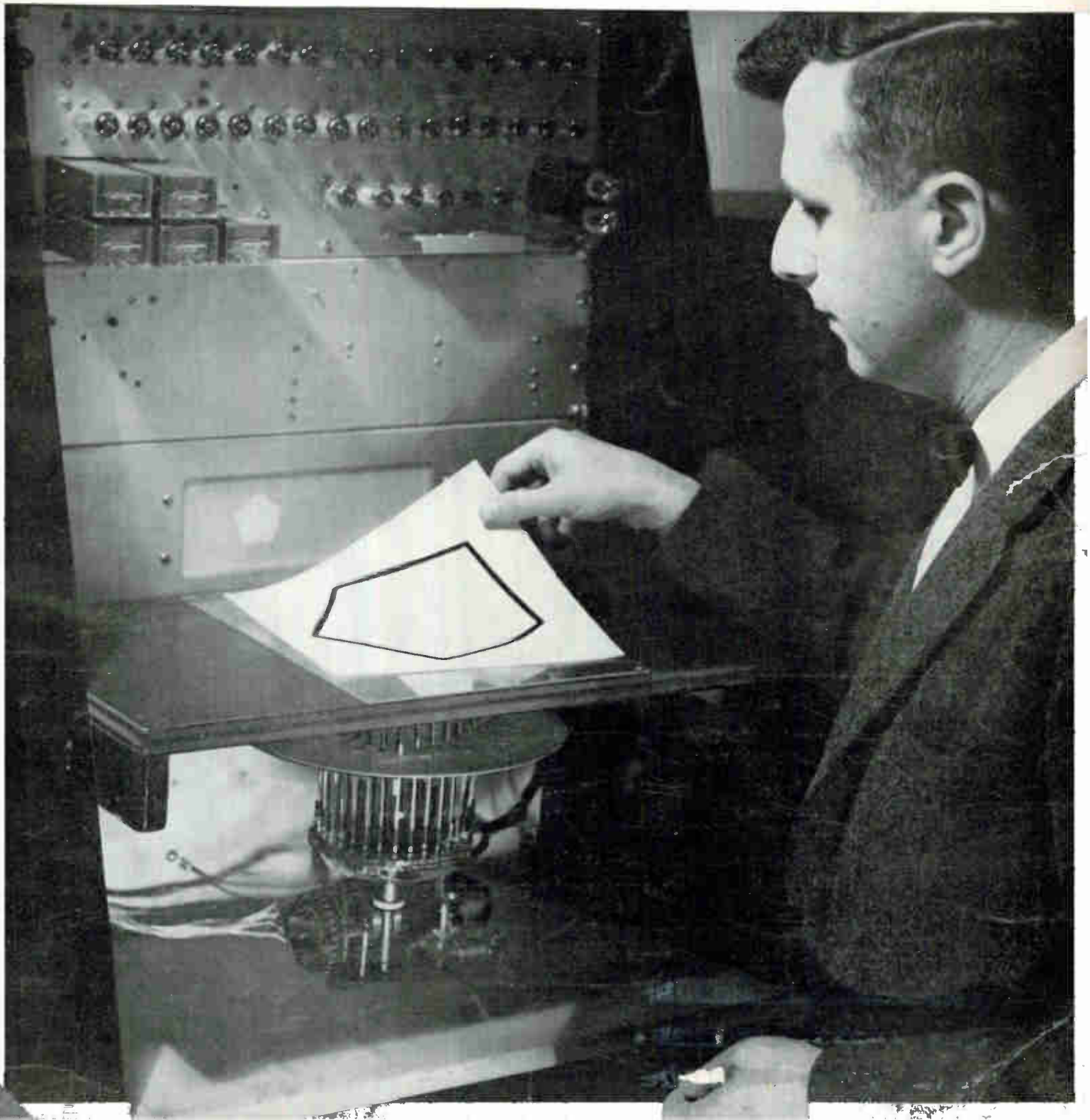
September 2, 1960

electronics

Dilating circular scanner using 32 small photocells recognizes opaque two-dimensional geometric figures independently of size, rotation, precision of drawing or positioning. *See p 39*

A McGraw-Hill Publication *75 Cents*



. . . for Tachometry and Slow-Motion Analysis of Machines and Electromechanical Devices

Intense, white light — 70 times brighter than previous model (4.2 million candlepower on low-speed range).

Short-duration light flash (1 to 6 μsec) "freezes" motion . . . practically eliminates blur . . . lets you clearly see details that are invisible with other commercial stroboscopes.

Long-throw beam reaches into machine innards — made possible by basic new flash tube developed exclusively for this instrument.

Measures speeds directly with $\pm 1\%$ accuracy up to 25,000 rpm . . . useful to at least 250,000 rpm.

Unique carrying case provides full enclosure for protection against damage and doubles as an adjustable stand for convenient bench use.

Pivoting lamp rotates 360° horizontally and 180° vertically.

One simplified dial and range control adjusts rate of flash — eliminates errors accidentally caused by reading wrong scale.

Type 1531-A STROBOTAC $260. ***Write for complete information.***

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

STROBOTAC: *A useful design and test aid for—*

September 2, 1960

electronics

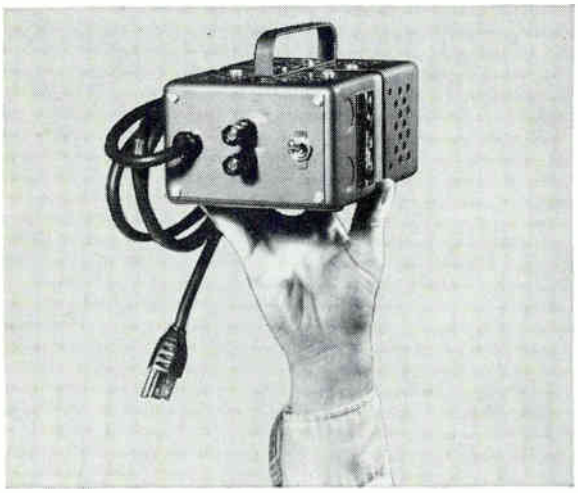
A McGraw-Hill Publication 75 Cents

BUSINESS

ENGINEERING

DEPARTMENTS

Take your voltage supply where you need it with Sola's portable sources of regulated voltage



Portable filament transformer insures stable test conditions

This static-magnetic voltage regulator, with capacity of 30va, provides a stabilized output of 6.3 volts, automatically and continuously regulated within ±1% despite line voltage swings between 95 and 130 volts.

Since no variants are introduced by line voltage dips or surges, your experimental and test equipment is given a consistent reference datum against which it can yield reliable data on other variables.

The unit provides a high degree of isolation between input and output. Simple, rugged design eliminates moving parts, replaceable parts, manual adjustments, routine inspection and maintenance.

Handy in the laboratory or at the shop bench, it plugs into any a-c wall or bench outlet, and provides an on-off switch and output jacks.

Write for Bulletin CVF

Portable Solavolt power supplies give regulated a-c and d-c voltage for laboratory and test work.

A-C and D-C Solavolts regulate output within ±1% for line voltage variations as great as ±15%, with a response time of 1.5 cycles or less.

Output of the a-c model is fully adjustable from 0 to 130 volts, with less than 3% total rms harmonic content. This makes it ideal for instrument calibration, testing, or any operation involving elements sensitive to wave shape.

The d-c model consists of a special type of Sola Constant Voltage Transformer, semiconductor rectifier and choke. Ripple voltage is held within 1% rms at full load.

Solavolts have no replaceable parts, require no routine maintenance. They are portable for bench use, or may be mounted on a standard 19-inch relay rack.

Write for Bulletin CVL/DCL

Portable Televolt improves performance of TV sets, radios, hi-fi, tape recorders

This static-magnetic voltage regulator improves television reception by correcting line voltage variations which often cause picture flicker and distortion. It also stabilizes voltage for improved performance of high-fidelity amplifiers, radios and tape recorders. The unit regulates within ±3% of nominal for input voltages between 95 and 130 volts, to give a nominal fixed output within the range of 115-120 volts. Requires no installation—merely plug it in and forget about it. The compact Televolt is automatically switched on or off by a relay whenever the equipment power switch is operated.

Write for Bulletin 7J-CVA

SOLA

SOLA ELECTRIC CO.

B P C

Sola Manufactures: Constant Voltage Transformers, Regulated DC Power Supplies, Constant Wattage Mercury Lamp Transformers and Fluorescent Lamp Ballasts

A Division of Basic Products Corporation

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DELAY LINES, INDUCTORS, FILTERS AND CHOKES...
ARNOLD IRON POWDER CORES CUT COSTS

Iron powder cores are commonly specified for such applications as delay lines (illustrated below), inductors, filters and filter chokes because of their inherent low cost. And Arnold cores are your logical choice, for the principal reasons of superior dependability and the wide selection available to you.

Arnold's overall magnetic knowledge, and unequalled facilities for manufacture and test, are of prime importance in assuring you a source of cores that are highly uniform, shipment after shipment. You'll find them dependable, not only in permeability and resultant inductance at high frequencies, but in high mechanical strength and dimensional accuracy as well.

The Arnold line also offers a wider range of shapes and sizes of iron powder cores for your selection than any other one brand on the market. It includes bobbin cores, cups, toroids, plain, sleeve and hollow cores, threaded cores and insert cores, etc. Facilities for special cores to your order. Ask for new Bulletin PC-109A. ● Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Illinois.*

ADDRESS DEPT. E-9

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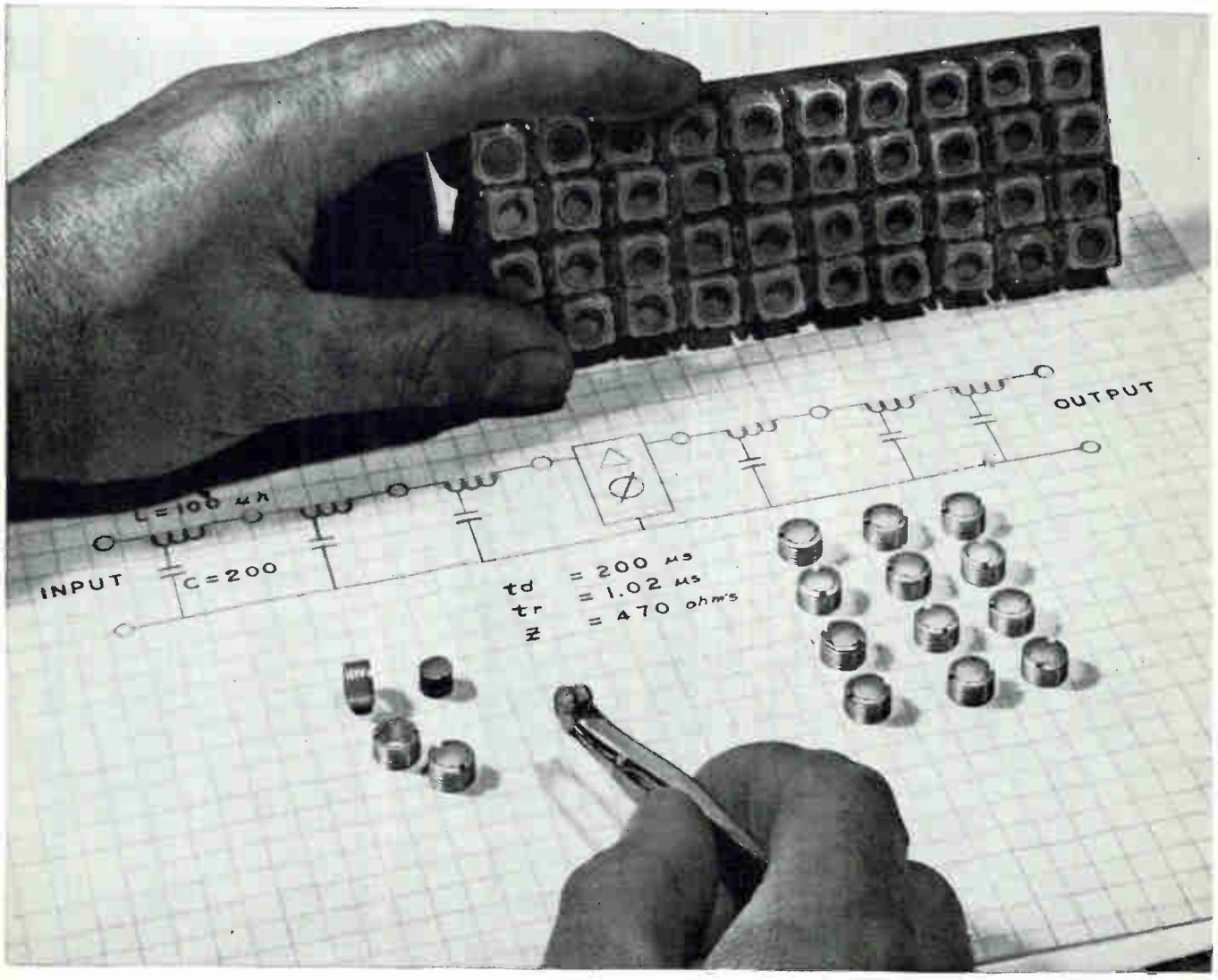
SPECIALISTS in MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES • *Find them FAST in the YELLOW PAGES*

2284



electronics

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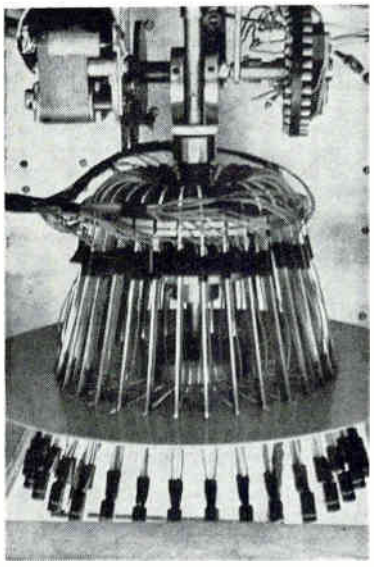
CROSSTALK



PATTERN RECOGNITION. Line-drawing pattern recognizer described on p 39 by L. D. Harmon of Bell Telephone Labs employs the scanning photocell arrangement shown in the accompanying photograph. The photocells are attached to the free ends of the rods and face upward. When identification of a figure is requested, the cells are actuated by the motor-driven mechanism and move along radial paths in a circle of variable radius.

THE COMMUNICATIONS INDUSTRY is on the threshold of a new stage that will revolutionize communications methods — and therefore the equipment used—and that will meet growing demands for more communications traffic.

This evolutionary landmark is the communications satellite—passive and active. The satellite culminates progress in hundreds of areas in the field of electronics.

The latest development is Army's active repeater communications satellite Courier.

Associate Editor Mason reported details of Courier's ground system on July 22 (p 38). Now, for a comprehensive rundown on the satellite payload, see Mason's article on p 26.

Coming In Our September 9 Issue

ULTRASONIC VELOCIMETER. One tool coming into increasing use in oceanography is the velocimeter. As brought out in a recent ELECTRONICS Special Report (p 53, July 29), sound velocity profiles in ocean water can now be measured to depths of 16,000 ft at accuracies better than 1 in 15,000.

In our next issue, W. D. Wilson and D. D. Taylor of U. S. Naval Ordnance Laboratory describe an ultrasonic velocimeter capable of measuring directly the velocity of sound for the conditions of temperature, pressure and salinity found in the oceans. The instrument also has many industrial applications. One is quality control. Similar instrumentation has also been used to measure the longitudinal and shear velocities in solids.

FURTHERMORE. Other interesting material appearing next week includes: The design of a transistorized tv camera by D. Carreon of Blonder-Tongue Electronics; a variable-program triggering source by B. E. Bourne of the National Research Council; use of reflex klystrons as millimeter-wave detectors by K. Ishii of Marquette University; predicting and suppressing interference by P. B. Wilson, Jr., of Interference Testing and Research Laboratory; and a digital time code and data correlation system by V. B. Morris, Jr., of Westinghouse.

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HIGH IMPEDANCE.

HIGH GAIN

LOW DRAIN

LONG LIFE

You Get Them All With The Raytheon CK6611 and CK6612

There's no need to compromise when you design Raytheon CK6611 or CK6612 into your RF stages. These fully shielded, subminiature pentodes are specially designed for battery-operated communication applications where high input impedance and maximum gain along with low filament drain are required.

Military specification approval and Raytheon's intensive quality control program assure the ability of both types to meet and surpass vibration, shock, fatigue, and life test requirements. Average life expectancy, for example, is in excess of 5,000 hours. Excellent uniformity of characteristics and availability are the result of Raytheon's special production facilities and long experience in manufacturing these types.

For technical data on the CK6611 and CK6612 please write to: Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

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CHARACTERISTICS AND TYPICAL OPERATION — CLASS A_1 AMPLIFIER

	Filament Voltage (dc)	Filament Current	Plate Voltage	Grid #2 Voltage	Grid #1 Voltage	Transconductance
CK6611	1.25 volts	20 mA	30 volts	30 volts	0*	1,000 μmhos
CK6612	1.25 volts	80 mA	30 volts	30 volts	0**	3,000 μmhos

*Grid Resistor = 5 megohms **Grid Resistor = 2 megohms

RAYTHEON

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

CIRCLE 5 ON READ

COMMENT

Electronics Probes Nature

(Ref.: your Special Report "Electronics Probes Nature," p 53, July 29 . . .)

The subject matter is especially timely, well presented, and should be of particular interest to a rather large number of laymen interested in scientific matters.

I am especially impressed with the sections on the Earth and the oceans. These two features more directly concern Coast & Geodetic Survey operations and would therefore be of more interest to members of this bureau. The sections on space, our atmosphere and living matter are equally effective, however, in rounding out the full theme of your study.

I am glad that the Coast & Geodetic Survey was able to contribute special information that you found useful in developing your subjects. I should like to give this paper as much attention as possible in the bureau and also in our field activities. . .

RAdm H. Arnold Karo
U. S. Coast & Geodetic Survey
Washington, D. C.

I have read the article "Electronics Probes Nature," and have been impressed with its completeness and the neat way in which it fills a bad gap in the existing literature on space and geophysical research. It is quite apparent that you went to great effort in searching out the many sound sources of information used as background for the article.

We have received a good deal of mail from members of the electronics profession as a result of references to us included in your article. This suggests that your article received wide attention, and turned on many lights in places where people had not known what was going on about the world.

I hope we will see more articles of the same calibre.

F. D. Drake
National Radio Astronomy Observatory
Green Bank, W. Va.

I think your special section is excellent: To get the ambitious scope of your subject matter in 30 pages and at the same time keep it lively and attractive must have been a staggering job. But you have certainly succeeded. In the space section I can judge, and it is undoubtedly true in the others, that your selection of what to discuss and what to omit has been particularly apt to indicate the full range of the topic.

Congratulations on a very difficult job very well done.

E. R. Spangler
Space Technology Laboratories
Los Angeles

I found your July 29 article "Electronics Probes Nature" both interesting and informative, an excellent survey of the field.

In the section on the Earth, however, the nuclear magnetism log for oil-well surveying was mentioned as a Varian Associates development. Preliminary experiments were carried out independently by Varian Associates and California Research Corp., the Varian work being sponsored by Byron Jackson Co. Since then, a cooperative research program between Byron Jackson division of Borg-Warner Corp. and the California Research Corp. led to the development of the logging system.

The design of the first nuclear magnetism log tool was carried out largely by the Roy C. Ingersoll research center of the Borg-Warner Corp. Further development is being done by Byron Jackson division . . .

Donald H. Ward
Borg-Warner Corp.
Des Plaines, Ill.

Plasma Studies

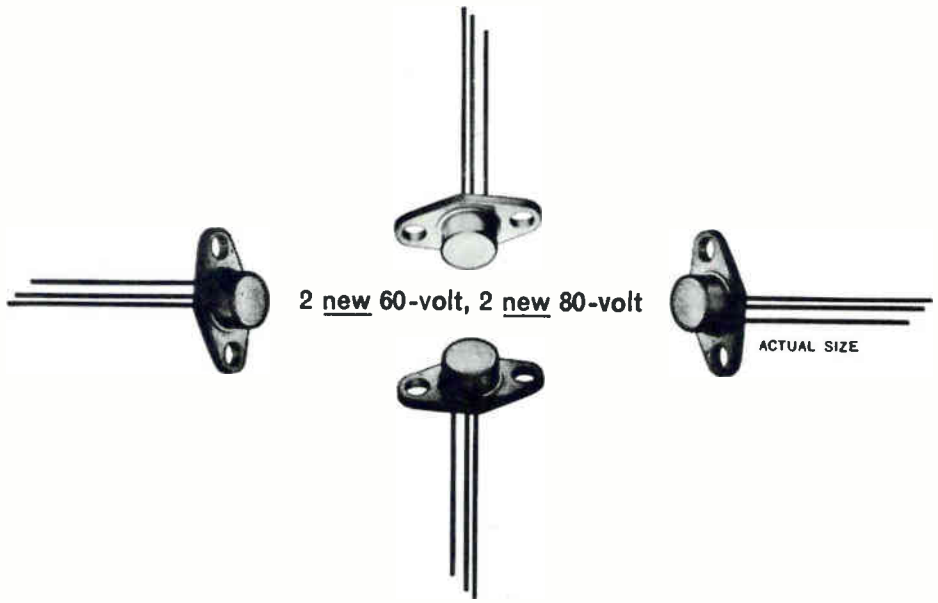
(Re: "Plasma Studies May Aid Space Communications," Research and Development, p 70, Aug 5) . . .

I notice that you have inserted captions for all the graphs. Unfortunately the caption for Fig. 3 is erroneous as there is neither left-hand wave nor right-hand wave in the presence of transverse magnetic fields; only a linearly polarized wave is transmitted . . .

Henri Hodara
Hallicrafters Co.
Chicago

We goofed. Sorry.

4 new miniature DELCO POWER TRANSISTORS



NOW, FROM DELCO RADIO, A COMPLETE LINE OF SMALL, HIGH-POWER TRANSISTORS!

	2N1172	2N1611	2N1612	2N1609	2N1610
V_{CB}	40	60	60	80	80
V_{EBO}	20	20	20	40	40
V_{CEO}	30	40	40	60	60
I_C	1.5 A	1.5 A	1.5 A	1.5 A	1.5 A
I_{CO}	200 μ a	100 μ a	100 μ a	100 μ a	100 μ a
H_{FE}	30/90	30/75	50/125	30/75	50/125
V_{Sat}	1.0 V	1.0 V	0.6 V	1.0 V	0.6 V

The four new Delco transistors, plus the 2N1172 40-volt model, offer highly reliable operation in a new range of applications where space and weight are restricting factors.

Designed primarily for driver applications, Delco's versatile new transistors are also excellent for amplifiers, voltage regulators, Servo amplifiers, miniature power supplies, ultra-low frequency communications, citizens' radio equipment and other uses where substantial power output in a small package (TO 37) is required.

Special Features of Delco's Four New Transistors: Two gain ranges. Can be used on systems up to 24 volts. Can be mounted with the leads up or down with the same low thermal resistance of 10° C/W. Dissipation up to 2 watts at a mounting base temperature of 75°C.

Available in volume production. Write for full engineering data.

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DEPENDABILITY
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With hp ELECTRONIC COUNTERS you are SURE

525A Frequency Converter

525B Frequency Converter

526A Video Amplifier

526B Time Interval Unit

526C Period Multiplier

hp 524C/CR PRECISION ELECTRONIC COUNTER

New $3/10^8$ stability • Big, bright, in-line readout
Covers 10 cps to 18 KMC*
Utmost flexibility from versatile plug-ins

Automatically, directly, instantaneously, without tedious calculation or interpolation, Model 524C/CR reads frequencies to 10.1 MC directly, to 220 MC with plug-ins, to 18 KMC with external accessories*. The instrument also measures time interval 1 μsec to 100 days or period 0 cps to 100 KC. Maximum resolution is 0.1 μsec; stability $3/10^8$ short term and $5/10^8$ per week.

