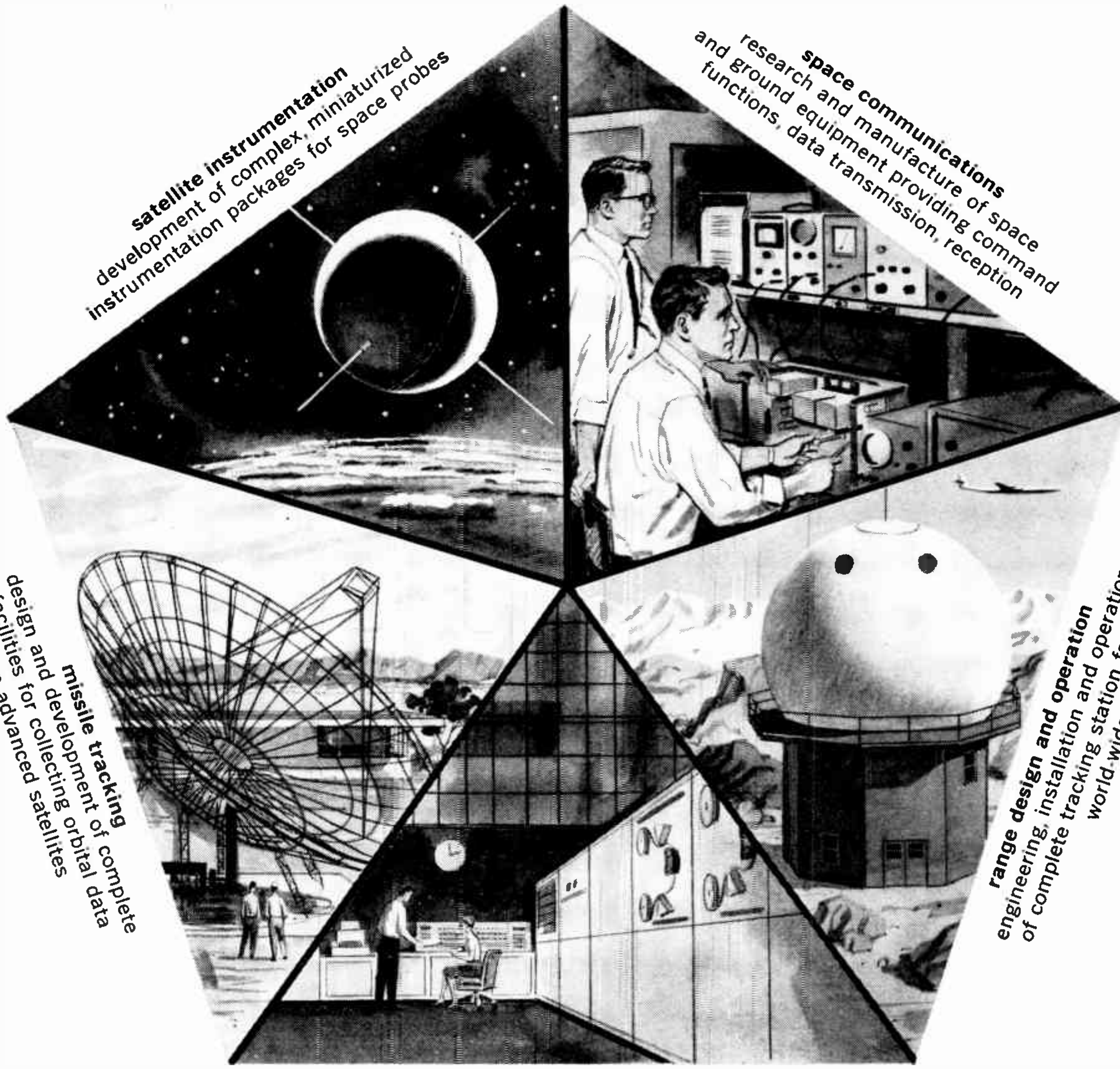

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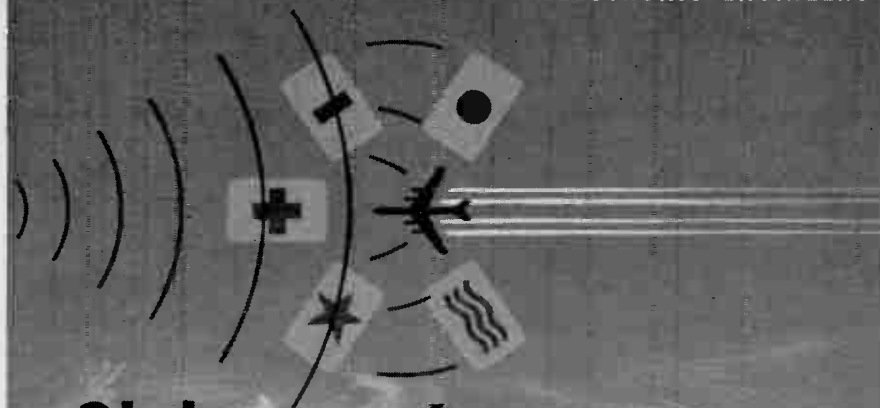

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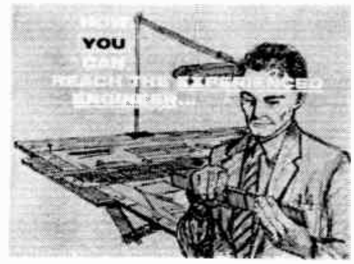

The top-flight engineers and technical personnel you want are at a premium. . . as this twelve page booklet points out. How you can reach and influence these men is the story told.