One or the 524's most helpful features is its plug-in design. You do not need to pay now for circuitry you can't use now. Just order the measuring capability you need now — later add other versatile plug-ins to triple and quadruple the daily utility of your 524.

Five highly useful plug-ins are offered. hp 525A Frequency Converter, $250.00, extends frequency range to 100 MC. hp 525B Frequency Converter, $250.00, further extends the frequency coverage to 220 MC. hp 526A Video Amplifier, $175.00, increases sensitivity to 10 mv. hp 526B Time Interval Unit, $175.00, for time interval measurements from 1 μsec to 10^7 sec. hp 526C Period Multiplier, $225.00, increases period measuring accuracy.

Other important features of hp 524A and plug-ins include variable display time, automatic count reset, repetitive action, illuminated automatic decimal. The instrument features high sensitivity, high impedance and rugged reliability.

hp 524C (cabinet) $2,300.00
hp 524CR (rack mount) $2,275.00

hp 524D/DR ELECTRONIC COUNTER

For engineers preferring eight-place neon columnar readout Models 524D/DR are offered. These instruments are electrically similar to 524C/CR, but are priced slightly lower. hp 524D (cabinet) $2,150.00; hp 524DR (rack mount) $2,125.00.

*with hp 540B Transfer Oscillator and hp P932A Waveguide Mixer.

# of accuracy, dependability, value and versatility... yet you buy only the instrumentation you need

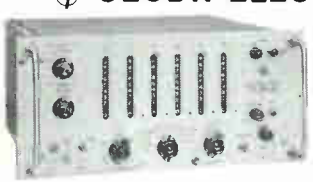
Counters—time-tested standard of the industry for frequency, period and time interval measuring

523CR ELECTRONIC COUNTER

New 0.1 v sensitivity
Improved circuitry prevents triggering by unwanted signals, noise
Covers 10 cps to 1.2 MC
Big, bright in-line readout

Here is broad versatility, high accuracy and integrated compactness in one moderately-priced instrument. In addition to its frequency measuring capabilities, Model 523C measures time interval 1 μsec to 10^6 sec (278 hours) and period 0.00001 cps to 100 KC. Stability is 2/1,000,000 per week, readout is direct in numbers visible under any ambient light condition. Results appear in seconds, msec, μsec or KC with automatic decimal. Display time is variable 0.1 sec to 10 seconds or "Infinite". 5 gate times, trigger output during time interval measurement for modulating an oscilloscope Z-axis. 523CR, (rack mount) $1,485.00.

523DR ELECTRONIC COUNTER



Electrically identical to 523CR, Model 524DR is available for engineers preferring columnar readout on neon indicators. 523DR, $1,285.00.

See your representative or write direct for complete information and demonstration of any electronic counter

HEWLETT-PACKARD COMPANY

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Low cost, "low" frequency laboratory and industrial counters

521 INDUSTRIAL COUNTERS

Five Model 521 Counters are offered, all broadly useful in measuring frequency, random events per unit of time; and, with transducers, speed, rps, rpm, weight, pressure, temperature, etc. Readings are direct, display time is variable or "hold"; frequency range of four instruments is 1 cps to 120 KC; the fifth instrument measures to 1.2 MC. Accuracy is ± 1 count ± stability of the power line or crystal time base; minimum input is 0.2 v rms, input attenuators adjust sensitivity from 0.2 to 100 v rms. Input impedance is 1 megohm with a 50 μμf shunt. Two or three gate times depending on model, and "manual" gate. Two models with big, bright, in-line numeric readout (pictured) three with columnar neon display. Prices, $475.00 to $880.00. Cabinet and rack models available.

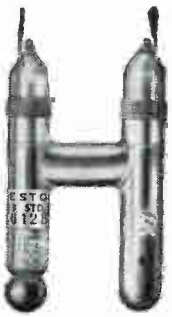
522B/BR ELECTRONIC COUNTER

One of the most widely used of all counters. Measures frequency 10 cps to 120 KC, period 0.00001 cps to 10 KC, time interval 10 μsec to 10^5 seconds. Reads direct in cps, KC, seconds, milliseconds. Time base stability 1/100,000 per week; counts automatically reset, action repetitive. Applications include measurement of production line quantities, nuclear radiation, power line frequencies, very low frequencies, and with transducers, rps and rpm, weight, pressure, temperature, other physical quantities, etc. 522B (cabinet) $915.00; 522BR (rack mount) $900.00.

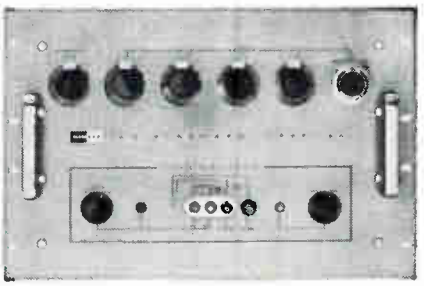
ON SPECIAL ORDER

Remote readout available for in-line counters.

Models 521 and 522 may be provided with frequency coverage to 220 KC.



This is a DC standard cell



This is a KIN TEL 601A AC voltage standard, the nearest AC equivalent

The 601A produces 1 to 501 volts, at 60, 400 or 1000 cps. Voltage accuracy is ± 0.1%. Frequency accuracy is ± 1.0%. Harmonic distortion is less than 0.3%. Power output capability is 5 amps up to 5 volts and 25 watts above. The output is completely floating and isolated from AC line and chassis ground.

If you calibrate high-accuracy AC measuring instruments, or design servo or gyro equipment, or evaluate magnetic properties, you probably need this new kind of voltage standard.

For more information call or write us direct, or call your nearest KIN TEL representative.

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KIN TEL manufactures electronic instruments for measurement and control, and closed circuit TV. Representatives in all major cities. Write for detailed literature or demonstration.

ELECTRONICS NEWSLETTER

What's Wage Scale In Tube Business?

THAT'S WHAT a special committee of EIA is getting ready to thrash out with the Labor Dept. It's leading up to a nation-wide Walsh-Healy minimum wage determination. Labor Dept. wants national pay scales; EIA wants regional rates.

Labor Dept. says wage rates were $1.42 an hour for tubes, $1.35 for semiconductors; EIA says rates are $1.36 and $1.31; labor unions say $1.52 prevails.

Soviets Predict Tv Stations in Satellites

FLUSHED WITH SUCCESS of their orbiting doghouse last month, Soviet scientists are predicting television stations in satellites to cover large areas of the globe.

The space ship recovered from orbit used three radio channels: for telemetering, televising activity of animals in cabin and remote control.

Telemetry channel carried measurements of cabin temperature, pressure and humidity; also pulse, respiration, blood pressure, electrocardiograms, heart tones and movement of animals. The two dogs had carotid artery grafted to skin for blood pressure measurement, had ekg electrodes inserted in skin.

Control channel sent signals to braking and retrorocket controls.

Television pictures were recorded on film and synchronized with telemetry data. Glass transmitting tubes were used in vehicles.

Orbiting measurements by computers helped space ship and capsule land separately within 10 Km of intended touchdown. Reportedly communication was maintained with ship even during reentry.

Will British Tv Adopt European Standards?

UNVEILED at a private tv exhibition now being staged by Pye Ltd., Cambridge, England is a combined 405 and 625-line tv receiver. It was designed with the thought the British may someday adopt European tv standards. A government advisory committee recommended this. The vhf/uhf receiver contains separate r-f units, picks up 51 television channels. Also shown was a 14-in. portable with rechargeable batteries. This receiver is completely transistorized, is priced at $300.

Thermionic Converters Ready for Market

LAST WEEK at Wescon, General Electric showed two production model thermionic converters. The Z-5386 will be ready for market in October. It's a close-space vacuum device delivering one watt with an efficiency of 2.5 percent. Optimum operating temperature of the 5-SQ-CN cathode is 1,100-1,150 C and is three ounces. Price will be about $300, operating life about 100 hours. GE expects to raise the power density of later models to 2 watts per sq cm.

Present facilities can turn out about 60 units a week. One problem solved was assurance of constant ½-mil spacing between cathode and anode with temperature changes, shock and vibration.

Second model is a vapor thermionic converter using cesium vapor in a tubelike reservoir separating cathode from anode. Efficiency of 15 percent, power density of 7.5 watts per sq cm at a cathode temperature of 1,800 C has been achieved in the lab models. Future units may reach 20 watts per sq cm.

Applications seen are power sources for satellites and space travel, temperature monitoring and military uses where power sources must be concealed.

Stockholm Meeting Stresses Space Advances

MICROWAVES beamed along lines of earth's magnetic field may open electromagnetic window through plasma sheath around space vehicles reentering atmosphere. So Henri Hodara of Hallicrafters told 11th annual International Astronautical Congress in Stockholm recently. Radio communications are temporarily blocked when air friction generates insulating sheath of charged particles.

Nuclear-thermionic-ionic system permitting deep-space vehicle to operate under full thrust for two years, long enough to go to Jupiter, was described by Lockheed's R. H. Olds. Small nuclear reactors would supply heat for direct conversion to electricity which would, in turn, power cesium vapor ion beam motors.

We need a world-wide satellite tracking system to monitor the coming traffic jam of some 1,000 man-made orbiting objects ten years from now, says P. R. Dax of Westinghouse. A network of seven powerful radar stations could feed a central computer system to do this.

Tv X-Ray Emission Findings Disclosed

EFFECTS ON X-RAY emission from home television receivers recently were studied by National Bureau of Standard's committee on radiation protection and measurements.

Genetically, even sources of minute radiation are important if they affect a large percentage of the population. The committee recommends the exposure dose rate at any readily accessible point 5 cm from the receiver surface shall not normally exceed 0.5 mr per hour.

Most receivers meet this requirement with a high safety factor, no additional shielding will be needed. The recommended limit will insure that future sets, operating at higher voltages, do not present a hazard.

Defense Dept. Spikes Tv Spectrum Swap

FLAT REJECTION of two plans by Federal Communications Commission to swap some uhf-tv space for some government allocations leads to predictions there will not be any counter-proposals soon. FCC had suggested an exchange of some uhf slots for frequencies between 222 and 450 Mc back in March and again in April. The Office of Civil and Defense Mobilization last month turned thumbs down. Now OCDM adds that the exchange would weaken national defense.

GENERAL INSTRUMENT | silicon rectifiers

all the available JAN TYPES to meet MIL-E-1 specifications

Maximum Values for GENERAL INSTRUMENT Military Type Silicon Rectifiers

Type No.	Peak Reverse Voltage (VDC)	DC Output Current (MA) Av. @ 135° C. Case Temp.	@ 25° C. Ambient	@ 150° C. Ambient	Maximum Reverse Current (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
1N253	100	1000	—	—	0.1*	Stud	1024A
1N254	200	400	—	—	0.1*	Stud	989B
1N255	400	400	—	—	0.15*	Stud	990B
1N256	600	200	—	—	0.25*	Stud	991B
1N538	200	—	750	250	0.350†	Axial Lead	1084A
1N540	400	—	750	250	0.350†	Axial Lead	1085A
1N547	600	—	750	250	0.350†	Axial Lead	1083A

*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current; case temperature 135° C.

†Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150° C. ambients.

Without qualification, these rectifiers are the finest available today, designed and manufactured to meet stringent government requirements and General Instrument's exceedingly high quality control standards.

General Instrument also makes a complete line of JAN type subminiature glass encapsulated germanium and silicon diodes . . . and all are offered in volume quantities for *on time delivery* at prices that reflect our years of production experience. Data sheets on any of these diodes or rectifiers are available upon request.

Semiconductor Division

GENERAL INSTRUMENT CORPORATION

65 Gouverneur Street, Newark 4, N. J.

Midwest office: 5249 West Diversey Ave., Chicago 39

Western office: 11982 Wilshire Blvd., Los Angeles 25

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, SEMICONDUCTOR DIVISION, RADIO RECEPTOR COMPANY, INC., THE HARRIS TRANSDUCER CORPORATION, MICAMOLD ELECTRONICS MANUFACTURING CORPORATION AND GENERAL INSTRUMENT — F. W. SICKLES OF CANADA LTD. (SUBSIDIARIES)

WASHINGTON OUTLOOK

LATEST WORD on EIA's plea for import curbs on Japanese transistors is that the Office of Civil and Defense Mobilization expects to rule on the case late this month or in October. The odds are still overwhelmingly against the EIA petition for relief.

The Association requested an investigation of imports of transistors and other semiconductor devices last September. The request was made under section 8 of the 1958 *Trade Agreements Act. This law provides for import restrictions on products that OCDM rules are needed for defense mobilization and are being imported in quantities that threaten national security.*

So far about 12 industries have petitioned for relief under the law's provisions. About half the applications were later withdrawn. Of the other cases, which underwent prolonged investigation, the politically potent domestic oil producers have been the only successful petitioners.

THE COMMERCE DEPT. reports that Japanese electronic production is running 53 percent ahead of last year. During January-March 1960, the value of Japanese electronic output amounted to $282.1 million. At an annual seasonally adjusted rate, this comes to $1.4 billion, compared with $936 million of production in 1959.

Biggest percentage gain in production was racked up by semiconductors. Output rose 67 *percent to* $19.1 *million in the first quarter. Next fastest growing electronic product group was electron tubes, up* 63 *percent to* $44.5 *million.*

Manufacture of consumer electronic products increased from $99 million in January-March 1959 to $158.5 million for the same period this year. Production was down in television broadcasting apparatus and mobile communications equipment.

THE AIR FORCE has revamped R&D management of satellite systems, reflecting the service's plan to give what the Pentagon calls increased emphasis to satellite projects. A vice commander for satellite systems has been named to ARDC's Ballistic Missile Div. at Inglewood, Calif., Brig. Gen. Robert E. Greer.

Greer's appointment means more strongly centralized direction of Samos, Midas, Discoverer and advanced satellite projects.

Washington insiders say the Air Force is pushing hard for greater responsibilities in the man-in-space program. The Air Force is said to be impatient about progress in NASA's project Mercury, believes it could place a man in orbit more quickly and at less cost if it were given the green light with additional funds and authority.

THE NAVY is pushing work on a study to reduce crew requirements on surface combat vessels by increased use of electronic data processing and automation equipment to simplify and centralize shipboard operations.

The work is being carried out under project SURIC (Surface Ship Integrated Control). Sperry Rand has been awarded a $260,000 *contract to carry out the study. Gibbs and Cox, Inc., naval architect firm, is also participating in the project. Destroyer escorts would be the major beneficiary of the study—particularly for antisubmarine operations.*

THE OFFICE OF NAVAL RESEARCH is equipping homing pigeons with tiny radio transmitters to study navigational secrets useful to military aircraft. Transmitters weighing less than 2 oz are attached to the pigeons with a light harness. Signals are emitted over a range of 20 miles, are picked up by receivers on the ground, tracking the birds to their destination every inch of the way. Says ONR: Over a period of weeks, deviations in routes, speed and so on may well reveal how homing pigeons are able to detect, identify and navigate toward a given target.

202A FUNCTION GENERATOR—Down to 0.008 cps; transient-free!

Uses: Electrical simulation of mechanical phenomena, vibration studies, servo research and testing, medical research, geophysical problems, subsonic and audio testing.

Advantages: No switching transients, continuously variable 0.008 to 1,200 cps range, 30 v output peak-to-peak constant, hum less than 0.05%, square, triangular or electronically synthesized sine waves, 1% stability, 0.2 db response, less than 1% distortion (sine waves) on all but x 100 range.

Price: $525.00 (cabinet model), $510.00 (rack mount).

650A TEST OSCILLATOR—Flat within 1 db, 10 cps to 10 MC!

Uses: Testing TV amplifiers or wide-band systems, measuring filter transmission characteristics and tuned circuit response, determining receiver alignment, making telephone carrier and bridge measurements

Advantages: No zero set, no adjustments during operation, output voltage range 30 μv to 3 v, less than 1% distortion, 20 cps to 100 KC; less than 2%, 100 KC to 1 MC; approx. 5% at 10 MC. Hum less than 0.5%, output voltage attenuator, self-contained voltmeter, 2% to 3% stability.

Price: $490.00 (cabinet model), $475.00 (rack mount).

Easy to operate, highly stable, wide range

PRECISION OSCILLATORS

hp precision oscillators perform a wide variety of audio, video, and low frequency tests. They offer the outstanding advantages of flexibility and broad usefulness at moderate cost. Employing the hp pioneered RC resistance capacity circuit, the units combine accuracy and reliability with ease of operation and minimum adjustment.

205AG AUDIO SIGNAL GENERATOR—Six instruments in one; 20 cps to 20 KC!

Uses: Measure amplifier gain and network frequency response, measure broadcast transmitter audio and loudspeaker response, drive bridges, use in production testing or as precision source for voltages. Monitors oscillator output, measures output of device under test.

Advantages: Self-contained instrument, no auxiliary equipment needed. 5 watts output, ± 1 db response, less than 1% distortion, hum more than 60 db down, no zero setting, output and input meters read v and dbm; four output impedances.

Price: $500.00 (cabinet model), $485.00 (rack mount).

206A AUDIO SIGNAL GENERATOR—Less than 0.1% distortion; 20 cps to 20 KC!

Uses: Convenient, precision audio voltage source; checks FM transmitter response, makes high quality, high fidelity amplifier tests, transmission measurements.

Advantages: Continuously variable audio frequency voltage, (output 15 dbm) 0.2 db response, hum 75 db down, 2% frequency accuracy, less than 0.1% distortion. 111 db attenuator with 0.1 db steps

Price: $750.00 (cabinet model), $735.00 (rack mount).

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

hp pioneered the world-famous resistance-capacity oscillator circuit

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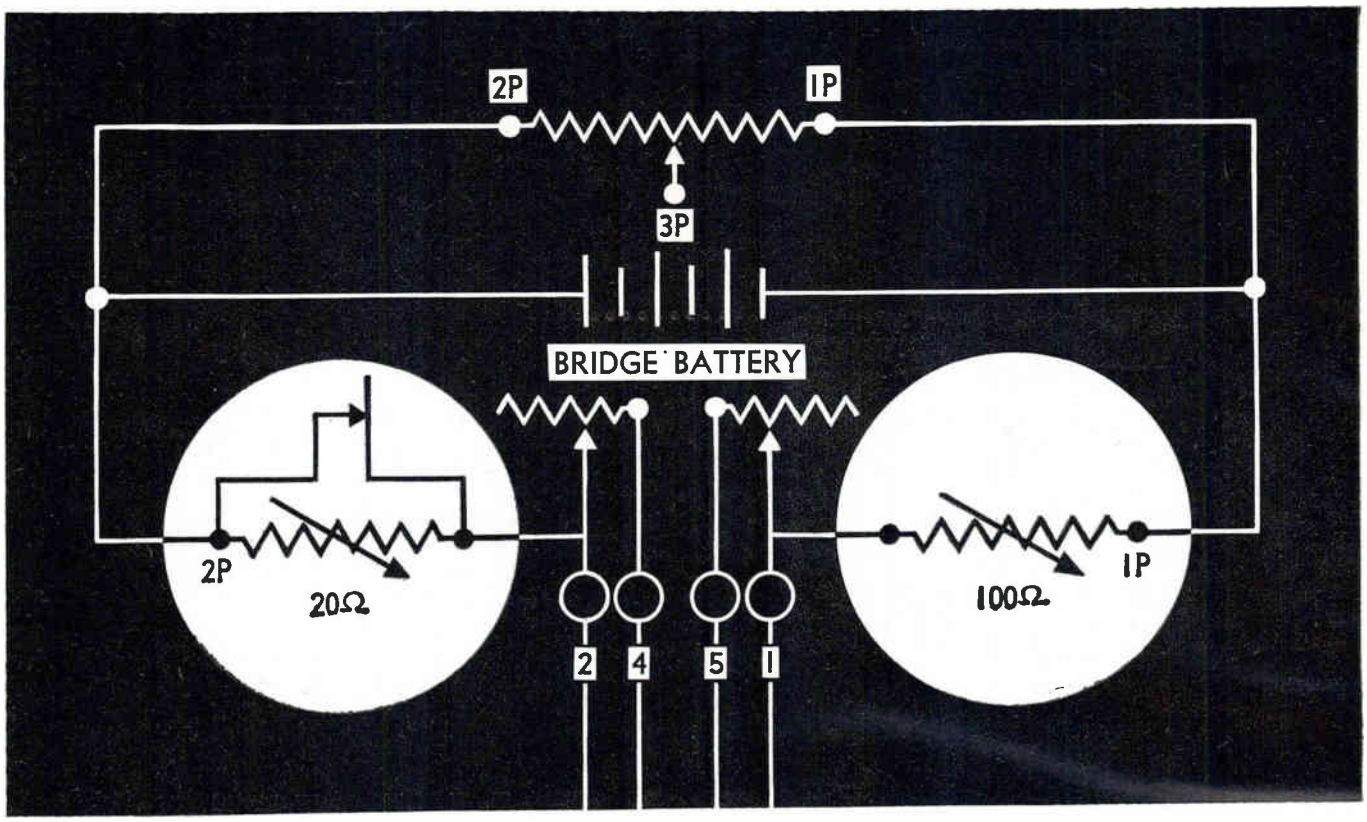
Field representatives in all principal areas

6428



Eliminate Trimming Resistor Problems with Borg Absolute-Linearity Micropots

The above schematic illustrates how many original equipment manufacturers are eliminating trimming networks from circuits by replacing conventional potentiometers with Borg 900 Series *Absolute Linearity* Micropots. The Borg 900 Series eliminates electrical overhang . . . trimming becomes unnecessary. A further advantage is accomplished by setting the 900 Series mechanical stop to a phasing point. Field replacement of the primary potentiometer now becomes a simple mechanical process of attaching leads and phasing from the preset stop. This means you do not have to replace trimmers or resistors each time you replace the primary potentiometer. The design advantages and cost savings brought about by the *absolute linearity* of the Borg 900 Series can now be fully appreciated. With 900 Micropots, your equipment will afford greater accuracy, reliability and practicality because trimming and adjustments with auxiliary resistors are no longer required. Trained assembly personnel can now be concentrated on more profitable areas of production. Many other 900 Series advantages can help solve your potentiometer problems as they are now doing in all types of industry. The 900 Series is available in ten and three turn models with several optional features. Contact your Borg technical representative or let us put him in touch with you. *Ask for data sheets BED-A128 and BED-A129.*

BORG®

BORG EQUIPMENT DIVISION

Amphenol-Borg Electronics Corporation
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Micropot Potentiometers • Turns-Counting Microdials • Sub-Fractional Horsepower Motors • Frequency and Time Standards

CIRCLE 17 ON READER SERVICE CARD→

ELECTRON TUBE NEWS ...from SYLVANIA

NEW!

10-PIN TUBES in T-6½ envelope offer

• CIRCUIT ECONOMIES • IMPROVED PERFORMANCE • NEW MULTI-UNIT COMBINATIONS

Sylvania adds a 10th pin to the center of the standard 9-pin miniature circle of the T-6½ envelope . . . offering dramatic circuit advantages with a minimum of circuit redesign.

Now, with Sylvania 10-PIN TUBES, new multi-unit combinations can be contained efficiently in one envelope . . . offering potential savings in circuitry, reducing space requirements. Tube elements can be tied separately . . . improving interelement isolation. The 10th pin provides sturdy support for improved shielding between tube units. Now, 10-PIN design can offer tubes with inherently low input capacitance-high gain. Note, too, that sockets designed for 10-PIN TUBES can accept conventional 9-pin miniature tubes.

Specific examples of 10-PIN TUBES include a new medium-mu triple-triode designed to provide the combined function of rf amplifier, oscillator and mixer for VHF. This unique triple-triode features separately terminated cathodes and heater. Cathodes, therefore, can be connected to "ground" without grounding heaters—enabling better tube placement in series string arrangement.

Design around SYLVANIA 10-PIN TUBES

A further 10-PIN TUBE development is a new high-performance double tetrode in a T-6½ bulb. It provides small size, big performance as a combination rf amplifier, oscillator-mixer. Additional types will include a dual-pentode, triode-pentode and a new sextuple-triode.

Contact your Sylvania Sales Engineer for complete information. He will gladly work with you on the individual tube requirements of your design.

NOW! SYLVANIA-6146 SYLVANIA-6883 SYLVANIA-6159

All three beam power pentodes are manufactured and tested to exacting Sylvania standards for highest quality. They are designed for reliable service as an af power amplifier and modulator, rf power amplifier and oscillator. Maximum plate dissipation is 25 watts (ICAS). They are identical in electrical characteristics except for heater ratings: Sylvania-6146 has a 6.3V heater; Sylvania-6883 — 12.6V; Sylvania-6159 — 26.5V. Ask your Sylvania Sales Engineer for complete data and delivery information.

Sarong Cathode significantly minimizes plate-to-cathode arcing. Surface of *Sarong* is virtually free of "peaks and valleys," provides uniform spacing between cathode and plate.

Sarong Cathode eliminates "hot spots." Control of density of *Sarong* coating assures uniform temperature and emission over the entire cathode surface.

NEW! SARONG CATHODE

extends life, improves reliability of

SYLVANIA-6AU4-GTA, 6AX4-GTA

Sylvania *Sarong Cathode* prolongs service, increases performance of two highly popular TV damper tubes. *Sarong Cathode* minimizes plate-to-cathode arcing. *Sarong* eliminates "hot spots," increases stability. This vital development plus individual tube-type improvements such as—the use of "pigtail" heater welded firmly to the stem lead in the 6AU4-GTA, the use of laminated plate material for strength and heat dissipation in the 6AX4-GTA—combine to minimize possibility of early-hour field failures. Your Sylvania Sales Engineer will gladly give you complete information.

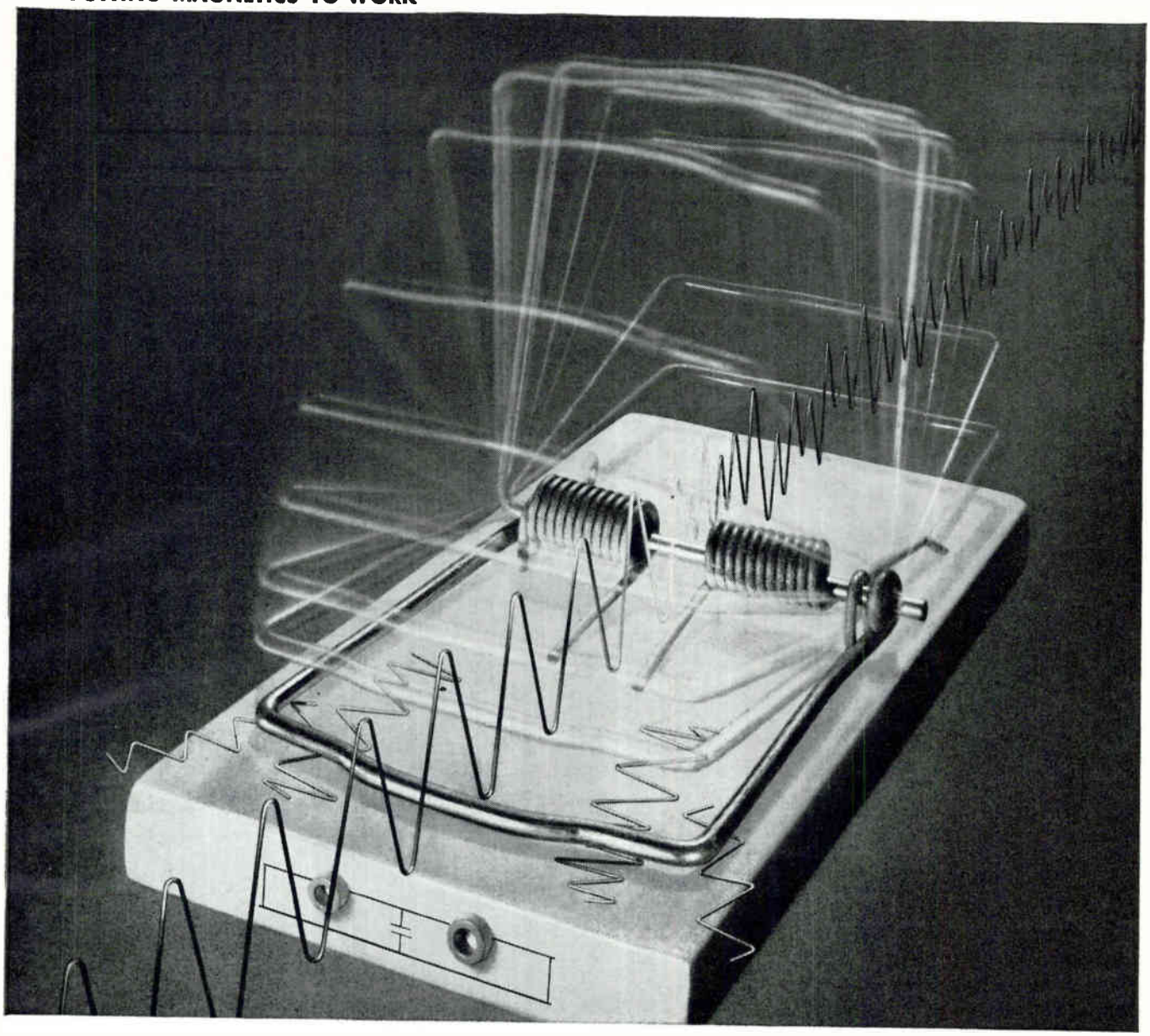
For further information, contact the Sylvania Field Office nearest you. Or for data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. I, 1100 Main Street, Buffalo 9, N.Y.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

N-8189

PUTTING MAGNETICS TO WORK



How to build a better (audio signal) trap!

Magnetics Inc. permalloy powder cores give filter designers new attenuation and stability standards—and miniaturization to boot!

The art of trapping unwanted frequencies has been advanced during the past year with a succession of improvements in molybdenum permalloy powder cores by Magnetics Inc. Most audio filter designers now work with smaller cores, more stable cores and cores whose attenuation characteristics are ultra-sharp. Do you?

Do you, for example, specify our 160-mu cores when space is a problem? With this higher inductance, you need at least 10 percent fewer turns for a given inductance than with the 125-mu core. What's more, you can use heavier wire, and thus cut down d-c resistance.

What about temperature stability? Our linear cores are used with polystyrene capacitors, cutting costs in half compared to temperature stabilized moly-permalloy cores with silvered mica capacitors. Yet frequency stability over a wide swing in ambient temperatures is increased!

And what do you specify when you must rigidly define channel cut-offs, with sharp, permanent attenuation at channel crossovers? Our moly-permalloy cores have virtually no resistive component, so there is almost no core loss. The resultant high Q means sharp attenuation of blocked frequencies in high and low band pass ranges.

Why not write for complete information? Like all of our components, molybdenum permalloy powder cores are *performance-guaranteed* to standards unsurpassed in the industry. *Magnetics Inc., Dept. E-82, Butler, Pa.*

MAGNETICS inc. ®

←CIRCLE 18 ON READER SERVICE CARD

CIRCLE 19 ON READER SERVICE CARD

product needs can come from Mallory Mercury Batteries

WHEN you're looking for ways to give your battery-powered devices extra miniaturization . . . extra precision . . . extra dependability . . . see how the unusual properties of Mallory Mercury Batteries can go to work for you.

There's no battery like them. They have considerably higher capacity per unit volume than any other chemical system commercially available. They outlast conventional batteries several times in service life . . . eliminate nuisance of frequent battery changes. Their shelf-life is unequaled; after six years of storage they show only minor loss of capacity—and batteries we've set aside for over nine years have still tested out with plenty of life.

Mallory Mercury Batteries provide ±½% voltage regulation . . . give ample precision for use as voltage reference in measuring circuits. Constant voltage discharge makes them the preferred source for transistor circuits.

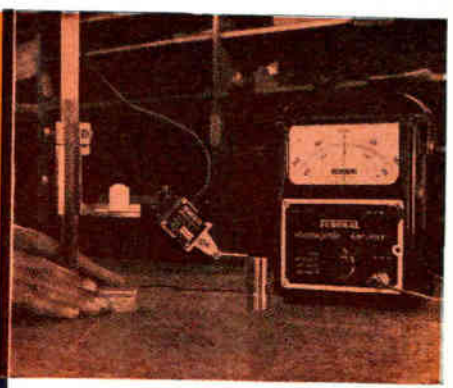
Pioneered and perfected by Mallory, mercury batteries are adding sales-boosting values to many products. A few of their hundreds of uses are shown here. For a consultation on how they can be applied in your new designs or in modernizing of your current models, write to us today.

MALLORY BATTERY COMPANY
North Tarrytown, N.Y.
a division of

P.R. MALLORY & CO. Inc.
MALLORY

High Energy per unit volume. Mallory Mercury Batteries were selected for the power pack of the PARAMI Miss-Distance Indicator, made by Ralph M. Parsons Co., Electronics Division. The 100 cubic inch unit, consisting of 62 Mallory cells, supplies 450 milliampere-hours at 28 volts and 70 milliampere-hours at 180 volts to a transponder used in missile firings.

Non-leaking. In cordless electric clocks made by Jefferson Electric Company, Mallory Mercury Batteries were preferred for several reasons: exhausted cells will not leak and damage the clock mechanism; steady output contributes to precise time-keeping; and long life minimizes need for battery replacement.



Precise Voltage. In the ElectroProbe Test Indicator, a portable dimensional test instrument, made by Federal Products Corporation, Mallory Mercury Batteries were chosen because of their ability to provide constant voltage for long periods of time. Their steady output minimizes instrument drift, eliminates a common source of erroneous readings, reduces need for calibration checks.

FINANCIAL ROUNDUP

Sperry Rand Quarter Sales Rise

CONSOLIDATED NET sales of products and services of **Sperry Rand Corp.** for the three months ended June 30, 1960, the corporation's first quarter, increased to $291,761,602 from $274,694,309 in last year's first quarter. Consolidated net income came to $5,410,579, or 19 cents per common share, compared with $9,014,872, or 31 cents per common share in the corresponding period last year. H. F. Vickers, company president, says earnings for the first quarter were affected by heavy investment in preparation for expanded sales and services of Univac edp equipment.

Loral Electronics Corp., New York, N. Y., reports new record first quarter in sales and earnings—more than double those of the comparable period last year. Consolidated net sales were $9,084,000 for the three-month period ended June 30, 1960, compared with $3,587,000 for the same period last year, an increase of 250 percent. Net earnings after taxes for the quarter were $310,537, an increase in actual earnings of 310 percent over last year's figure of $100,800. Per-share earnings were 53.5 cents on 580,000 shares outstanding this year, as opposed to 23.7 cents on 425,000 average shares outstanding last year.

Houston-Fearless Corp., Los Angeles, announces that company sales have exceeded the $7.7 million predicted for the first half of 1960. Firm says the projected rise to $20 million at year-end is assured by recent increases in backlog. Richard Woike, financial vice president, says neither of these figures takes into account gross annual sales of seven companies that have recently signed acquisition agreements with HF.

General Precision Equipment Corp., New York, and its subsidiaries report net income for the six months ended June 30, 1960, of $2,467,136 or $1.57 per common share, compared with $2,063,121 for the same period a year ago—an increase of 19.5 percent. Sales for the period were $120,722,804, a rise of 18 percent over the $102,301,439 reported for the first six months of 1959. For the three months ended June 30, 1960, net earnings were $1,145,051 or 71 cents a share, compared with $1,143,114 or 77 cents a share a year ago.

Glass-Tite Industries, Providence, R. I., announces net sales for the six months ended June 30, 1960, of $1,729,336, compared with $866,378 for the same period a year ago. Net profit before federal income tax for the first half of this year was $256,592. In the same period last year it was $168,801. Net profit after taxes came to $123,165 this year, as against $86,068 in the first half of 1959.

Amphenol-Borg Electronics, Broadview, Ill., reports consolidated sales of $31,403,805 for the first six months of 1960. This represents an increase of 12 percent over sales

25 MOST ACTIVE STOCKS

WEEK ENDING AUGUST 19, 1960

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avco Corp	3001	17¼	15⅝	16⅞
Ampex	1133	34⅛	30⅝	33⅝
Herold Radio	943	2⅞	1	2
Standard Kollsman	743	25⅞	21⅝	25⅝
Gen Tel & Elec	711	29⅜	28¼	29⅜
Sperry Rand	585	22⅜	21⅜	21½
Collins Radio	552	66¾	61⅝	65¾
RCA	550	63½	61⅞	62⅞
Univ Controls	544	16⅝	15⅛	16½
Avnet Electronics	524	18⅛	16½	18½
Westinghouse	510	57⅞	54½	55⅜
Audio Devices	494	21⅛	18¾	21
Cenco Inst	486	50¾	46⅜	48⅝
Gen Electric	476	84	81¾	82⅞
National Video A	474	21⅝	18¼	21
Gen Instrument	454	44¾	40⅝	43⅝
Telectro Ind	445	16¼	13½	15⅝
Zenith Radio	403	122⅜	113¼	121⅛
Int'l Tel & Tel	389	42⅜	41¼	41⅝
Bulova Watch	368	22	20¾	21
Fairchild Eng	366	8½	7⅝	7⅞
Edo Corp A	365	26¼	22⅛	25¾
Philco Corp	350	25⅜	24⅛	24⅞
Beckman Inst	341	95¾	90	93¾
Burroughs Corp	311	36⅞	35½	36⅛

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., investment bankers.

of $28,053,012 for the same period a year ago. Consolidated net income for the 1960 period was $1,598,257, a gain of 17 percent over earnings of $1,364,288 in the corresponding 1959 period.

Sales and earnings of **High Voltage Engineering,** Burlington, Mass., in the first half of 1960 were higher than in any six-month period in company history, according to Denis M. Robinson, president. Sales were $4,551,571, an increase of 30 percent over sales of $3,521,218 for the corresponding period a year earlier. Net income rose 45 percent to $377,281. Per share earnings for the first half of 1960 were 93 cents, as against 66 cents last year.

Litton Industries, Beverly Hills, Calif., for the fiscal year ended July 31, 1960, reports sales of about $185 million, an increase of almost 50 percent over the previous year. Company president Charles B. Thornton also announces that a 2½-percent stock dividend will be paid on Oct. 21 to shareholders of record on Oct. 7, with broker cutoff date slated for Oct. 14.

Republic Foil, Danbury, Conn., recorded net sales of $2,485,639 for the six-month period ended June 30, 1960. Net sales for the corresponding period last year were $2,546,305. Net income for the first half of this year was $85,182, compared with $165,051 for the same six months of 1959. Net income per share was 29 cents this year, as compared with 57 cents in the same period of 1959. The reduced earnings, according to John W. Douglas, president, follow a sales pattern typical of the metals industry. Republic is a major supplier of capacitor foils.

Indiana General Corp., Valparaiso, Ind., announces net sales of $10,410,082 for the first half of 1960, as compared with $9,772,311 in the same period of 1959. Consolidated net income before taxes was $1,487,593 this year, $1,512,673 for the same period last year. Per share earnings for the first six months of 1960 were 65 cents. The firm produces gear for computers, telecommunications.

MARKETING

Relay Sales to Turn Up This Year?

MANUFACTURERS look for an improvement in relay sales in latter part of this year.

Surveys of relays show sales for all types during first quarter of 1960 were off 25 to 30 percent from same period last year. Second quarter results are expected shortly.

Cutback in military aircraft orders is given as the main reason for the sales drop. Expected higher rate of military expenditures in last half of the year, particularly for missiles, is expected to brighten the sales picture, manufacturers say.

Big question in minds of many is how much of a pickup can be expected. Observers point out military spending was somewhat disappointing in preceding months, but other components were not hit as hard. Sales of all components for first quarter of 1960 were up about 20 percent over last year.

Though the overall sales prospects for relays appears somewhat clouded, outlook for a number of special types is good. Miniature and sub-miniature types are doing very well, manufacturers report. One manufacturer of pressure sensitive types says he looks for a 10- to 20-percent sales increase over last year.

Sales of color tv sets for 1960 at factory value may total about $70 million, somewhat higher than earlier predictions.

A basic source for the new estimate upward is John L. Burns, president of RCA. He told a radio and tv dealers association that current annual retail volume for color television receivers, tubes and other equipment for servicing and for local independent broadcasting (non-RCA) has become a more than $100-million-a-year business.

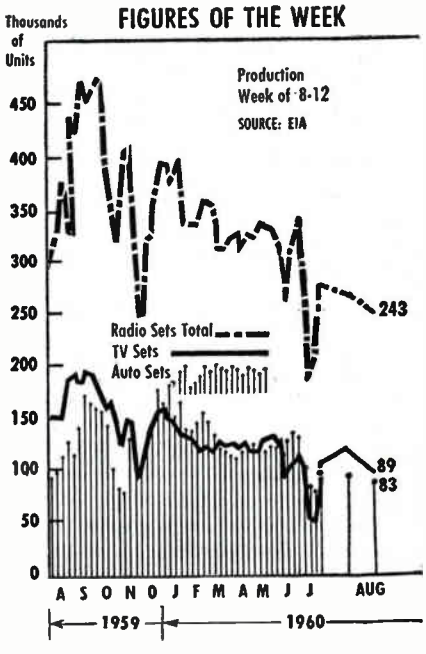
ELECTRONICS learns that the "more than a $100 million" actually represents an estimate of $120 million. From this estimate we deducted $20 million for repairs and broadcast equipment, plus $30 million, or 30 percent of official list price, for dealer margins.

Market for transducers is a lot larger than many in the industry realize. Sales are growing along with rising instrument and process control sales and climbing military electronic expenditures, particularly for missiles. Total transducers sales in 1959, excluding light, sound and radiation types, amounted to slightly more than $100 million, industry market experts say. Sales are expected to gain 15 percent this year, mounting to nearly $120 million. By 1965 sales total should reach $200 million.

Independent studies by Arthur D. Little, Inc., indicate total sales are even higher. The firm concluded total sales in 1958 amounted to $100 million.

Pressure-type transducer sales of $39 million are expected for 1960, up from $34 million in 1959. Five-year look-ahead calls for sales of about $80 million.

FIGURES OF THE WEEK



LATEST MONTHLY SALES TOTALS

(Source: EIA)
(Add 000)

	June 1960	May 1960	Change From One Year Ago
Rec. Tubes, Value	$29,065	$25,580	−12.2%
Rec. Tubes, Units	33,916	30,354	− 9.4%
Pic. Tubes, Value	$15,505	$13,330	+ 2.4%
Pic. Tubes, Units	757	660	− 1.3%
Transistors, Value	$27,342	$24,146	+51.6%
Transistors, Units	10,392	9,046	+49.9%

NO POTS AT ALL

V44 - the new, ultra-stable, all-electronic digital voltmeter

No longer must you trim decade or amplifier gain potentiometers to make accurate, high-speed measurements with an all-electronic digital voltmeter. The new transistorized NLS V44 has *no pots at all* in its decade circuits because of ultra-stable electronic switches . . . *no pots at all* in the amplifier because amplifiers are used only within the feedback loop, where amplifier drift becomes inconsequential. Here is the speed you need — 3 milliseconds per reading — for measuring high-speed transient data . . . for multi-channel data logging. Contact NLS for complete information.

BRIEF SPECIFICATIONS: Accuracy ±0.01% . . . speed 3 milliseconds per reading . . . input impedance 10 megohms . . . "anti-jitter" circuit . . . DC voltage ranges ±9.999/99.99/999.9 . . . millivolt ranges with preamplifier ±99.99/999.9 . . . AC ranges with AC/DC converter 9.999/99.99/999.9 from 30 cps to 10 kc . . . 98% plug-in modular construction . . . digital output in both decimal and binary coded decimal form . . . simple plug-in accessories for automatic data logging and measuring systems . . . complete, $6,150.

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (SAN DIEGO), CALIFORNIA

Courier To Speed New Communications

Orbiting relay stations will be standard communications equipment in the not too distant future. Here's how Courier, the prototype, works

THE NEW ERA in communications—which uses satellites, active and passive—gains another foothold with the development of the delayed repeater communications satellite Courier, due to go up Sept. 30.

The Army Signal Corps' Courier (developed for the Advanced Research Projects Agency) follows the successful launch and performance of the passive communications balloon satellite, Echo I, put up by the National Aeronautics and Space Administration (ELECTRONICS, p 38, Aug. 26).

Courier's mission is to provide the equivalent of 20 continuously available 100-wpm teletypewriter channels at strategic points throughout the world. An alternate mission is to provide low-priority voice channels between two or more points.

As the satellite orbits into view of a ground station, it receives and stores information while simultaneously transmitting messages from other stations previously received and stored. The ground communications system was provided by ITT with Radiation, Inc. supplying the antenna installations. (For ground system details see ELECTRONICS, p 38, July 22.)

The 500-lb, 51-in. diameter payload (see box) was developed by Philco Western Development Laboratories. It is powered by 19,152 solar cells, has built-in circuits that reject any command or query not properly coded. The circuit carries spare parts for repairing itself. These spares—which take up nearly half the weight and space in the satellite—can be switched into operation by ground command.

The microwave communications subsystem has four microwave transmitters, four microwave receivers, baseband combiner, five data-storage tape recorders, microwave antennas and diplexers.

Two microwave antennas with hemispherical radiation patterns are located on the equatorial band of the satellite. Two independent transistorized f-m receivers are connected to each antenna through the diplexers and r-f cables.

The receiver noise figure (NF) is less than 12 db. Each receiver weighs 6.4 lb and requires 3.3 watts of primary power. The video baseband output of the four receivers are combined in the diversity combiner. The signal-to-noise ratio of each receiver output is measured and the outputs are combined proportionally to their signal-to-noise ratios.

The baseband combiner also provides a fail-safe switching for the receivers. If one of the receivers connected to each antenna fails, the system will still perform without loss of signal. The baseband combiner weighs 3.4 lb and requires 800 mw of power input.

To avoid complexity in switching, the four f-m transmitters are operated in pairs, with each transmitter of the pair connected to one of the microwave antennas. The other two transmitters are spares.

Except for the final power amplifier tube, the transmitters use solid-state active-circuit elements. Frequency stability over the environmental temperature range is assured by a crystal controlled reference oscillator that operates an electromechanical frequency control system. Pressure sealed cases insure reliable operation of the electromechanical elements in the high vacuum orbital environment.

Each transmitter weighs 26 lb and requires less than 80 watts input for an r-f power input of seven watts.

Four of the tape recorders store teletypewriter digital communications data. The fifth tests the system capability with analog or voice information. Data can be read into, or out of, each recorder for five minutes. Each weighs 5.6 lb and consumes approximately 10 watts.

A pam/f-m/f-m telemetry system evaluates the performance and environmental condition of the satellite. An all-transistorized telemetry generator commutates 26 system parameters, such as equipment temperatures and equipment performance, receiver signal-to-noise ratios, transmitter power outputs and power system voltage and current. Also, the telemetry system transmits verification of commands to the ground station.

The various telemetry sensors, the telemetry generator and redundant 1.5 watt f-m transmitters comprise the telemetry subsystem. All active circuit elements in this subsystem are solid state devices.