The booklet tells where to find the experienced engineer. It explains how you can make contact . . . channel and concentrate your employment advertising to just the men with the job qualifications you want. Included are testimonials from personnel men who use technical publications successfully . . . sample advertisements that got results . . . helpful hints to consider and pitfalls to avoid when you prepare your copy and layout for an Employment Opportunity advertisement.

Write for your free copy to:

V. C. Downey
Classified Advertising Division
McGraw-Hill Publishing Co., Inc.
P.O. Box 12
New York 36, New York

IMPORTANT NOTICE TO PHYSICISTS AND ELECTRONIC ENGINEERS:

RADAR AND COMMUNICATIONS SYSTEMS ENGINEERS
SERVO ENGINEERS
COMPUTER ENGINEERS (analog & digital)
ELECTRONIC PACKAGING ENGINEERS
FIELD SERVICE ENGINEERS
THERMO-CHEMISTS

DYNAMIC EXPANSION IN ELECTRONICS & AVIONICS:
Even greater impetus is being added to Emerson's dynamic long-range expansion program. Last year was the most successful in our history. In 1959 we are setting still higher records. Emerson's growth means excellent opportunity for your professional growth!

EMPHASIS ON SYSTEMS APPROACH:
We emphasize the systems approach which means Emerson engineers explore and contribute in many diversified areas. This climate of creative freedom has paid off in solid achievements. Our Electronics and Avionics Division is daily influencing the "state of the art" in fire control systems. Our engineers are meeting needs for further refinements in the development and production of both analog and digital computing and automatically programmed data processing systems. Transistorization and other solid state electronic applications are currently being applied to advanced airborne and ground based projects.

CURRENT PROJECTS AT EMERSON ELECTRIC:
B-58 fire control system, mortar locators, radar components and assemblies, servomechanisms, missiles and rockets, ground support equipment, microwave antennas, plus a host of other electronic devices for the space age.

CONSIDER THESE EMERSON BENEFITS:
- Excellent salaries
- Outstanding advancement opportunities
- Graduate and undergraduate education program at two highly-rated universities
- Beautiful, convenient suburban location
- Moving expenses to St. Louis fully paid
- Plus other top-level benefits

FOR UNUSUAL OPPORTUNITIES, CONTACT US AT ONCE:
If you feel your talents can be better utilized in assuming greater responsibility with accompanying long-range and immediate opportunities — you owe it to your future to contact us at once! Please write in confidence, including business and educational background and approximate salary requirements, to Mr. A. L. Depke.

YOUR FUTURE IS OUR BUSINESS!

Electronics and Avionics Division

EMERSON ELECTRIC

8100 W. Florissant • St. Louis 36, Mo.

SEARCHLIGHT SECTION
(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
PROPOSALS, $2.40 a line an insertion.
BOX NUMBERS count as one line additional in undisplayed ads.
DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

WANTED:

ALLEN-BRADLEY

RESISTORS
POTENTIOMETERS
CAPACITORS

ANY VALUES and TYPES

LEGRI S COMPANY

391 Riverdale Ave. Yonkers 5, N. Y.

U. S. Army Telephones EE-8 fully reconditioned. Suitable for intercommunication between 2 or more points. $35.00 for 2 telephones, including 100 ft. of wire and batteries. Additional wire 1¢ per ft. or $25.00 per mile. Write for free list on telephones. All shipments F.O.B. Simpson, Pa.

TELEPHONE ENGINEERING CO.
Dept. E-89 Simpson, Pa.

WANTED TO BUY
AN/TPS-10A Radar Set

New or used, in operating condition

Write: Purchasing Agent
University of Chicago
Chicago 37, Illinois

PROJECT WANTED

Small company in London, England, making transformers etc. up to about 5kva, and employing about 25 persons interested in project which could bring about their expansion.

BO-1963, Electronics
Class. Adv. Div., P. O. Box 12, N. Y. 36, N. Y.

MACHINERY WANTED

Tektronix Square Wave Generator #107; Tektronix Transistor Curve Tester #575; Hughes Memotron Cathode Ray Tube; Dumont 7YP—Cathode Ray Tube; Amperex 6688 or E1880F; 3'6" to 6' Squaring Shears; Minifon wire recorder; Stabilized Power Supply 300v at 1 amp.

W-2033, Electronics
Class. Adv. Div., P. O. Box 12, N. Y. 36, N. Y.

INDEX TO ADVERTISERS