The commutated data modulates six Interrange Instrumentation Group (IRIG) subcarriers which in turn frequency modulate the telemetry transmitter. A seventh subcarrier is used for timing. The total weight of the telemetry generator is 21 lb. It requires 4.6 watts during normal operation.

The f-m vhf telemetry transmitters are of an advanced transistorized design. Parallel power transistors supply 1.0 watt power output under all environmental conditions. The 24 cu in. package weighs one lb and requires 5.6 watts of primary power.

The telemetry transmitter power is radiated from four whip antennas located on the equatorial band of the satellite. A vhf diplexer is included to permit simultaneous vhf transmitter and vhf receiver operation.

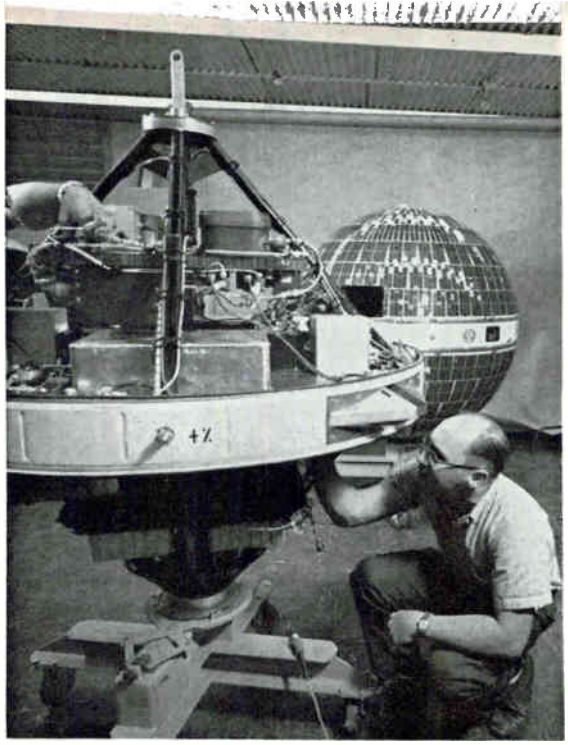
The command subsystem is the switchboard for the microwave communications and telemetry subsystems. It is also a clock to synchronize satellite functions. It also switches from faulty equipment to spares. The command subsystem comprises redundant vhf receivers and a command decoder, comparable to a small-scale digital computer.

Over 500 transistors and 700 semiconductor diodes are used in the command decoder. The decoder performs many logical operations on the command data which ensure that erroneous commands are not accepted, and reduces the probability that deliberate or accidental interference will cause loss of communications data.

Commands are delivered to the

Era

Epoxy glass fiber shells are put on dummy form to check fit of parts



Electronics in satellite weighs 300 lb; total satellite, 500 lb. Completed satellite (rear) is covered with 19,152 solar cells

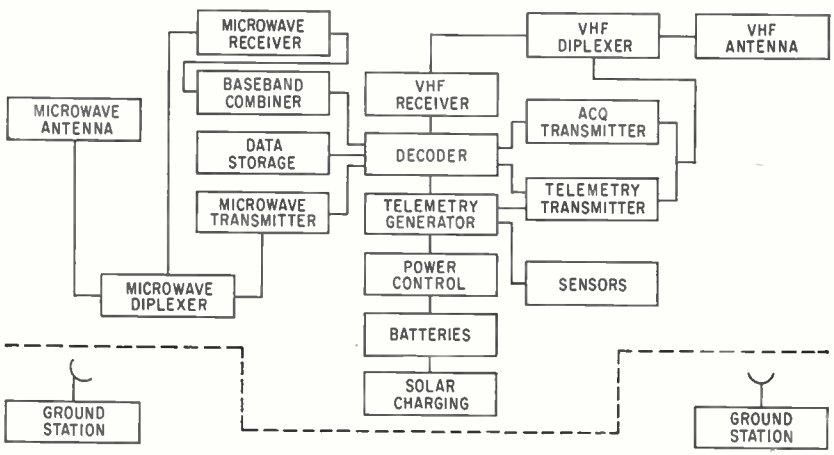
decoder from two all-transistorized, crystal-controlled f-m command receivers. Each receiver weighs 2 lb and requires 530 mw of power.

The Courier has a 50 mw transistorized vhf beacon transmitter. Redundant transmitters are used to increase system reliability. One of the transmitters is operating when the satellite is not in active use to permit the ground station to determine when the vehicle comes over the horizon. The beacon can give tracking signals to the Minitrack stations to help determine orbital parameters of the Courier. Each beacon transmitter weighs 6 oz and requires 480 mw of primary power.

A low voltage sensing device in the power system prevents inadvertent damage to the batteries if excessive power drain occurs.

Philco built the satellite with the help of 43 principal subcontractors and over 200 materials suppliers.

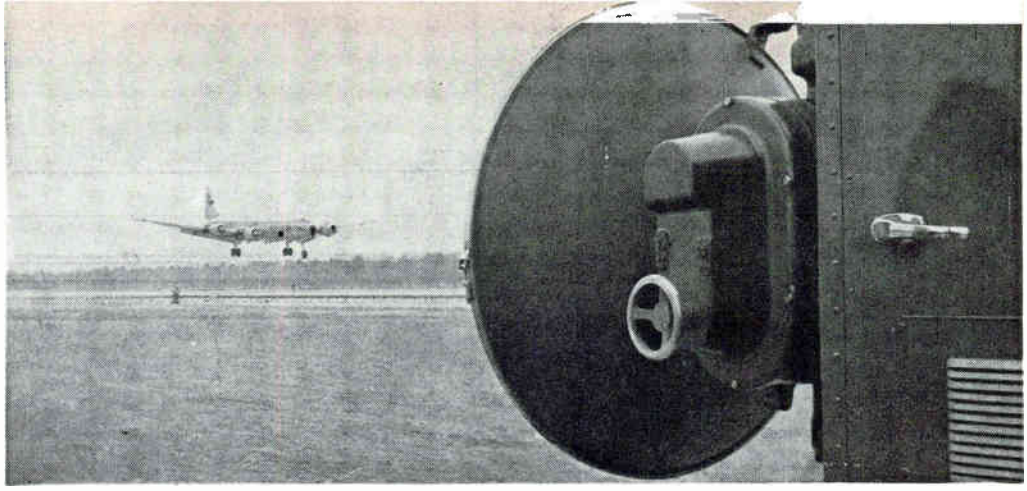
The main subcontracted components, Philco says, are: Magnetic tape recorder/reproducer by Consolidated Electrodynamics; code tape reader by Tally Register; nickel cadmium batteries by Sonotone; materials for bonding solar cells to the satellite surface and for internal structuring fastening by Dow Chemical and Westech Plastics; protective coatings for solar energy system by Optical Coating Laboratory and fabrication and testing of the cables by Sierra Electronic Corp.



Spare parts take up nearly half the weight and space of satellite payload

SPECIFICATIONS FOR COURIER SATELLITE

Weight	500 lb
Size	51 in. diam.
Satellite spin rate	40 rpm
Orbit altitude	600 n mi.
Speed of satellite	14,400 mph
Primary power supply	nickel cadmium batteries 12 amp hr, 28 v
Charging supply	19,152 solar cells, average charging rate 1.8 amp
Total power consumption	
stand by	10 w
active	225 w
Tracking method	beacon in satellite; automatic tracking antenna on ground
Commanding method	active, 21 selected commands by vhf and microwave
Date storage method	5 tape recorders: 4 digital and 1 analog
Storage capacity	15 megabits NRZ teleprinter at 55 kilobits/sec or 30 cps, 50 Kc analog equivalent
Read in-read out time	5 min
Four microwave transmitters	vhf, 8 w power output f-m, dev ±100 Kc
Four microwave receivers	vhf, transistorized, f-m, NF 12 db
Vhf transmitters	2 telemetry; 1.5 w output, f-m, dev ±6 Kc; 2 acquisition: 50 mw, output unmodulated
Two vhf receivers	command type, transistorized, unmodulated, NF 6 db
Telemetry	7 IRIG commutated channels, 35 parameters
Two ground stations	Puerto Rico and Ft. Monmouth, N. J.



On NAFEC's runway, Bell Aircraft's all-weather landing system brings down a laboratory C-54. One of two radar antennas is in right foreground

What Our Air-Traffic-Control Dollars Buy

Federal R&D program for fiscal 1961 will spend $47 million on systems research, data-acquisition, communications

By FRANK LEARY
Associate Editor

ON SATURDAY September 10, between 2 a.m. and 8 a.m. Eastern daylight time, North American Air Defense Command will be staging its Sky Shield exercise, a training requirement for continental air defense. During the exercise all air traffic will be grounded.

Although scheduled for a slack period, the exercise will ground some 1,700 aircraft, including about 1,000 commercial flights that would normally carry 37,000 people, and 700 general aviation craft.

Our national airways are getting more and more crowded. There are now 70,000 civil aircraft registered with the Federal Aviation Agency. The 44 million passengers carried on domestic scheduled airlines in 1957 will grow to twice that figure by 1965, and by 1970 should top 100 million.

Technical problems pile up on the National Aviation Facilities Experimental Center, the FAA's big proving grounds near Atlantic City, N. J. In the past six months or so, NAFEC has finished the evaluation of some three dozen projects and reported them out to FAA. Some of these will shortly begin to filter into the nation's traffic-control system.

In fiscal 1961, FAA will spend about $47 million on research and development, of which NAFEC will spend the major part. Expenditures include $4.5 million for systems research; $3.85 million for radar development, including data-acquisition devices for air-traffic control; $5.85 million for development of navigation devices including all-weather landing systems; $4.8 million for R&D in communications equipment; $19.7 million for development of display systems for air-traffic control; and $6 million for weather-data systems. The center will also spend $17.6 million for its operations budget and $2.4 million for new plant.

Proposed allocations for the current fiscal year for new equipment to be installed in the air-traffic system include $50 million for long-range navigation equipment; $6.3 million for terminal navigation gear; $2.7 million to build new traffic centers and $5.1 million to equip them; $7.1 million for tower projects; $15.6 million for domestic communications stations and $6.6 million for international communications stations; $2.2 million for Vortac; $8 million for instrument-landing systems. These are new funds for fiscal 1961, and do not include carryovers from previous years.

Principal jobs in the shop at NAFEC right now are mostly concerned with increasing the extent and use of automatic control procedures. Studies of airspace configuration and use at the center have led to the simulation of several airport complexes on a big simulator built for NAFEC by Aircraft Armaments. The complex problems of the airports in Anchorage, Alaska, for example, were hashed over at the center by simulation. Another study evaluated the impact of the all-instrument-flight rule in the Chicago-Indianapolis terminal area on the traffic procedures in this air nexus.

A continuing program to develop data-processing techniques and data displays, aimed at providing the airways with semiautomatic traffic controls, is now working with real hardware. General Precision has delivered its Librascope-built computer, and other components of the system—data displays, flight-data entry units, punch-print units, a flow-control console—are also installed. NAFEC engineers expect to be working experimentally with the system by yearend, with some components still to be delivered.

The center is making progress in its 3-D radar project, "a vital link in radar coverage as far as we're concerned." The air height surveillance radar (AHSR-1) tower is up; the antenna will be mounted this month. The W. L. Maxson-built AHSR-1 is a passive system using an S-band surveillance radar to illuminate the target. Height-finding radar is designed to furnish comparative heights of aircraft within 50 miles of the airport complex.

Evaluation of the AN/FPN-34 terminal radar is continuing. This military system, if accepted by FAA, will extend radar coverage from today's 30 to 40 miles to 100 miles.

The center is also working on doppler detection techniques for

monitoring approaches and departures. In the system under test, doppler detectors are sited at strategic points on runways, exits, turnoffs, taxiways and so forth. Signals from these detectors enable the controllers to keep track of aircraft on the ground.

Engineering tests on radar beacons are continuing. FAA is currently installing $5.7 million worth of beacons from Telecomputing Corp. at 27 airports and nine air-route control centers, plus 31 partial installations scheduled for other sites.

Communications remains a major test effort. Experiments in intelligibility are being continuously run. Two breadboards of an air-ground-air communications system (AGACS) are completed; components from manufacturers are under test. Airborne teleprinter units, automatic communications techniques and digital communications systems are under evaluation.

"The final AGACS," says a NAFEC spokesman, "will undoubtedly be a marriage of several of the designs."

Navigation, final approach and landing systems form a dramatic group of projects. Bell Aircraft's AN/GSN-5 landing system is bringing aircraft in at NAFEC regularly; the system can land two planes a minute. Gilfillan's REGAL has just begun its flying tests. In the former system, a radar provides space-position data to a groundbased computer, which generates command signals to guide the aircraft's autopilot into touchdown. REGAL's computer is airborne; the system rides a narrow-beam glideslope sent from the ground, follows the glideslope only to flareout.

This fall, the center will begin evaluating the British-built blind-landing equipment (BLEU) and the U.S. Air Force's AN/APN-114 blind-landing system.

Among navigation systems, doppler vor (vhf omnirange) is still undergoing test. Pictorial navigation displays of several kinds are under evaluation; in one, a small computer sits in the lap of the pilot; on the display, a moving light shows him his craft's position over the ground.

Crosley
creates new aerial highways

Stacked aircraft in the skies over the nation's busy airports may soon become a problem of the past. Avco's Crosley Division, working with the U.S. Air Force's Cambridge Research Center, has developed a new, improved system for directing high-density air traffic accurately and reliably.

This unique solution to the air traffic control problem is *Volscan*, a ground-operated electronic system that employs surveillance radar and vectoring techniques in scheduling aircraft to touchdown. It can work at any airport, with any aircraft carrying a two-way radio.

With *Volscan*, a crowd of randomly arriving aircraft can be converted into an orderly, safe procession. Not only does *Volscan* enhance safety in the air, but it greatly increases the traffic-handling capability of any airport. The flight of as many as 24 aircraft can be directed at one time with *Volscan* and up to 120 landings and take-offs—one every 30 seconds—can be made in an hour.

Volscan has undergone complete systems testing, and is about to be installed at Atlantic City for careful and extensive field testing under direction of the Federal Aviation Agency and the U.S. Air Force.

For further information on Volscan write: Director of Marketing, Crosley Division, Avco Corporation, Cincinnati 25, Ohio.

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CONSTRUCTION BEGINS ON

GIANT RADAR TRANSMITTER

THE WORLD'S LARGEST radar telescope, now under construction for the Air Force in Puerto Rico, moves a step closer to realization with a recent contract award to build the telescope's powerful transmitter.

Levinthal Electronic Products, a subsidiary of Radiation, Inc., will build the transmitter for the 1,000-ft-wide bowl-in-the-ground under a $580,000 subcontract from prime contractor Cornell University. The project, which is being supervised by the Air Force Cambridge Research Laboratory for the Advanced Research Projects Agency (ARPA), will cost $4.5 million.

The space required to house the transmitter will be 41 ft wide, 60 ft long and 25 ft high. Peak power will be 2.5 Mw and average power, 150 Kw. Maximum frequency will be 440 Mc.

The pulse rate and repetition rate are variable over ranges of 500 to 1. The transmitter provides coherent signals at the fundamental frequency, and at submultiples of it, for application of data processing techniques.

The 1,000-ft wide dish will be scooped from a natural valley of coral limestone near Arecibo, P. R. The limestone is porous and will allow for drainage. The surface will be lined with aluminum mesh. The feed antenna will be supported by a tripod 600 ft high. Though of course not mechanically steerable, the spherical-section antenna has a 40-degree beam sweep— ±20 degrees from vertical.

Besides functioning as a radar, the antenna can also be used passively as a radiotelescope.

Once completed, the world's largest window to the cosmos is expected to illuminate a number of heretofore unknown quantities. Cornell says the telescope will make it possible to probe millions of miles deeper into outer space than man has ever penetrated before.

ARPA's primary interest in the facility is to gather information for Project Defender—the program devoted to studying new approaches to defense against enemy vehicles from out of space.

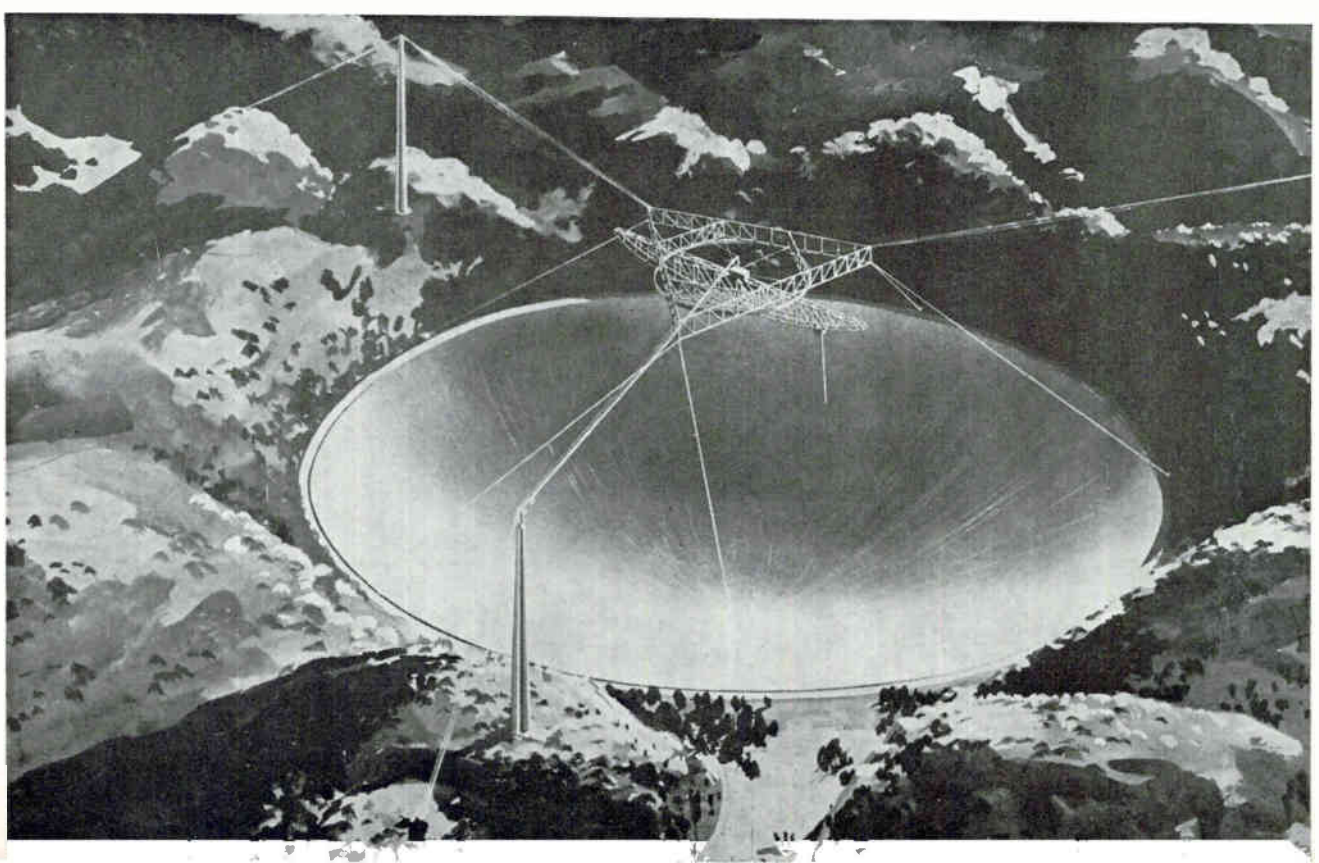
Information the telescope can get and that Defender can use includes precise missile characteristics outside the atmosphere—the installation is close enough to the Atlantic Missile Range to study missiles in flight—as well as environmental conditions through which a missile must pass.

The new radar will obtain measurements of electron density and electron temperature at different heights and times in the earth's ionosphere to heights of one or more radii of the earth.

Also, it may measure ionization and detect transient streams of aurorae—the charged particles coming from outer space in connection with the phenomenon, and explore the existence of a ring current.

Cornell scientists believe the radar will be powerful enough to obtain echoes from the moon, Venus, Mars, Mercury, the sun, and probably Jupiter.

Aluminum-mesh, 1,000-ft-wide fixed reflector with suspended movable line feed assembly provides 40-degree beam sweep



Soviet photos, obtained from Sovfoto, show electronic equipment Russians displayed at Powers U-2 trial. Placards label gear (left photo) airborne radio-reconnaissance equipment (l) and an antenna. Right photo (l to r): Astro-tracker, airspeed indicator, altimeter, exhaust gas temperature gage potentiometer, engine speed indicator, oil pressure indicator, transmitter indicating rate of fuel flow, and autopilot type A-10

What REDS Learned About Our COUNTERMEASURERS

MOSCOW—SOVIET SPECTATORS at the recent espionage trial of U-2 pilot Francis G. Powers were probably startled by the capabilities of the electronic countermeasures equipment described by Army experts.

Findings of the committee set up to examine the equipment were read to the court by Colonel R. A. Andreyev.

Andreyev said the plane had antennas covering four frequency bands. He described three antenna types: parabolic antennas for 7,500 to 13,000 Mc, dipole antennas for 1,425 to 5,000 Mc and flat spiral antennas for 300 to 3,000 Mc (possibly a log-periodic type). The bandwidth of the flat spirals were limited to 300 to 1,000 Mc by an r-f filters.

The witness noted that the plane carried two identical antennas of each type and announced that this indicated a direction-finding capability.

Andreyev described two pieces of receiving equipment. One was a receiver for the three-cm band. It had seven r-f amplifiers and reportedly was for receiving radar signals. The other receiver was described as an automatically tuned crystal-stabilized superheterodyne that could determine the exact frequency of radar signals. The receiver tuned from 50 to 145 Mc. Some Soviet early-warning radars operate as low as 72 Mc; some fire-control radars as low as 66 Mc.

Andreyev told also of a captured magnetic-tape recorder. Only one recorder was recovered from the wreck but the number of reels of tape found with the plane indicated that there must have been three recorders. Each recorder reportedly was capable of eight hours continuous recording.

Six tape reels were recovered with the recorder. The tape was ¼ in. wide and 20 microns thick. Tape speed apparently was 1⅞ ips. Only 760 feet of used tape and two reels of unused tape were recovered; the rest burned.

The recorder had three tracks. The middle track recorded navigational data so that intercepted signals could later be correlated with geographical location. Navigational data was impressed on the tape as two tones at 900 and 2,700 cps. The tones recurred each 30 seconds and could presumably indicate heading and speed.

The tape drive mechanism included a space heater and other provisions for low-temperature, high-altitude work.

Andreyev concluded that the passive countermeasures system made possible the detection of radar, determination of its frequency, location and mission. Mission of a radar set can be deduced not only from its frequency, pulse repetition rate and pulse width but also from the length of time a plane is exposed to a radar beam. Exposure time indicates how wide the beam is, what its beam pattern is, its rotation rate or other scanning data.

Testimony also indicated that the U-2 carried active countermeasures equipment for confusing radar and prematurely detonating antiaircraft rockets, but details were not given.

Soviets Twist Truth in Engineer Case

COMMUNIST distortions of truth were fairly clearly illustrated by comparison of press reports on the arrest of electronics executive Geoffrey Post and the actual event.

Post, former engineering vice president of Gensys Corp., Los Angeles, was a delegate to the congress of the International Federation of Automatic Control in Moscow last June. While he was there, bystanders reported him to the police for taking some pictures of a poorer quarter of the Soviet capital, including some slum-type dwellings and a beggar. The police detained him for two hours, interrogated him courteously, did not jail him, let him go on to Paris with no trouble. The only complicating factor in the whole event was that Post speaks Russian fluently, which made both bystanders and police suspicious.

Recent Soviet reports had Post "taking photographs in an area of Moscow where military objects are located."

Since no mention was made of the incident in the Soviet press at the time, Post tells ELECTRONICS he was surprised at the furor it had aroused in the U. S. press by the time he got home.

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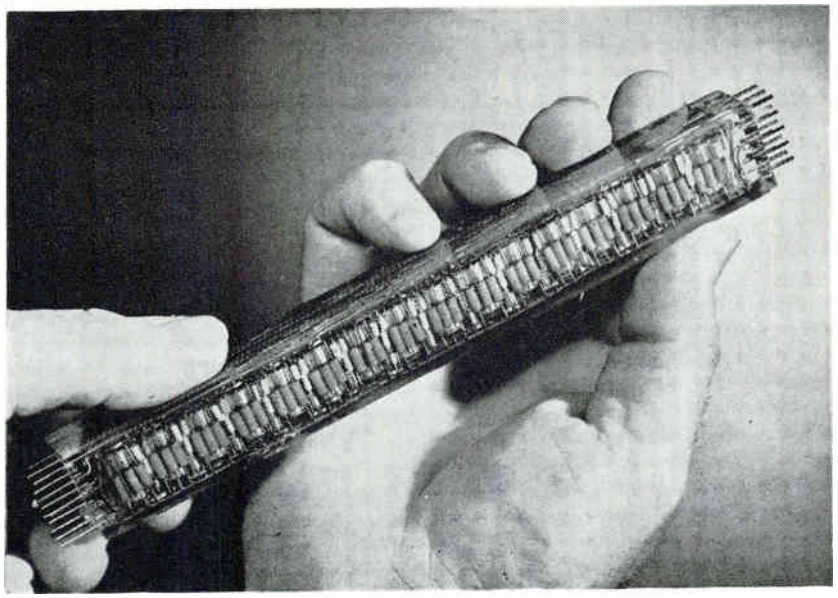

High-density electronic circuit packaging (like transparent model above) cuts weight of Polaris missile's inertial guidance by four

Weight-Saving Design Opens Market

HIGH-DENSITY electronics packaging has spawned a new inertial guidance system for the Polaris submarine-launched missile, one fourth the weight of the present system; extended the range of the Polaris; and opened a new market for the new generation missile.

The high-density Weld-Pak (photo) is a complete circuit module or stick consisting of conventional or miniature resistors, capacitors, diodes and transistors, packed closely together and joined by precise, space-saving welds.

With interconnecting wiring matrices, especially designed connection plugs, and potting, these sticks become complete interchangeable circuits.

The Massachusetts Institute of Technology's Instrumentation Laboratory developed the packaging.

Raytheon, which developed the manufacturing procedures under a previous contract, will produce prototypes of the new subsystem under a new $2.5-million contract.

General Electric will fabricate the complete guidance system under a new $1,247,000 contract with Navy's Bureau of Naval Weapons.

Russians Hit Snags In Automation

WHILE RESEARCH REPORTS from the proliferous scientific institutes and academies in the Soviet Union crow about new automatic production techniques, the hardheaded planners in the Communist Party's Central Committee are tacitly admitting snags in applying the techniques to industry.

July's plenary meeting of the Central Committee, called to assess industrial progress under the current seven-year plan, met behind closed doors with controlled leaks to official Moscow press. Two problems show up in all reports: convincing quota-conscious plant managers to install automatic controls in their production lines, and improving the reliability of systems that are installed.

Some 250 "automatic or semi-automatic" production lines went onstream in 1959, but key Soviet spokesmen admit that reliability problems require "profound research." Eight research institute branches have been set up to bring the excellent but highflown Soviet theoreticians into contact with the realities of production. Despite government pressure, introduction of automatic rail-traffic control is lagging; 37 percent of industrial

loading or unloading is still done manually; a quarter or more of all machine tools in the most advanced industrial areas are more than 20 years old.

Recent Soviet developments include a system to control steel smelting in arc furnaces, said to increase furnace capacity 35 percent, cut power costs 15 percent, and up output quality. Automatic controls have caught on to a degree in heavy-metals industry anyway: 96 percent of all pigiron produced in the Russian Federation these days comes from blast furnaces which have an "automatic thermal regime."

One answer Soviet planners find is to return to the old practice of importing capitalist gear. One Soviet chemical plant for nylon manufacture is being designed by Zimmer GmbH of Frankfurt/Main, Germany.

It is being constructed by Vickers-Armstrongs (Engineers) of London, with controls worth $560,000 from Honeywell Controls Ltd.

Ham Moon Shot Goes Across U. S.

MOON BOUNCE transmissions by ham radio operators have linked San Carlos, Calif., and Medfield, Mass., through a transmission path about 500,000 miles in length.

The amateur operators say it is the first time such transmissions have been made. They call it a milestone in ham radio.

Signals were transmitted in both directions on 1,296 Mc, with the first successful contact made on July 21 between 7:30 and 8:00 a.m., Pacific Standard Time.

The first transmission was from west to east, going from W6HB manned by members of the Eimac Radio Club in San Carlos, Calif., and being received by W1BU by Sam Harris of the Rhododendron Swamp VHF Society, Medfield, Mass.

The transmission pattern was then reversed.

At each end of the circuit, a 1,000-watt klystron was used in the transmitter and a Microwave Associates MA2-1000 parametric amplifier in the receiver.

MEETINGS AHEAD

Sept. 7-8: Value Engineering, EIA, Disneyland Hotel, Anaheim, Calif.

Sept. 7-9: Automatic Control, Joint Conf., ASME, IRE, AIEE, ISA, MIT, Cambridge, Mass.

Sept. 8-9: Conference on Technical Communications, Society of Technical Writers and Editors, Univ. of Dayton, Dayton, O.

Sept. 9-10: Communications: Tomorrow's Techniques—A Survey, IRE, Roosevelt Hotel, Cedar Rapids, Ia.

Sept. 13-14: Bionics Symposium, Applying Biological Principles to Engr. Design, ARDC, Wright Air Devel. Div., Dayton Biltmore Hotel, Dayton, O.

Sept. 14-15: Industrial Electronic Test Equipment, Symposium, Armour Research Foundation, Chicago.

Sept. 15-16: Engineering Management Conf., IRE, Morrison Hotel, Chicago.

Sept. 15-17: Upper Midwest Electronic Conf., Twin Cities Elec. Wholesalers, Civic Auditorium, Minneapolis.

Sept. 19-21: Data Transmission, International Symp., PGCS of IRE and Sectie Voor Tele. of Koninklijk Ins. van Ingonieurs, Delft, Neth., Contact B. B. Barrow, Benelux Section, IRE, Postbus 174, Den Haag, Nederland.

Sept. 19-22: Space Electronics and Telemetry, Nat. Symposium, Shoreham Hotel, Washington, D. C.

Sept. 21-22: Industrial Electronics, Annual, PGIE of IRE, AIEE, Sheraton-Cleveland Hotel, Cleveland.

Sept. 23-24: Broadcasting Symposium, PGB of IRE, Willard Hotel, Washington, D. C.

Sept. 26-30: Instrument-Automation Conference and Exhibit of 1960, ISA Annual Meeting, Coliseum, New York City.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

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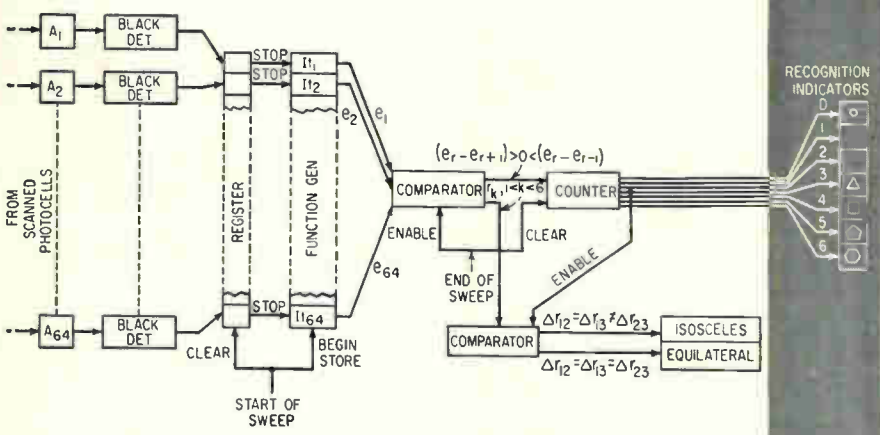

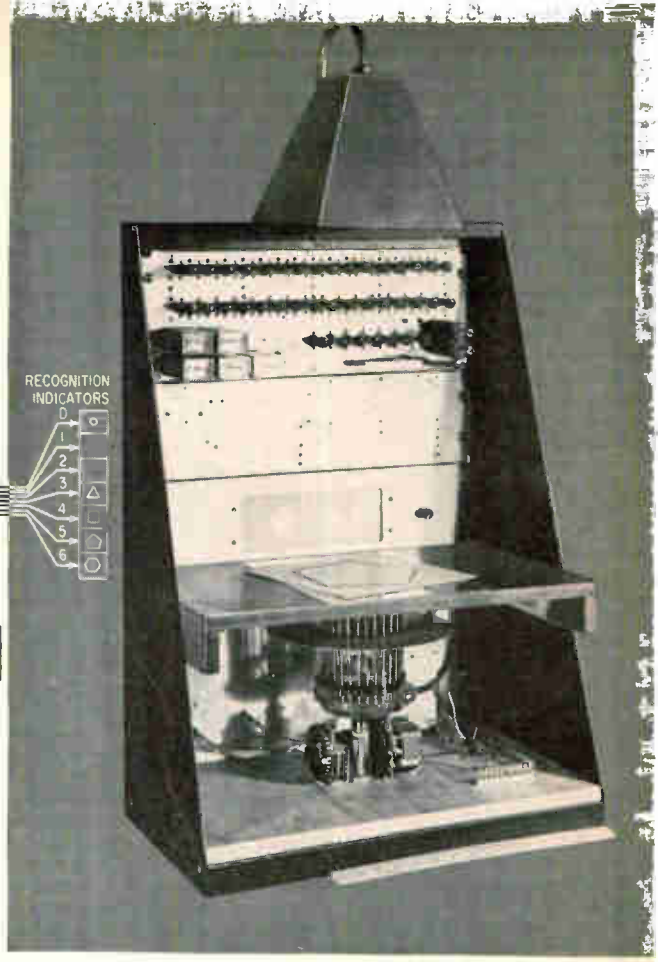

FIG. 1—Generalized block diagram of an n-gon recognition system which can make use of the dilating circular scan. At right, pattern-recognition machine recognizes a pentagon line drawing and displays it on screen

Line-Drawing Pattern Recognizer

Use of a dilating circular scan resolves some of the problems encountered in the development of a non-specialized reading machine. Technique is applicable to automatic detection of letters and numbers over a variety of styles

By LEON D. HARMON
Bell Telephone Laboratories, Inc.,
Murray Hill, N. J.

MACHINE DETECTION of two-dimensional visual patterns has been generally restricted to carefully constructed and positioned alphanumeric characters. Although a number of systems and proposals for obtaining limited recognition exist[1-4], and although considerable effort is currently being put into finding more general and flexible systems[5-11], many difficult problems remain to be solved.

Ideally, pattern recognition should be independent of character size, rotation, position, style and noise. A really useful reading machine, for instance, will be one that can recognize the symbol 5 whether it is continuous or in two parts, and whether it has been printed by a machine or scrawled by a child.

Such general or Gestalt recognition is approached by the machine that is described here. It recognizes line drawings of circles, triangles, squares, pentagons and hexagons independent of their rotation and, within limits, of their size, precision of drawing, or positioning. In addition, it distinguishes and counts separate objects up to six with limited independence of size, shape and object position. Furthermore, the technique is applicable to automatic detection of letters and numbers over a wide variety of styles.

This Gestalt recognition is achieved by the use of a dilating circular scan. This scanning method yields similar transformations for geometrically similar figures — object-size changes translate into time-of-arrival changes while object rotation preserves topological relationships.

Consider an array of picture elements arranged in c concentric rings, having r elements in each ring. If each ring is inspected sequentially, say from center outward, the resultant c sequences of r signals can be shown to have the

←CIRCLE 38 ON READER SERVICE CARD

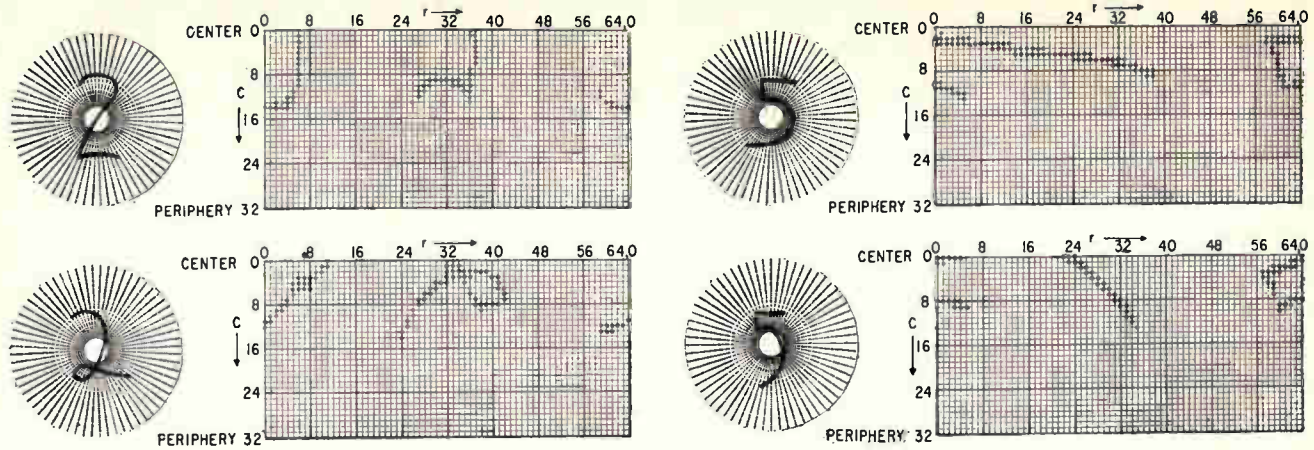

FIG. 2—Numerical examples. Here, size changes appear as vertical (time) shifts while rotation causes lateral displacements. Many figures have unique invariants when interrogated with this circular scanning

desired transformation properties. A logically equivalent implicit scan is possible with unidirectional propagation along radii and with unit delays inserted between adjacent elements on each radius.

Suppose that an equilateral triangle is centered on such an array. The first intersections of the scanning interrogation ring with the figure will be three simultaneous hits on the mid-points of the triangle's sides. As the scan continues its outward sweep, points on each side of the initial intersections are progressively touched. The last parts of the triangle which are inspected are the vertices, those points at the greatest radial distances from the center.

Thus the outward puckering scan produces three radially equidistant epicenters of activity. An accumulating register of r places, representing the r elements of each ring in turn, will display three single active cells initially, equally spaced along the length of the register. There will then be a spread of activated cells in each direction from each of the initial locations. Finally the apices of the equilateral triangle will cause the last three cells of the register to be activated. Again these are equally spaced, representing the 120-deg radial symmetry of the vertices.

A similar but smaller triangle would have generated similar signals earlier in the sweep cycle; conversely for a larger presentation. Rotational changes are represented as lateral shifts in the contents of the register. Thus the detection of three simultaneous, equidistant, and uniformly expanding waves of activity is sufficient to recognize an equilateral triangle independent of size or rotation. (Bounds on size exist, of course. The lower limit is fixed by the resolution of the array of elements while the upper bound is determined by the field seen by the array.)

An isosceles triangle will generate easily detectable time and position asymmetries. Squares and rectangles are differentiable in a similar manner; their unique common property in this system is, of course, a count of four. A convex polygon of any number of sides can be detected, given sufficient resolution; circles are represented by a simultaneous filling of all places in the inspection register.

Let us consider now how a system can be developed to make use of such scanning. Suppose for example that the input transducer consists of 32 concentric rings of 64 photocells each. Let a sweep cycle comprise the simultaneous gating of all 64 cells in each ring, one ring at a time, into 64 corresponding amplifier channels. Thus for an outward puckering scan, the innermost ring is first interrogated, then the next, and so on, until the gating-out of the contents of the outermost ring completes a sweep cycle. Figure 1 shows one system for using this information.

The beginning of each sweep initiates a storage operation in each of the 64 function generator locations. A linear accumulation (e.g., current) continues in each location until stopped by the first black element encountered by the expanding sweep.

The value of each function at the end of sweep may be read out as a voltage level which is proportional to the radial distance of the corresponding image point from the center of the array.

At the end of a sweep, a comparator makes peak detections on the 64 generated functions. This operation is performed by local differencing over several adjacent locations. A count of such peaks is sufficient to identify an n-gon, while a measurement of inter-peak distances (given by the addresses of the radii on which the peaks occur) establishes criteria for separation of isosceles and equilateral or of square and rectangle. The alphabet of line drawings recognizable by this system is not restricted to a few polygons.

Many figures have unique invariants if they are interrogated with an expanding circular scan whose origin is near the center of gravity of the figure.

A modest number of more complex comparator operations produces much more sophisticated recognition. Detection of a few types of specially defined groups of signals distributed in time over the 64 channels leads to identification of numerals, for example. A series of experiments on many examples of hand-printed digits has shown that very modest extensions of logic considerably enlarge the classes of recognizable images. Figure 2 shows several examples of numerals which have been recognized in these experiments.

Each of the four numerals was drawn freehand and roughly centered on a layout of the photoreceptors. The rectangular grids

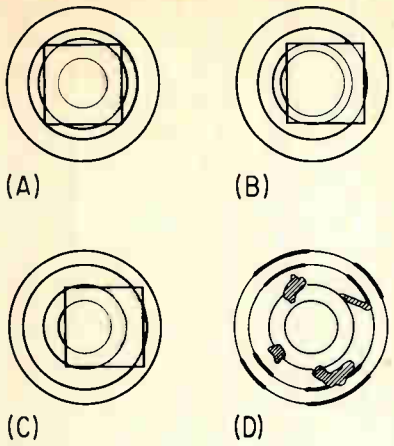

FIG. 3—How the sweep encounters patterns (A to C) and objects (D)

are obtained by unfolding the circular array after making a cut from the center to the top of that array. Thus points along the top of the rectangle represent points on the inner circle of the photocell matrix while the bottom line contains the points forming the periphery of the circular array. The left and right vertical edges of the rectangle were coincident in the original layout, being the two edges of the cut.

This simple transformation makes it considerably easier to follow the scanning events and to discover useful detection criteria. The expanding sweep circle is seen to be represented by a horizontal line 64 cells wide moving down in time through 32 positions. Any given horizontal line may be thought of as the contents of a 64 place register at any epoch. Each activated receptor location on the circular array is shown as a dot in the rectangular representation. Size changes appear as vertical (time) shifts while rotational transformations cause lateral displacements of the pattern. Since the left and right edges of the rectangle are actually contiguous in the original array, lateral displacements simply wrap around the rectangular grid, disappearing off one vertical edge and reappearing at the other.

A set of tests for the examples shown in Fig. 2 will now be given. These tests are for illustrating principles and should not be considered the most complete or effective rules which can be found. We shall invoke two simplifications: the numerals will be centered and there will be no rotation.

An ascending function will mean a mostly continuous, mostly monotonic decrease in values of c as r increases. The first 2 shown would be said to have an ascending function from $r = 0$ to $r = 6$; conversely the first 5 has two descending functions between $r = 0$ and $r = 6$. In a similar manner we may describe horizontal segments, concave or convex functions, etc. We test for the following: (1) An ascending function for $0 \leq r \leq 8$. This describes the curved section of the upper right portion of most 2's. (2) An ascending function for $24 \leq r \leq 32$. This describes that portion of the tail of a 2 lying to the right of center. (3) A partially horizontal or ascending function for $32 \leq r \leq 40$. The presence of at least a short segment which is level or rising during this interval indicates the left end of the tail or the bottom of the down-stroke for most 2's and is independent of whether or not a loop is present. (4) A two-valued function for $0 \leq r \leq 8$ and $60 \leq r \leq 64$ establishes the presence of the top bar and top of the curved portion of a 5. (5) A descending function for $16 \leq r \leq 40$ describes the tail of a typical 5.

The limits of r need not be taken as absolute. If our tests are based on relative r values, then the results of the tests can be independent of rotation of the sample numerals.

Rules based on the five tests listed above are sufficient to obtain unique recognition of the samples given and a variety of other examples of these two numerals. The first three tests concern properties of the number 2 which are relatively invariant over a population of about twenty samples which have been checked. Similar rules have been successfully applied to all of the ten digits for a number of handprinted samples. The extension to letters, while more complicated, does not, in principle, appear difficult.

To demonstrate principles, a simplified model has been built to recognize line drawings of circles, triangles, squares, pentagons, and hexagons. The device detects and counts the segments intersected during one expanding sweep cycle. It is the largest count which determines the correct number for identification. In general, this maximum count may occur only briefly during part of a cycle, or it may be generated by several different segments encountered sequentially during the cycle. For any non-concentric placement of the figure with respect to the sweep center, one or more sides will be encountered earlier than the others. The relationships are depicted for the case of a square in Fig. 3.

In 3A, the innermost circle represents the minimum sweep diameter where no part of the figure has been encountered. The next circle out, corresponding to a time later in the sweep cycle, indicates the four segments cut from a well-centered figure. The next circle out has just encountered the vertices. Finally the sweep has passed out of the

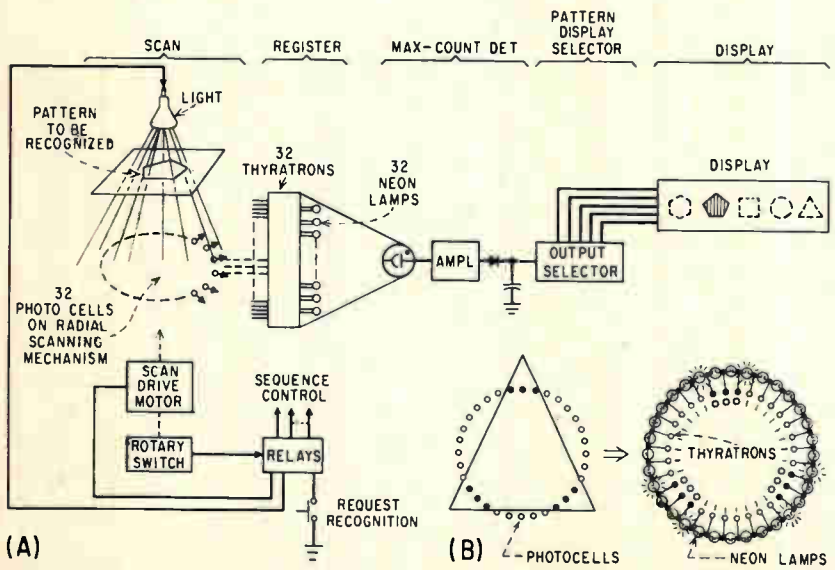

FIG. 4—The n-gon recognition system as constructed (A), and an illustration of how n sides produce 2n discontinuities (B)

square; all portions of the inspection circle have encountered the figure.

A slightly non-concentric placement, as in 3B, results in first one side of the square intersected, then three, perhaps four for a moment, then one again. This is in contrast to the case 3A where if any sides were contacted at any instant, all four were. In 3C where the decentering is excessive, there are never more than three sides intersected at any radius of the expanding sweep. It is required then to detect, store, and sum the number of separate sides encountered during one sweep cycle. This number can never be more than n for any position of an n-gon, and except for accurate centering of regular figures it is generally less than n at any instant.

Let the expanding circular sweep be quantized into a sufficient number of elements, and suppose that those elements which have not passed through the figure are given the value of ZERO; those which have encountered the figure are called ONE. The system then must count the transitions between strings of ONES and ZEROS around the circle. This count thus indicates the number of sides in the figure.

We can distinguish separate objects as follows. For any closed figure lying within the swept area and enclosing the center of sweep, all ONES will eventually be generated; this is not the case for separate objects as in Fig. 3D. Here there will be four discrete strings of ONES and ZEROS but not all ZEROS will have been changed to ONES by the end of sweep. This simple fact is used to provide discrimination of separate objects from continuous (or nearly continuous) line drawings. The count does not depend on the size or shape of the objects, but only on continuity of form, that is, on unbroken strings of ONES.

The block diagram for this system is shown in Fig. 4A. In this version, 32 rather than 64 quantized positions are used in each ring. Also, successive positions of the expanding sweep provide continuous signals rather than 32 discrete signals described earlier in the general model.

The requisite scanning and resultant signals which provide input for the machine are obtained from 32 small photocells which are mechanically puckered across the input plane. As successive portions of the line drawing are encountered, a 32-thyratron register records this information. At the completion of a sweep cycle, this stored data is examined for ONE-ZERO strings (a series of ONES followed by a series of ZEROS).

Conventional means for determining these binary sequences in a register involve shifting the contents of the register or otherwise sequentially commutating the digits. The present system avoids this complication by a simple parallel operation. For a count of the numbers of strings of ONES and ZEROS, the essential information is contained in the transitions between strings, that is, the ONE-ZERO locations in the binary number. For a closed ring of digits, as in the register representing the state of the 32 photocells, the numbers of strings of ONES and ZEROS are equal. Consequently there will be $2n$ transitions for n strings of ONES. Since the number of strings of ONES (or ZEROS) corresponds to the number of sides of the inspected figure, a triangle is represented by 6 transitions, a square by 8, etc.

Parallel inspection of the thyratron register is obtained by connecting a small neon lamp (NE-2) between adjacent thyratron plates. As photocells pass beneath portions of the figure being scanned, they fire their respective thryatrons, which thus change state from ZEROS to ONES. Those thyratrons yet unfired, because their photocells have not been darkened, remain as ZEROS. At the junctions of ONES and ZEROS, the neon lamps light, since there is sufficient potential difference between the plates of fired and unfired thyratrons.

Figure 4B shows that n sides produce $2n$ discontinuities and thereby $2n$ lighted neons.

The lighted lamps are counted in the maximum-count detector circuit (see Fig. 4A) which sums the light output of these lamps and produces a voltage proportional to the number of sides of the figure. This part of the system consists of an enclosure with the 32 neon lamps arrayed in it together with a photocell. The signal from this cell is amplified, peak detected, and stored in a capacitor.

Since the peak detector indicates only the maximum number of neons lit at any instant, there will be fewer than the correct number of sides indicated in some cases. Consider Fig. 3B and 3C. Unless the object and scan centers are coincident, there may not be n intersections at any one time; rather the n sides of the object may be encountered successively during the sweep. One simple solution to this problem is to save sides, that is, to prevent the n strings of ONES from flowing into each other as the vertices of the figure are encountered. This is accomplished by inhibiting that thyratron controlled by the last photocell passing through a vertex. It is locked up by adjacent thyratrons and consequently the neon lamps on either side remain lighted for the duration of the scan.

In the final step, a level detector classifies the stored signal and lights up the corresponding display. Since the amplitude of the signal is proportional to the number of sides in the figure inspected, the level detector is set to report a hexagon for the highest signal, a pentagon for the next lower, and so on through square, triangle, circle, and no-figure.

This detector circuit comprises five thyratrons, each of which has a preset firing threshold corresponding to the signal it is expected to classify. The stored, peak-detected signal is applied in common to all five stages. A common holdoff bias is then removed from one thyratron at a time, starting with the hexagon (highest level) detector and proceeding monotonically to the circle (lowest level) detector. When that stage is encountered where the signal is sufficient to fire the thyratron, recognition occurs.

This machine can also count up to 6 small objects placed at the inspection station. Only if a closed figure is inspected will *all* photocells be shadowed, whereas if discrete objects are presented, only a few cells, those passing beneath the objects, will have responded by the end of a sweep cycle. The distinction is easily made by monitoring the total plate current of the 32 thyratrons.

A working model of this system, built to demonstrate principles, is shown in the photo. A schematic of

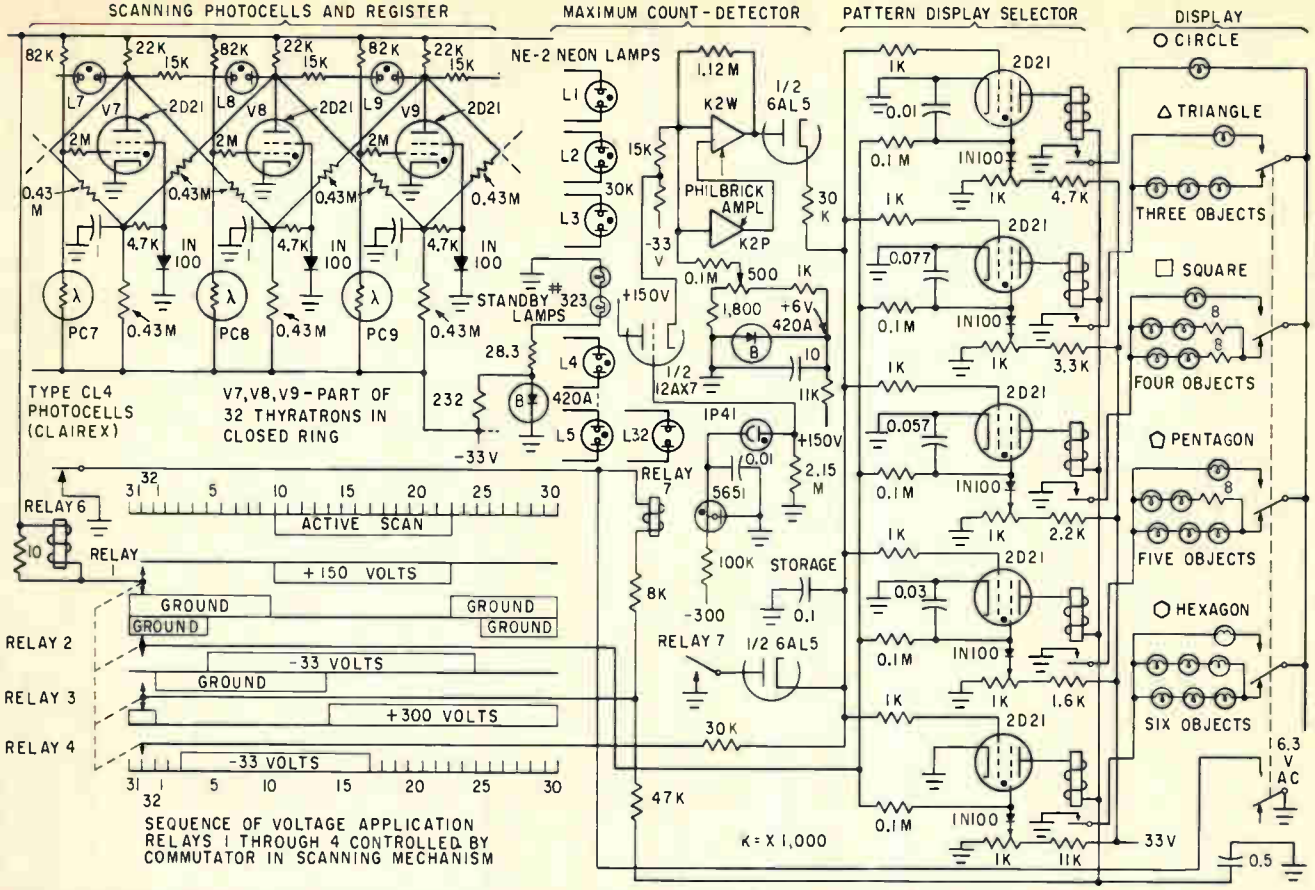

FIG. 5—Schematic of the n-gon recognition system based on the principle of dilating circular scan

the system is shown in Fig. 5.

Scanning photocells are actuated by a motor-driven mechanism when identification of a figure is requested. The same motor drives a rotary tap switch which programs the sequences and durations of voltage applications to different parts of the circuit. The rotary tap switch has two sections of 32 contacts each, one section being used to close control relays and the other section to open them. These relays enable and disable different sections of the circuit by switching appropriate voltages. The sliding contactor arrangement in Fig. 5 represents the operation of these relays.

In the register (Fig. 5), the ONE signals derived from the lines of the figure by the photocells are used to fire thyratrons, thus registering these events for subsequent use. At the start of a cycle, the 32 thyratrons are disabled (no plate voltage) so that the scanning mechanism can come up to speed. When it does, relay 1 applies voltage to the plate bus and the active scan cycle begins. As a photocell passes under a line of the figure, it generates a positive pip, large enough to overcome the bias on the thyratron control grid, causing firing.

The 32 thyratrons form a closed ring, tied plate-to-plate by small neon lamps such as L_7, L_8 and L_9. When one thyratron conducts, its plate potential falls, while that of its neighbors remains high, and so the two lamps on either side will light up. If a neighbor is fired, the lamp between the fired thyratrons, having little or no potential difference across it, goes out. However, another lamp goes on between the newly fired thyratron and its unfired neighbor. As more thyratrons are fired, lamps are progressively turned on and off, the lit one at any moment locating the boundary of fired and unfired stages. As the cycle proceeds, two lamps will light at the first points of contact with each side of the figure, then separate and run out toward the vertices. The photocell in the lamp housing will see $2n$ lit lamps corresponding to all sides scanned, regardless of the temporal sequence. Thus an analog voltage proportional to the number of sides is generated.

In the final step of the recognition cycle, this electrical analog of an n-gon is classified and then identified by a lighted display.

I acknowledge the assistance of C. F. Mattke and S. E. Michaels.

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Broad-Band Frequency

Used in studies of the ionosphere, this system has a

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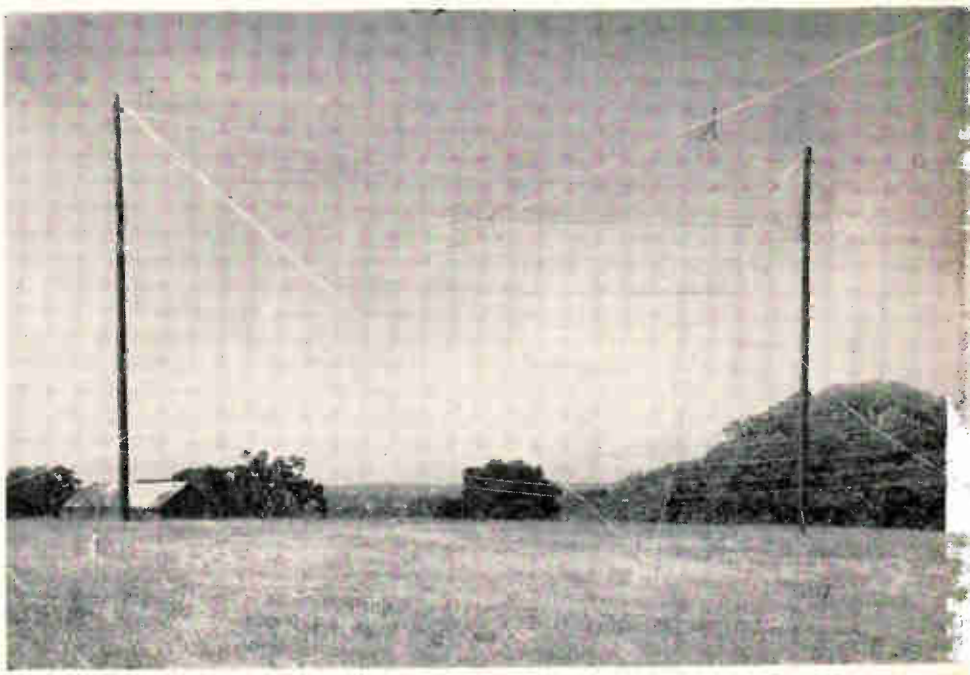

This 6-to-50 Mc log-periodic antenna is the transmitting antenna of the system

RADAR STUDY of artificially or naturally produced clouds of ionization at ionosphere heights requires a radar system which covers a wide range of frequencies at a high rate of frequency scan. The radar probe should permit doppler observations of the cloud velocity and diffusion, have sufficient output power and receiver sensitivity to yield acceptable signal-to-noise performance, and provide antenna performance independent of frequency. The system sequentially scans seven frequencies in the 6 to 50-Mc band at 60 frequencies per second, operates on a coherent basis in providing doppler data on each frequency, has a peak power of approximately 15 Kw and sufficient sensitivity to insure that the detected noise level is set by atmospheric or cosmic noise. The system uses log-periodic antenna yielding a gain of approximately 10 db and a vswr (voltage standing wave ratio) under 2.5:1.

The principle of operation of this multifrequency h-f radar system is explained by Fig. 1A. The r-f portion of the system consists of seven independent exciter and receiver combinations. The exciters are keyed in sequence by a pulse distributor, whose output rate is 60 pps. Outputs of the seven exciters are combined in a transmitting multicoupler and amplified by a linear distributed amplifier. The distributed amplifier yields a pulse power output of approximately 15 Kw and a gain of approximately 17 db at 1-percent duty cycle, and drives a log-periodic antenna through a 50-ohm coaxial feed line. The five receiver channels which operate below 30 Mc are connected through a receiving multicoupler and preamplifier to a transmit-receive (t/r) switch. The 30 and 50-Mc receivers are connected through low-noise preamplifiers (the 30-Mc preamp is not shown) to individual Yagi antennas to avoid the sensitivity degradation associated with the t-r switch receiver multicoupler at these frequencies. Video outputs of the receivers are combined with range mark signals in a combiner unit, and recorded on individual channels of a seven-channel tape recorder. A monitor cro permits visual monitoring of any video channel with an A-scope presentation.

The phase-path oscillator provides for observing the effects of doppler shifts associated with target motion directly on the A-scope display. The ouput of this highly stable oscillator, which is approximately 10 Kc, establishes the exact frequency and phase of the prf generator. This oscillator output voltage also generates a suppressed carrier single-sideband modulation

SCANNING SYSTEM CAPABILITIES OF THIS RADAR

***This** system makes it possible to obtain data on target-characteristics that heretofore were unobtainable. Data that must be known to interpret many experiments are the frequency dependence of target size and echo intensity. The wide band width and fast frequency scanning of this system enable it to obtain such data without the obscuring effects of differing system parameters and differences in target aspect that are inherent when independent radars are employed on each frequency. The system's phase-path display feature permits accurate determination of target velocity and when scanning ionized clouds, determination of diffusion rates.*

If the basic system described here is expanded to include several reception sites, with these sites being synchronously stepped in frequency, the system's information yield is considerably augmented

Scanning RADAR SYSTEM

novel arrangement for detecting doppler shifts caused by target motion

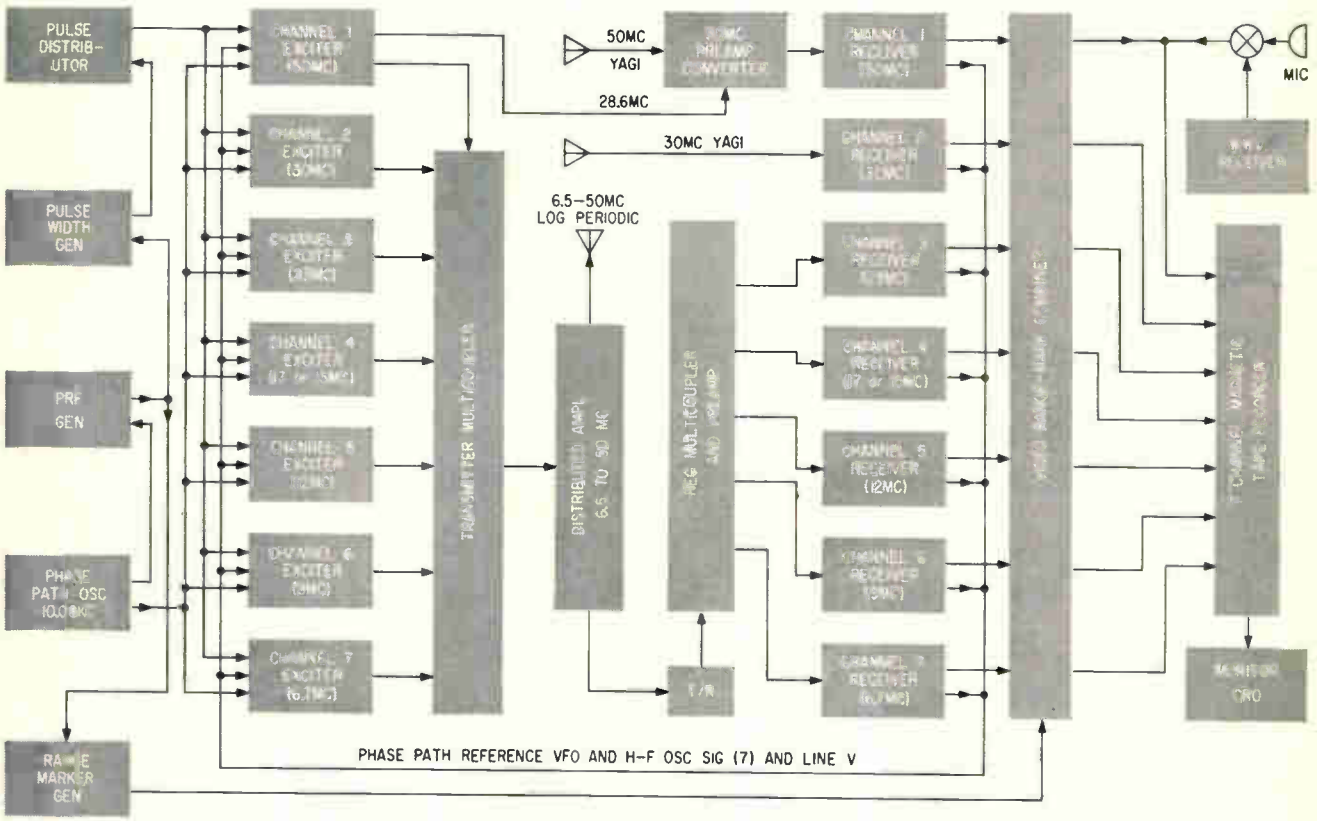

FIG. 1A—Scan radar system has seven sequentially operated channels in frequency range of 6 to 50 Mc

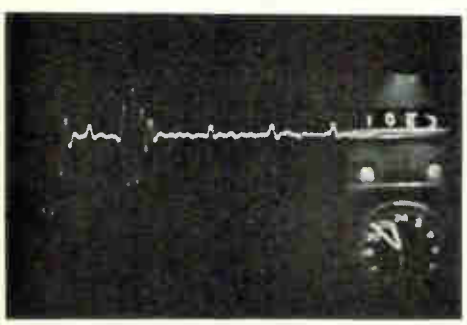

FIG. 1B—Crt readout at 23 Mc showing echo and 100 Km range marks

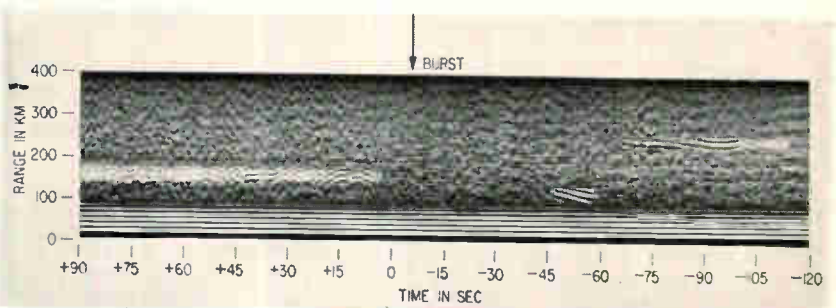

FIG. 1C—Taped response of radar: high altitude electrochemicals show returns commencing at t = O, while meteor trails appear at t = −120

in each exciter. Each transmitted frequency is therefore offset 10 Kc from the carrier-frequency reference voltage coming from each receiver. This permits synchronous, or coherent, detection of the radar echoes in which the relative phase of the echo is retained from pulse to pulse. Thus the transmission on each channel is a series of pulses with the modulation (offset) frequency and prf accurately interlocked to a phase at the initiation of each pulse. Figure 1B shows a typical A-scope display at 23 Mc. The 10-Kc offset modulation superimposed on the transmitted and echo pulses is visible, as are the 100-Km-range marks. If the target is stationary, the sine-wave pattern imposed on the echo will remain stationary. If the target is moving, however, comparison of successive received pulses will reveal an apparent right-to-left or left-to-right motion of the sine-wave pattern of the echo pulse. Direction of this motion indicates longer or shorter ranges, depending on whether the target motion is away from or toward the radar. Figure 1C shows a range-time recording at 23 Mc. In this record, time increases from right to left and range from bottom to top. The echoes occurring in the interval $t = -50$

to $t = -120$ sec are from meteor trails. The echo commencing at $t = 0$ was produced by releasing a photochemical from a high-altitude sounding rocket. The alternate dark and bright bars produced on the intensity-modulated display by the 10 Kc phase-path signal are visible, as is their displacement due to target motion. A shift in range to the target of one half wavelength at 23 Mc (approximately 14 ft) displaces the bar pattern by 180 degrees; that is, light and dark spaces change places. This method of measuring and displaying target motion provides a far more accurate determination of target velocity than is possible from measurements based on pulse delay alone. However, the accuracy in absolute measurement of range is still set by usual parameters such as receiver bandwidth and pulse shape.

The distributed linear power amplifier and log-periodic antenna combination makes possible the wide-band fast-frequency-change character of the system. This approach permits an efficiency, power gain and stability of performance with frequency that cannot be realized with wide-band video amplifiers and antennas using resistance loading or termination. Furthermore, this approach avoids the electromechanical design and maintenance problems.

The distributed linear power amplifier uses six 4-250A tetrodes in a conventional low-pass configuration. To achieve maximum efficiency and full use of tube capabilities, the plate line has d-c isolation between the third and fourth stages and the plate voltage for the last three tubes is 60 percent higher than for the first three. The amplifier is screen pulsed. Optimum gain and power output are achieved with plate and grid-line characteristic impedances of approximately 600 and 200 ohms. Impedance matching to 50 ohms at the input and output, and at the terminations of the two lines, is obtained with ferrite-core autotransformers. The small-signal frequency response of the amplifier is plotted in Fig. 2. Large-signal response measurements indicate that power drop-off at the band edges is more gradual than in Fig. 2. The large-signal power gain is 17 db or

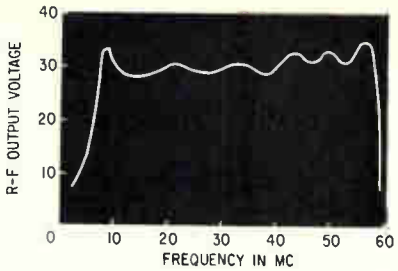

FIG. 2—Response of distributed amplifier to low level signals

greater across the band. An output power of 12 Kw at an 0.01 duty cycle is available with drive corresponding to Class A operation. Subsequent to the development of the system, a distributed linear power amplifier delivering a peak power output of greater than 100 Kw and a gain of 24 db from 5 to 35 Mc has been completed.

The log-periodic antenna is a transposed-dipole ($\tau = 0.8$, $\alpha = \psi = 45$ deg). The antenna provides a gain of approximately 10 db relative to an isotropic antenna and a vswr of less thnn 2.5 over the band. Radiation patterns shown in Fig. 3 A and B are independent of frequency in elevation, as well as in azimuth, because of the way the antenna is arrayed with its image in the ground. A ferrite-core balun permits use of 50-ohm coaxial cable.

Two t-r arrangements have been used. The t-r arrangement shown in Fig. 4 is connected between the plate line of the distributed amplifier and its reverse termination. In the interval between pulses, when the distributed-amplifier tubes are not conducting, the antenna is connected to the t-r through the low-pass filter formed by the plate line and tube output capacitances of the distributed amplifier. This results in a lower r-f voltage across the t-r during the transmitted pulse than when the t-r is connected directly across the antenna because of the inherent directional properties of distributed amplification. When transmitting, the transmitted pulse fires thyratron V_1, which connects the reverse termination. When back biased by a 2-Kv pulse from the screen pulser, the stack of eight 600-peak-inverse-volt silicon diodes isolates the receiving multicoupler during the transmitted pulse. A fuse and neon bulb protect the multicoupler in case of t-r failure. This provides approximately 52 db of receiver protection during the transmitted pulse, and a signal loss of approximately 1 db in receiving. A simpler alternative arrangement uses only the diode stack portion of Fig. 4 and is connected directly across the antenna.

The five lowest-frequency receivers are fed from the t-r switch by a low-noise multicoupler and preamplifiers. Two stages of r-f preamplification, using grounded-grid 417A's, provide sufficient gain to insure that the effective noise figure is set by that of the multicoupler. The noise figure is 5.5 db at 23 Mc and 7.5 db at 6.8 Mc. The second r-f stage feeds five identical 6AK5 isolation amplifiers, one for each receiver. Blanking circuits provide additional isolation during the transmitted pulse.

A schematic of the transmitting multicoupler is shown in Fig. 5. A low-pass T-section and a parallel-resonant trap are provided for each channel. A vtvm is plugged into the test point (*TP*) while each channel is adjusted in sequence. Starting from 6.7 Mc, the lowest frequency, each low-pass circuit is sequentially tuned to provide equal input and output voltage and each parallel-resonant trap is adjusted to minimize the voltage at the input of the next-higher-frequency channel. When adjusted, the multicoupler provides isolation between channels and a negligible insertion loss.

Each of the exciter-receiver combinations is a modified Collins 32S1/75S1 combination. The Collins equipment provides approximately 100 w carrier power, good receiver sensitivity and continuous coverage of the 3.4 to 30-Mc range (except for the 5 to 6.5-Mc band). A simplified frequency synthesizer permits a common frequency control circuit for the transmitter and receiver, a feature essential to the phase-path arrangement used here.

The Collins equipment has been modified to permit pulse operation, that is, grid pulsing of the first mixer and first r-f amplifier in the exciter, revised time constants and a direct-coupled output in the receiver, and the frequencies of the receiver bfo and h-f oscillator are changed to accommodate the 10 Kc phase-path signal. The resulting equipment, though not ideal, provides an economic and satisfactory

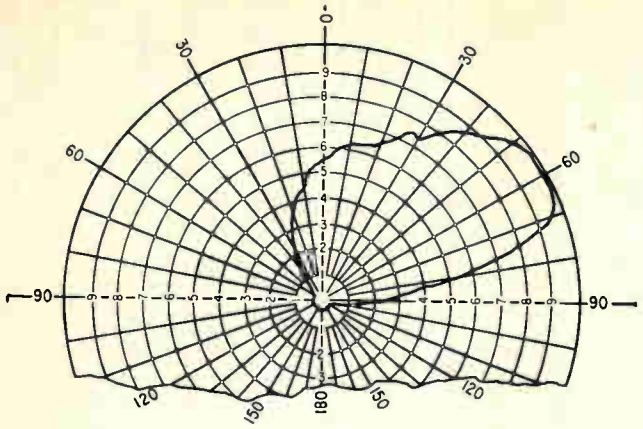

FIG. 3A—Antenna elevation radiation pattern has same shape over the whole spectrum (6 Mc to 50 Mc)

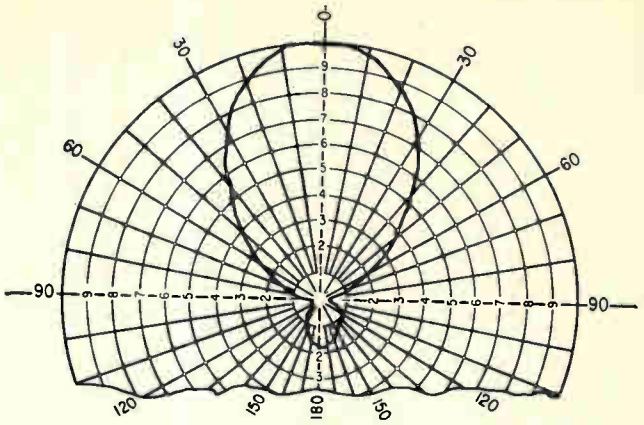

FIG. 3B—Azimuth radiation pattern, like that of elevation, is also independent of frequency of operation

solution to the exciter-receiver requirement.

The 50-Mc exciter-receiver requirement is met by adding to a modified Collins 32S1/75S1, additional conversion and amplifier stages to retain the interlocked feature, that is, the common frequency control facility, of the basic 32S1/75S1 system.

The pulse distributor accepts the phase-locked pulses from the prf generator and provides sequential keying pulses to the seven exciter-receiver combinations. Every eighth pulse is ommitted for synchronize data recording and analysis. The straightforward circuit uses a type 6700 magnetron beam switching tube. Diode gating is employed, followed by triode pulse amplifiers delivering the required pulse amplitude and polarity.

The multichannel magnetic-tape recording system provides flexibility in data reduction and analysis.

This system was first assembled and operated in the form described under subcontract with the Radio Sciences Laboratory of Stanford University (Subcontract S-117, Contract AF 19(604-2075 Air Force Cambridge Center). Credit is due to Phillip B. Gallagher, project director of the Stanford program, for his guidance and support in this program. At Granger Associates, the development program was under the direction of Stuart R. Hennies. The distributed linear power amplifier development was carried out by James E. Sterrett. William G. Hoover and Gordon F. MacGinitie were responsible for many of the other developments.

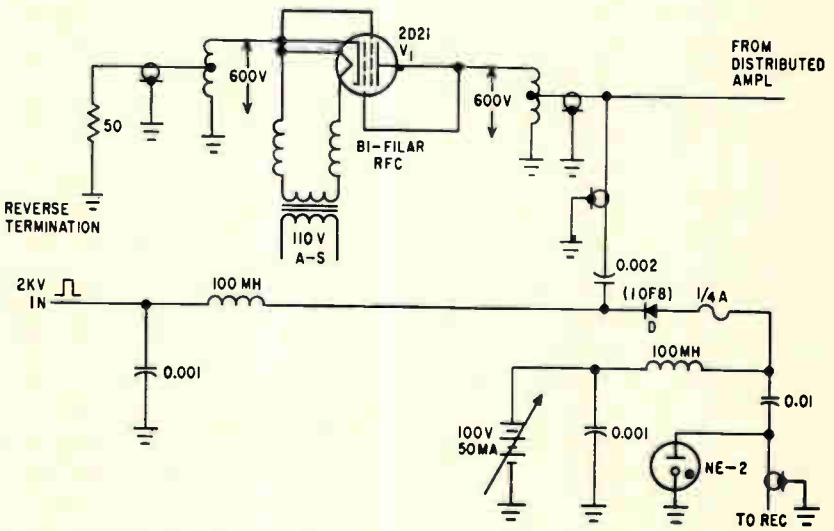

FIG. 4—Transmit-receive arrangement. In the receiving mode, an echo pulse would come from antenna, go through plate line of distributed amplifier, on to receiver

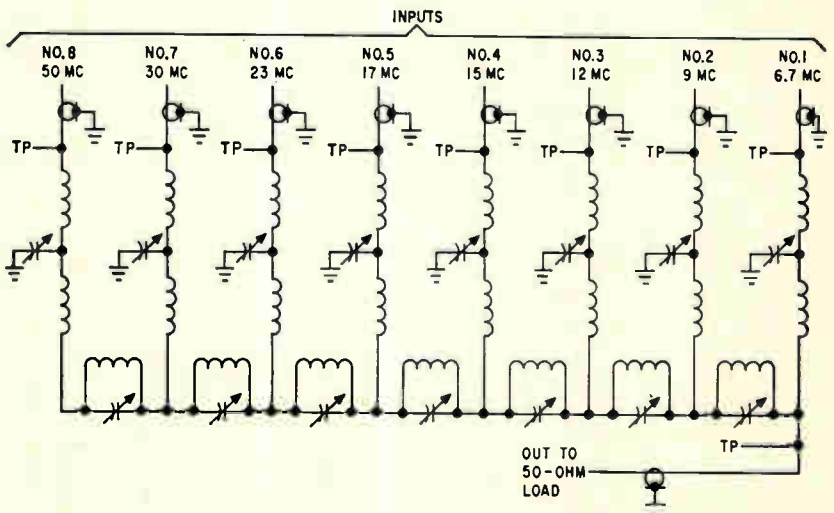

FIG. 5—Transmitting multicoupler with low-pass T-section and parallel-resonant-trap for each channel. Output is fed to distributed amplifier

Automatic Welder For Thin Foils

By DONALD D. KLINE,*
Hexcel Products, Inc., Berkeley, Calif.

TYPICAL EQUIPMENT for hand welding thin gage foils has been manual or at best semi-automatic, with maximum operating speeds of 1 to 3 welds per second. A completely automatic welder now available will produce uniform, high quality welds at rates up to 15 per second. Compactness and weight reduction are obtained with solid-state circuits, and welding energy is sufficient for foils 10 mils thick.

The operational functions of the welder—as shown in Fig. 1A are divided into three sections: an electronic control to govern movement of the welding electrodes, a circuit to adjust welding energy, and a pneumatic system for mechanical forces and movements.

The electrode movement control operates a solenoid valve in a pneumatic system. Energizing the valve closes the electrodes; when deenergized, the electrodes are open.

Pulse duration and the time interval betwen pulses are independently adjustable. The result is that the valve is energized cyclically, with the total cycle time being the sum of pulse duration and the interval between pulses. Each time period is adjustable from 0.5 to 0.033 seconds. Control circuits of the pulse generator permit a continuous series of welds or manual operation.

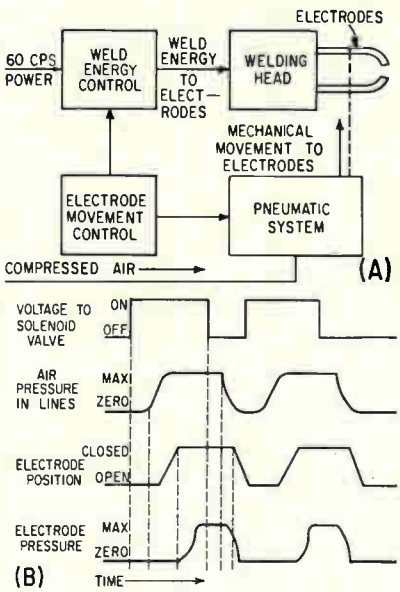

FIG. 1—Pneumatic actuator and electronic control (A) allow up to 15 welds per second. Electrode pressure in (B) does not decrease immediately when valve is deenergized

During the automatic operation, welds are made as long as a switch on the welding head is depressed. In manual operation, the solenoid valve is energized as long as the weld switch is depressed. The control section provides a precise, adjustable source of welding energy. Gating of electrical energy is accomplished by controlled rectifiers triggered by a typical phase-shift circuit.

The electronic circuits can be considered instantaneous but there is a time delay in the solenoid valve and pneumatic systems. Upon application of voltage to the solenoid valve, the electrodes do not close immediately. A timing chart of this action is shown in Fig. 1B.

As shown in Fig. 1B, the electrode pressure is maximum at the instant the solenoid valve is deenergized. One pulse of energy is delivered to the weld at this time. There is no synchronization between electrode movement and the 60 cycle line but mechanical and pneumatic inertias are such that if the weld is made at the first opportunity after deenergizing the solenoid valve, welding pressure will still be at the pre-set value. This system assures uniform pressure at the electrodes for successive welds, uniform energy levels to make the welds and high welding speed.

The cyclic or reciprocating mo-

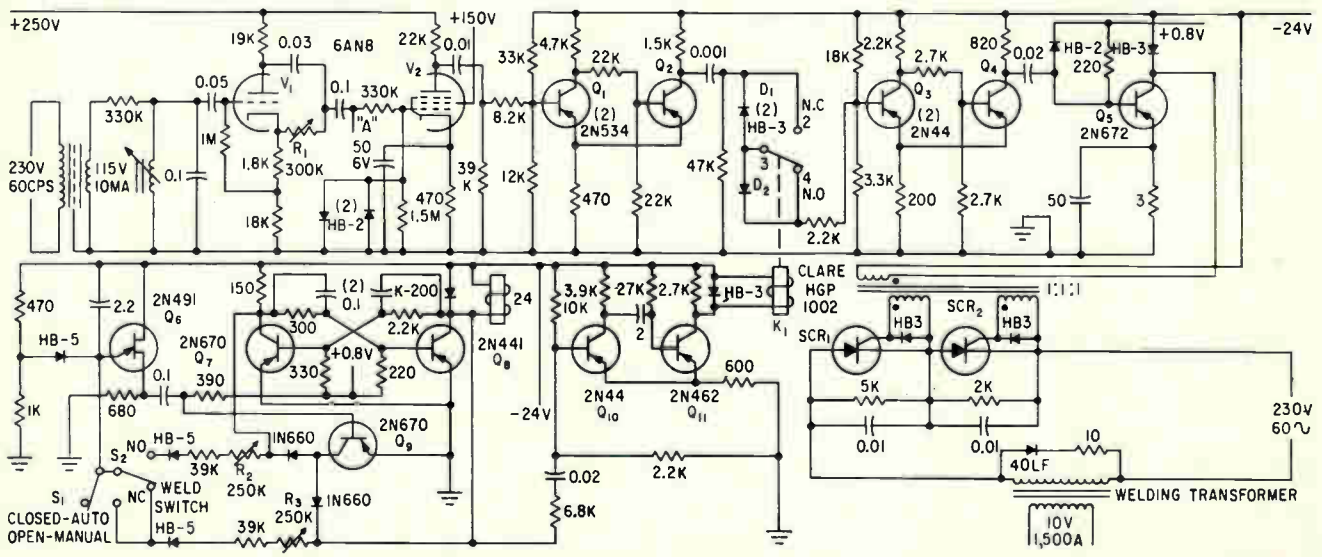

FIG. 2—Control circuit uses gated rectifiers to generate welding pulse. Power supply and on-off switches and relays are not shown

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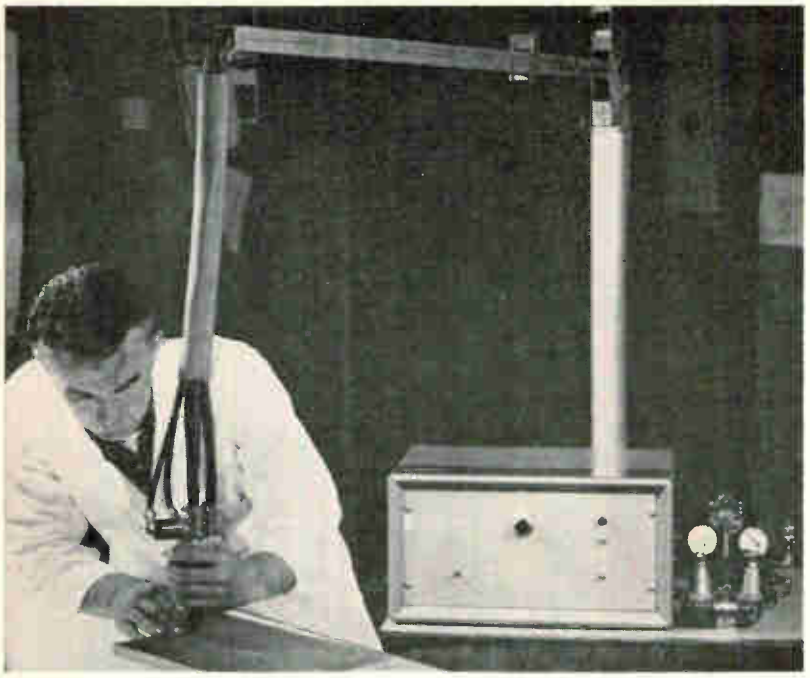
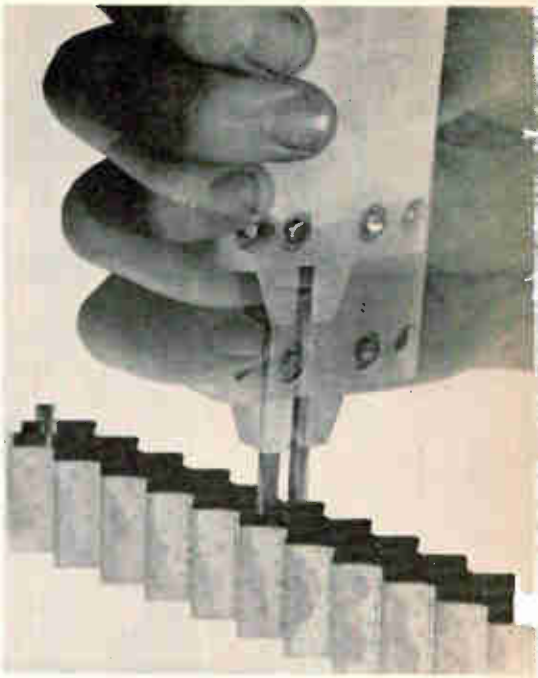


Welder averages 12 to 15 welds per second, is shown with honeycomb section for which it was originally developed



Double exposure shows how a string of uniform welds can be produced

tion of the welding electrodes allows a progressive movement of the electrodes along the work, obtained by a steady pushing or pulling motion. When the electrodes are closed, friction prevents them from moving during the time the weld is being made.

A schematic diagram of the welder is shown in Fig. 2. Energy from the 60-cps line is applied to a 60 cps resonant filter to remove line transients, then applied to a constant-amplitude phase shifting circuit (triode V_1).

Phase control is accomplished by adjusting the 300,000-ohm potentiometer R_1. The phase-controlled 60-cps signal is then clipped by a pair of diodes in the grid circuit of pentode V_2, amplified by V_2 and applied to a Schmitt trigger, Q_1 and Q_2.

The output at the collector of Q_2 is a square wave with fast rise and fall which is differentiated to yield positive and negative pulses. These pulses are in a fixed time relationship to the 60 cycle line, with the exact value of this relationship determined by the amount of phase shift introduced by R_1.

The differentiated timing pulses are passed through either D_1 or D_2, depending on the position of the contacts of mercury relay K_1, and applied to a second Schmitt trigger, Q_3 and Q_4, which acts as a memory. When the contacts of K_1 are shorting out D_1, only positive signals reach the base of Q_3. When the relay changes position, the Schmitt trigger changes state when the first negative pulse arrives. This pulse turns Q_3 on, causing Q_4 to cut off and thus provide a negative pulse to Q_5. Transistor Q_5 acts as a pulse amplifier to trigger the gated rectifiers and thus provides a pulse of weld energy. When K_1 returns to its original position, Q_3 and Q_4 are reset by the first positive pulse.

Because single controlled rectifiers with sufficient voltage rating were not available when unit was designed, two were used in series. Resistive and capacitive dividers assure equal voltage sharing. Diode and resistor across welding transformer primary are for damping.

Timing signals for electrode movement are generated by Q_6, a unijunction transistor in a relaxation oscillator circuit. Output pulses from Q_6 are amplified by Q_9 and cause the power flip-flop, Q_7 and Q_8, to change states. The solenoid valve, which controls electrode movement, is the collector load of Q_8. Charging voltage for Q_6 is obtained from the collector of Q_7 or Q_8 through isolating diodes. When the auto-manual switch, S_1 is in AUTO, and weld switch S_2 is depressed, both charging paths are completed and the binary will change states at intervals determined by the settings of R_2 and R_3. When the weld switch is released, the only charging path is through Q_8; therefore the binary will always stop with Q_8 in the cut-off condition. During manual operation (S_1 open) either — but not both — charging paths are available. With S_2 released, Q_8 will go off; with S_2 depressed, Q_7 will be off and Q_8 on.

With Q_8 on, the solenoid valve is energized and the electrodes are closed. Resistors R_2 and R_3 provide the means to control the intervals of the binary and thereby adjust the open and close times of the welding electrodes.

Each time Q_8 is turned off, thereby initiating the chain of events that lead to the welding electrodes opening, a negative step function appears at its collector. This step is differentiated and used to trigger a monostable multivibrator Q_{10} and Q_{11}. A fast-acting, mercury-wetted relay, K_1, is controlled by this circuit. The period of the one-shot is made greater than 17 milliseconds to assure that at least one negative pulse arrives at the base of Q_3. Thus a weld is made within 19 milliseconds after deenergizing the solenoid valve. (The maximum delay is 1 cycle or 16.6 milliseconds plus about 2 milliseconds drop-out time for K_1.)

The contributions of A. J. Van der Meer and L. C. Nichols to mechanical and pneumatic design are gratefully acknowledged.

HIGH INPUT IMPEDANCE

When designing such circuits, this method produces low noise

By IRVING LEVINE,
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IN TRANSISTOR-CIRCUIT design, the need often arises for a low-noise amplifier with a high input impedance. For impedance values under one megohm this problem can be handled by a common-collector stage with an unbypassed emitter resistance and a high-beta transistor. However, novel circuits must be used to achieve input impedances of one megohm to 100 megohms.[1, 2, 3, 4] Variations of the Darlington connection, which uses direct-coupled transistor stages and operates as a super-alpha transistor, and ways to achieve bias stability, will be covered. Four types of circuit noise, their contribution to the overall noise output of an amplifier and how to control noise will also be discussed.

In a conventional common-collector circuit, such as Fig. 1A, where V_{BB} is high, thus making R_B high, the input resistance is $R_{in} \approx \beta R_E$ neglecting R_B and excluding the high-frequency range.

Thus, if β is high and R_B is large, resistance in the order of one megohm is realizable. An extension of this was developed by Darlington as a double emitter follower (Fig. 1B). It has been shown that its $h_{fe} \approx (1+h_{22}')h_{21}''$ where the h's are the common-emitter values. The input resistance (Fig. 1C) of this configuration yields high values; using a high-gain 2N78, it is 1.5 to 30 megohms, depending on I_{E2}. Selection of transistors, bias stability of the operating point, as well as biasing of the first stage limits its usefulness as a production unit.

Referring to Fig. 1A and assuming that r_c (resistance from base to collector) is large, and taking R_B into consideration, the input resistance is

$$R_{in} = V_{in}/i_{in} = \beta R_E R_B/(\beta R_E + R_B) \quad (1)$$

The equivalent circuit of Fig. 1D indicates that if i_{in} is diminished, R_{in} increases proportionally.

Assume (Fig. 2A) that a signal (V_F) is available that is in phase with input signal V_{in} and smaller in magnitude than V_{in}. By applying this in-phase signal (V_f) to points on the initial circuit, the input resistance will increase by a large factor. Current i_B becomes i_B $(V_{in} - V_F)/R_B$ and assuming unity gain in a common-collector stage $i_E = (V_{in} - V_F)/R_E$

The new input impedance, R_{in}', is now equal to

$$R_{in} = V_{in}/[(V_{in} - V_F)/R_{in}] = V_{in} R_{in}/(V_{in} - AV_{in}) \quad (2)$$

where A is the gain and $V_F = AV_{in}$. Thus

$$R_{in}' = [1/(1 - A)]\, R_{in} \quad (3)$$

This indicates that if a high input impedance is desired, the gain must be positive and less than unity. If A is positive and equal to or greater than unity the system is unstable and will oscillate at the frequencies of the unstable points.

Let r_c equal the incremental l-f resistance of the transistor from base to collector.

Consider r_c and note its effect on input impedance. Referring to Fig. 2B and 2C, the input resistance is

$$R_{inT} = r_c R_{in}'/(r_c + R_{in}') \quad (4)$$

If R_{in}' is $>> r_c$,

$$R_{inT} \approx r_c = V_{in}/i_{in} \quad (5)$$

The problem here is similar to that previously encountered, that is to reduce the input current in the r_c branch. This can also be accomplished by choosing transistors with high r_c, but as the transistor is operated at higher temperatures, r_c will decrease. It is desirable that the impedance become independent of the r_c of the transistor. The solution is to use the in-phase feedback technique.

In Fig. 2D, assume that there is a signal available, V_F', which is in phase with V_{in} and is less than V_{in} in magnitude. Neglecting R_{in}'

$$R_{inT}' = [1/(1 - A')]\, r_c \quad (6)$$

where $A' = V_F'/V_{in}$

$$R_{in}'' = \frac{R_{inT}' R_{in}'}{R_{inT}' + R_{in}'} = \frac{[r_c/(1-A')]\,[R_{in}/(1-A)]}{[r_c/(1-A')] + [R_{in}/(1-A)]} \quad (7)$$

If $A' = A$

$$R_{in}'' = [r_c R_{in}/(r_c + R_{in})]\,[1/(1-A)] \quad (8)$$

Series resistor R_S, which is considered negligible in the analysis, isolates the a-c short point, V_{cc}, from the feedback point. To make $V_F = V_F'$, the feedback can be taken from a common point, as shown in Fig. 3. The feedback point is the junction of R_F and the R_E resistors. The two collectors are bootstrapped by capacitors CF_2 and CF_3 from the common feedback point. Feedback to emitter resistors RE_1 and RE_2 is by direct connection. So the system may work from one power supply and have a-c feedback, resistor R_{B1} is connected to the bootstrap point of the first transistor. This resistor acts in parallel with the resistance of r_{c1}.

The input impedance into Q_3 is

$$R_{in3} \approx \beta_3 R_L' \quad (9)$$

where $R_L' \approx R_F R_L/(R_F + R_L)$ neglecting r_c, which is $>>$ R_F and R_L. The input impedance to Q_2 consists basically of two terms in parallel, multiplied by the impedance multiplication factor. Referring to Eq. 8,

$$R_{in2}'' = [(r_{c2} R_{in2}/(r_{c2} + R_{in2})]\,[1/(1 - A)] \quad (10)$$

Here, r_{c2} is $>>$ R_{c2}, R_{S2} is negligible and

$$R_{in2} \approx \beta\,[R_{E2} R_{in3}/(R_{E2} + R_{in3})]$$

The input impedance to Q_1 is

$$R_{in1}'' = [r_{c1} R_{in1}/(r_{c1} + R_{in1})]\,[1/(1 - A)] \quad (11)$$

Here, $r_{c1} >> R_{c1}$ and

$$R_{in1} \approx \beta\,[R_{E1} R_{in2}''/(R_{E1} + R_{in2}'')]$$

with R_{B1} and $r_{c1} + R_{c1}$ being large enough to neglect, in computing r_{in1}.

TRANSISTOR CIRCUITS

Author checks a high input impedance transistor amplifier

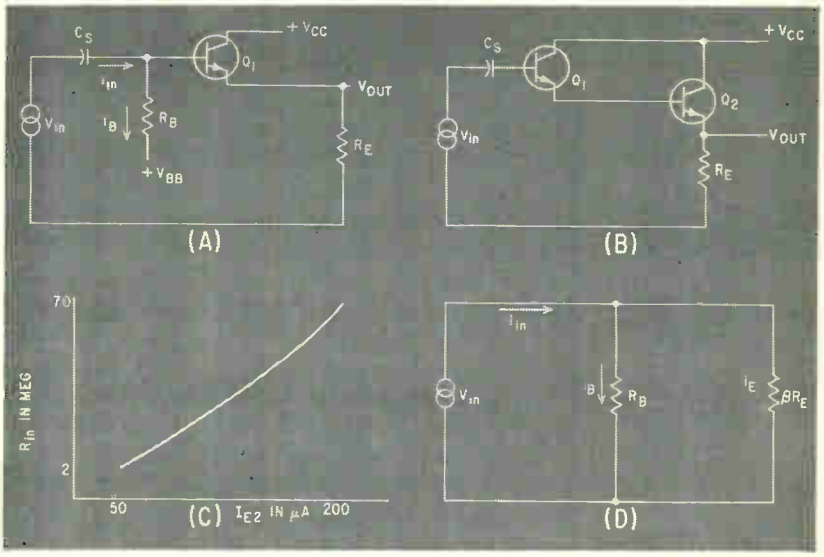

FIG. 1.—Circuit (A) was basis for Darlington circuit (B), whose R_{in} characteristic is shown in (C). Equivalent circuit for (A) is shown in (D)

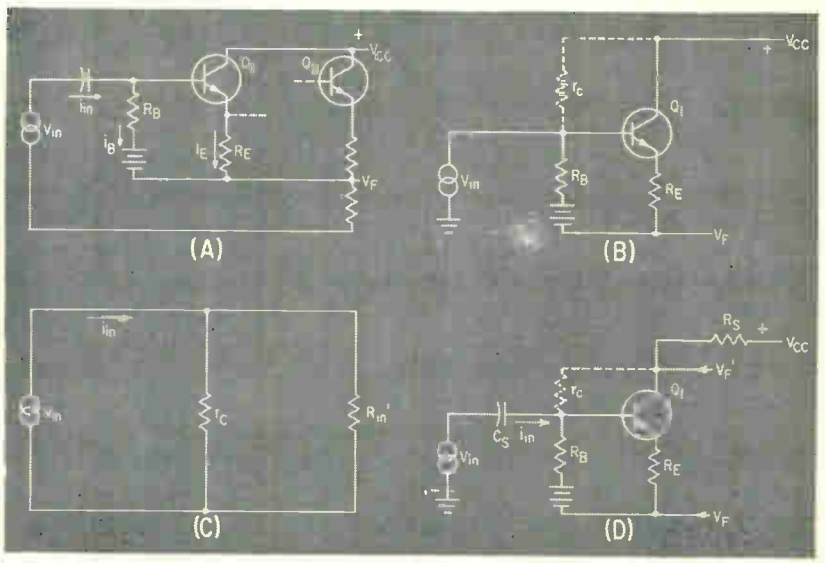

FIG. 2—Evolution of feedback design arrangement. In (A), (B) and (C) only V_F is used; in (D), V_F and V_F' are used

For uniform impedance over the temperature range of − 50 C to + 100 C, the collector of Q_2 is bootstrapped as well as the collector of Q_1. Capacitors C_{F1}, C_{F2} and C_{F3} should have a low reactance so as not to attenuate the feedback signal. They must not be leaky; if they were, they would shift the d-c operating points of the circuit.

Input impedance as a function of I_{c1} is shown in Fig. 4A. Collector current I_{c1} is normalized, abscissa 1 being equal to 500 μa. Using the circuit of Fig. 3 and silicon transistors, input impedance can be held to the set value over the temperature range of − 50 C to + 100 C. Data taken for over 2,000 production units that have the circuit of Fig. 3 show a minimum input impedance of 50 megohms over − 50 C to + 100 C.

The requirement of operation over − 50 C to + 100 C means the circuit must have dynamic swing and therefore requires d-c stability. Since this circuit is d-c coupled, the drift in each transistor, with respect to the d-c operating point of stage Q_3, will be multiplied by the respective transistor betas. To minimize these variations in d-c operating points, a thermistor network is inserted in place of R_F.

The fluctuation of current or voltage in semiconductor devices is termed semiconductor noise. Experiments[5] have shown that these fluctuations are independent of any signal transferred by the device and that at low signal levels they may obscure or override signal. The four types of noise in semiconductors are thermal, shot, leakage and surface noises.[6, 7, 8] Thermal noise is caused by random motion of the current carriers. Shot noise

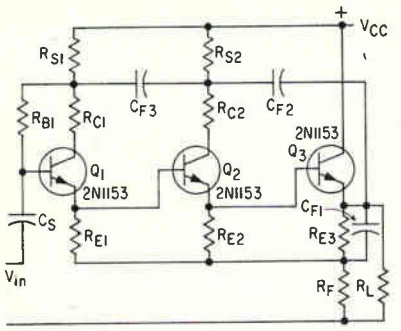

FIG. 3—High input resistance circuit used in noise experiments

results from the drift of the current carriers caused by an applied electric field. Leakage noise is due to erratic conduction paths across the junctions. Surface noise is due to fluctuations in conductivity and in surface states. Experiments using a high-input-impedance circuit such as that shown in Fig. 3, have indicated that thermal noise and shot noise are both much lower in magnitude than that of flicker or leakage and surface noise.

Causes of flicker noise[8] are not yet fully understood, but Fonger has successfully investigated these noise sources and discovered their proper place in the equivalent circuit. The characteristic of flicker is that it increases as the frequency decreases.

Surface noise is discussed in relation to the two types of energy levels at the surface of a semiconductor. These energy levels are slow and fast states. A slow state fluctuates the occupancy and modulates the conductivity. It also modulates the capture cross section of the recombination centers. This state basically acts as a trap for the majority carriers. Fast states act as a recombination center for minority carriers. The fluctuating current of minority carriers disappearing at the surface causes a fluctuating current to flow through the junctions and modulates the series resistance of the junction. This produces a slow current or voltage modulation at the junction that appears as noise at the output of the transistor. Surface noise is sensitive to ambient atmosphere, being large in a humid atmosphere. It can be considerably reduced by decreasing the forward bias of the semiconductor. It increases strongly with increasing forward bias.

Surface noise is caused by oxide impurities around base-emitter and base-collector junctions. These impurities are a function of the manufacturing process.

Leakage noise is caused by a thin conducting film that causes by-passing of the junction. The film occurs at the perimeter of the junction and gives rise to a d-c leakage conductance that increases with increasing bias. Spontaneous fluctuation in this leakage conductance causes leakage noise. This fluctuation is sensitive to ambient atmosphere as surface noise is. Surface treatment can reduce it so that it becomes negligible for bias voltages less than a few volts.

Leakage noise can be represented by a current generator i_L in parallel with the collector. In germanium semiconductors

$$i_{eqL} = 2 \times 10^{12} (i_L)^2/f \qquad (12)$$

where f is frequency of operation (3-db points) in cps, and i_{eqL} is the leakage equivalent saturated diode current. This equation has been verified by test within a factor of 10.

Leakage currents and noise are not simple functions of the reverse voltage, but show hysteresis and are dependent upon the reverse-bias history preceding the measurement. Measurements of flicker noise at low temperatures showed an increase in noise from that at room temperature. When the semiconductor was returned to room temperature, the level of noise followed an exponential drop, with some semiconductors showing a time constant of hours.

In Fig. 3, the first transistor contributes the majority of the noise and the second transistor the next largest amount, and so on. Ideally, for low surface and leakage noise, the first transistor would be operated at zero collector-to-emitter voltage and zero bias current. This cannot be accomplished, but a low value of V_{ce} and a low value of I_c can be obtained. The characteristic of noise voltage referred-to-the-input (e_i) as a function of collector current (I_{c1}) with a source impedance of 1,000 $\mu\mu$f is shown in Fig. 4B. Collector current in normalized, 1 being equal to 500 μa. If the source impedance is reduced to zero ohms, noise is reduced to about 1/15 the values shown.

Amplifiers have been produced with a maximum noise level of 750 μv rms (referred to input) over the temperature range of −50 C to +100 C. These units are primarily used for accelerometers which have an output impedance of 1,000 $\mu\mu$f. An amplifier unit consists of the 3-transistor high-impedance low-noise circuit (Fig. 3) and a 3-transistor feedback voltage amplifier. Its voltage gain is variable from 10 to 100 and holds within ±3 percent over the environmental range. Output impedance is 600 ohms with a frequency response of 5 cps to 20 Kc.

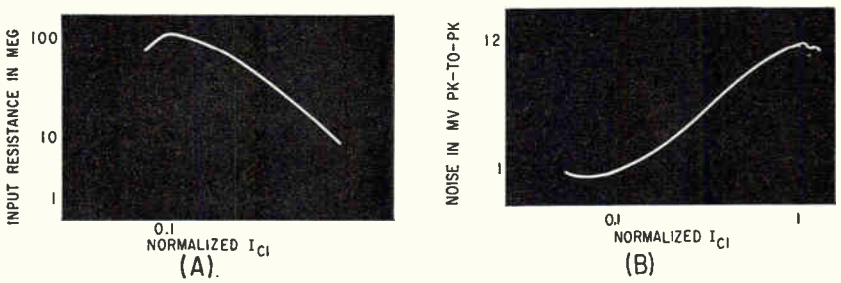

FIG. 4—Input resistance (A) and noise voltage (B) as functions of I_{c1}

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Electronic Blood Analyzer

Relative concentration of red cells is calculated by resistance measurement of blood sample in Wien bridge. Entire operation with electronic hematocrit takes less than one minute

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ELECTRONIC instrumentation in medicine and biophysics has been mostly research and development. Some large installations are being made for monitoring of patients in delivery and operating rooms but these contribute mainly by telemetering information from remote locations. There is another way for electronics to contribute in the medical and biophysical fields: by measurements of diagnostically significant parameters using the electrical properties of biological material. The electronic hematocrit is such a device. It detects the relative volume concentration of red blood cells (erythrocytes) in whole blood by resistance measurement.

Hematocrit measurements are taken in addition to or instead of red blood cell counts. Red-cell counting is a highly inaccurate technique as usually performed. With the hematocrit measurements, however, where the cell size is normal, the volume concentration correlates exactly with the cell count. Nevertheless, the count and hematocrit are basically two distinct measures and both are sometimes useful in diagnosis.

Hematocrit measurements are performed by spinning a sample of blood in a high-speed centrifuge, and visually measuring the percent of volume taken up by the red cells. This is possible because the heavier red blood cells retain their color against the clear plasma or serum. Errors are inherent in this technique. Due to shape effects, blood cells do not always pack uniformly, especially abnormal cells. Extreme centrifuging speeds damage the cells while practical speeds do not spin out all of the cells and even then probably damage some of them. Errors due to the blood holders not having a uniform dimension are also present. In addition the centrifuge requires a source of 110 v a-c power and is therefore not portable.

The electronic hematocrit is a portable (2 lb) battery-powered device that requires a small amount of blood (0.02 cu cm), and which gives a direct hematocrit reading in less than a minute without damage to the blood cells.

The electronic hematocrit operates on the principle that the red blood cells are electrically insulating below about 100 Kc, at which frequency their capacitive properties become significant. Serum, on the other hand, is a temperature dependent conductor. The resist-

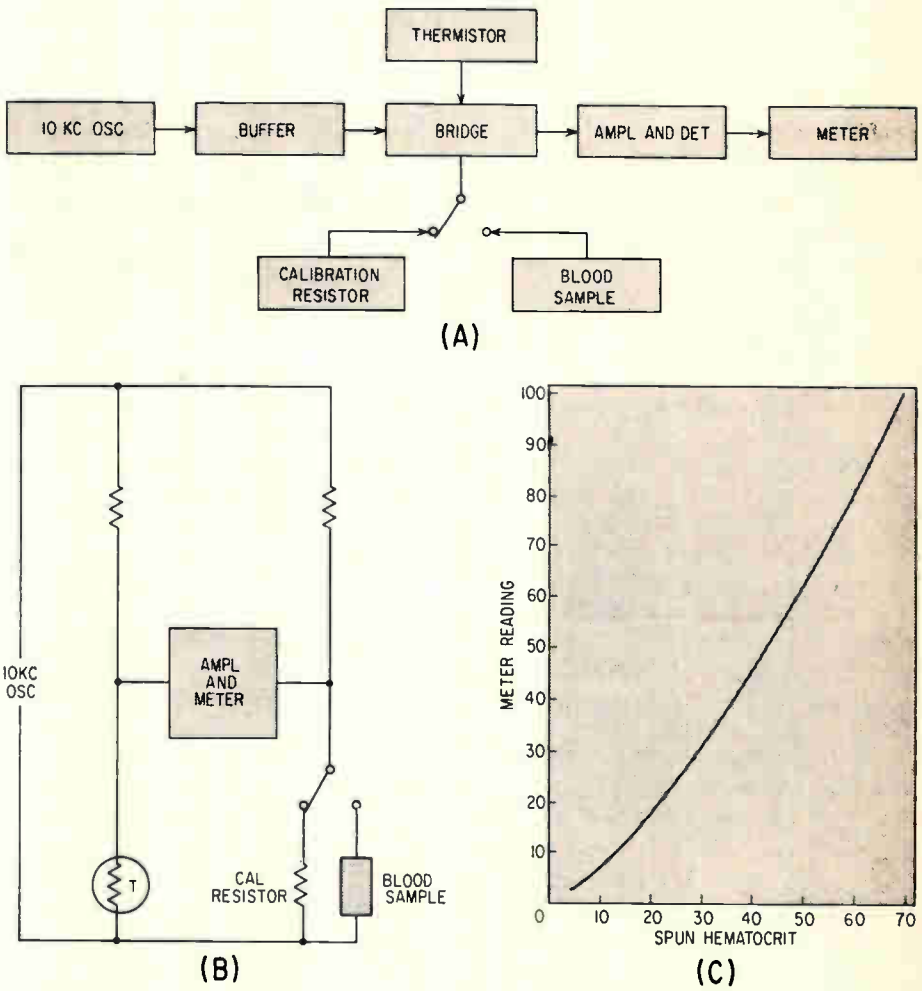

FIG. 1—Blood analyzer block diagram (A) and bridge schematic (B) show calibration resistor in circuit when power is on. Calibration curve (C) shows relation between centrifuged (spun) reading and electronic reading

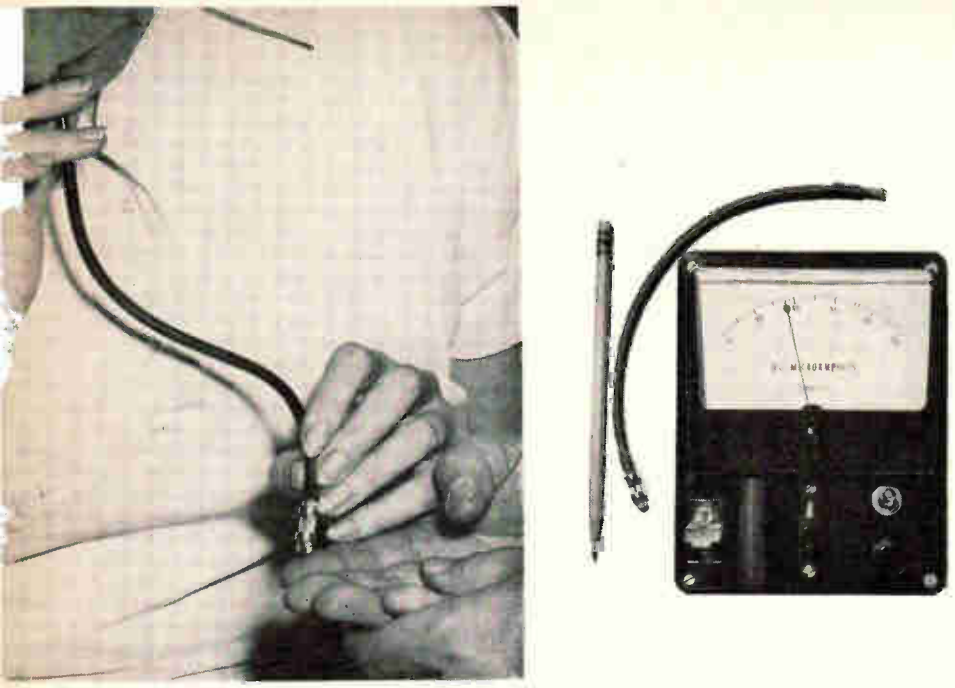

FIG. 2—Prototype instrument (right) shown with blood pipette and suction tube. Technician (left) takes blood into pipette from finger for use in electronic hematocrit

ance of a calibrated volume of blood is therefore a function of the relative volume concentration of the insulating blood cells.

It would not be possible to build an instrument to correlate resistance and hematocrit unless the ionic concentration of the plasma was consistent among people. However, although individual ionic strengths (such as sodium and potassium) vary from person to person, the total ionic concentration stays remarkably constant.

Abnormalities in ionic strength, serum protein concentration, cell size, and cell shape could conceivably affect the electronic hematocrit readings. This is considered advantageous since an abnormal reading will probably result, calling for further tests. The probability that these grossly abnormal effects could nullify themselves to give a normal reading is extremely small.

Figure 1A is a block diagram of the electronic hematocrit meter. The circuit contains five transistors and one diode. A 10-Kc Wien bridge oscillator feeds an emitter follower buffer which drives an off-balance bridge. The bridge circuit is shown in Fig. 1B. When the power switch is turned on, the calibration resistor is already in the bridge circuit, and the gain control is adjusted to a calibration position. When the operate switch is depressed, the blood sample is placed in the bridge circuit and the unbalance of the bridge is amplified, detected and sent through a 100-μa d-c meter. The meter reading is converted to hematocrit by the calibration curve shown in Fig. 1C. This calibration curve can be made into a meter scale for direct hematocrit readings from the meter face. Figure 2 (right) is a photograph of the prototype electronic hematocrit meter. The pipette for holding the blood is shown at the left attached to a flexible suction tube and mouthpiece. After the pipette is filled with blood it is snapped into the receptacle on the left side of the panel for connection to the bridge. The two outer rings of the pipette are electrical contacts that are connected externally to platinum electrodes inside the pipette. Platinum is required to reduce polarization impedance effects, which is the reason for requiring an a-c resistance measurement. Polarization impedance decreases with frequency, thus making the operating frequency a compromise between polarization impedance effects and red-cell capacitive effects. At 10 Kc the polarization impedance of the pipette used is less than 1 percent.

To the right of the pipette receptacle on the panel is the thermistor shield. The thermistor is outside the meter case to sense ambient temperature, and the shield is for physical protection. In the center is the operate switch which when depressed connects the blood pipette into the bridge, and when not operated connects the calibration resistor in the bridge circuit. The upper right switch is for ON-OFF power and below it is the gain control for calibration.

The sequence of operation is (1) turn on power and adjust meter to calibration marker with gain-control knob, (2) take blood into pipette and insert pipette into panel receptacle, (3) depress operate switch and take reading.

The whole operation takes less than a minute even with a cold meter because the transistor oscillator and amplifier have negligible warmup time.

Reading accuracy depends only on short-term stability and since the meter returns to calibration after releasing the operate switch, any drift is obvious.

Figure 2 (left) illustrates the finger-prick technique for obtaining a blood sample. Since the electronic hematocrit is a portable instrument, readings can be taken by the finger-prick technique in a physician's office, at a patient's home, or in the field. Now it will be possible for disaster field units to take hematocrit readings quickly without a source of a-c power. Hematocrit measurements are useful for indicating blood transfusion requirements, blood donor acceptability, and extent of radiation effects from atomic or nuclear explosion.

Hospital hematocrit techniques usually use blood taken from a vein in a large quantity. An anticoagulant such as heparin, which does not add a large amount of ions, is added to the blood. Recent clinical tests conducted at the University of Pennsylvania Hospital have verified that the electronic hematocrit is a precision determination of percent red-cell volume, as well as a useful mass-screening device.

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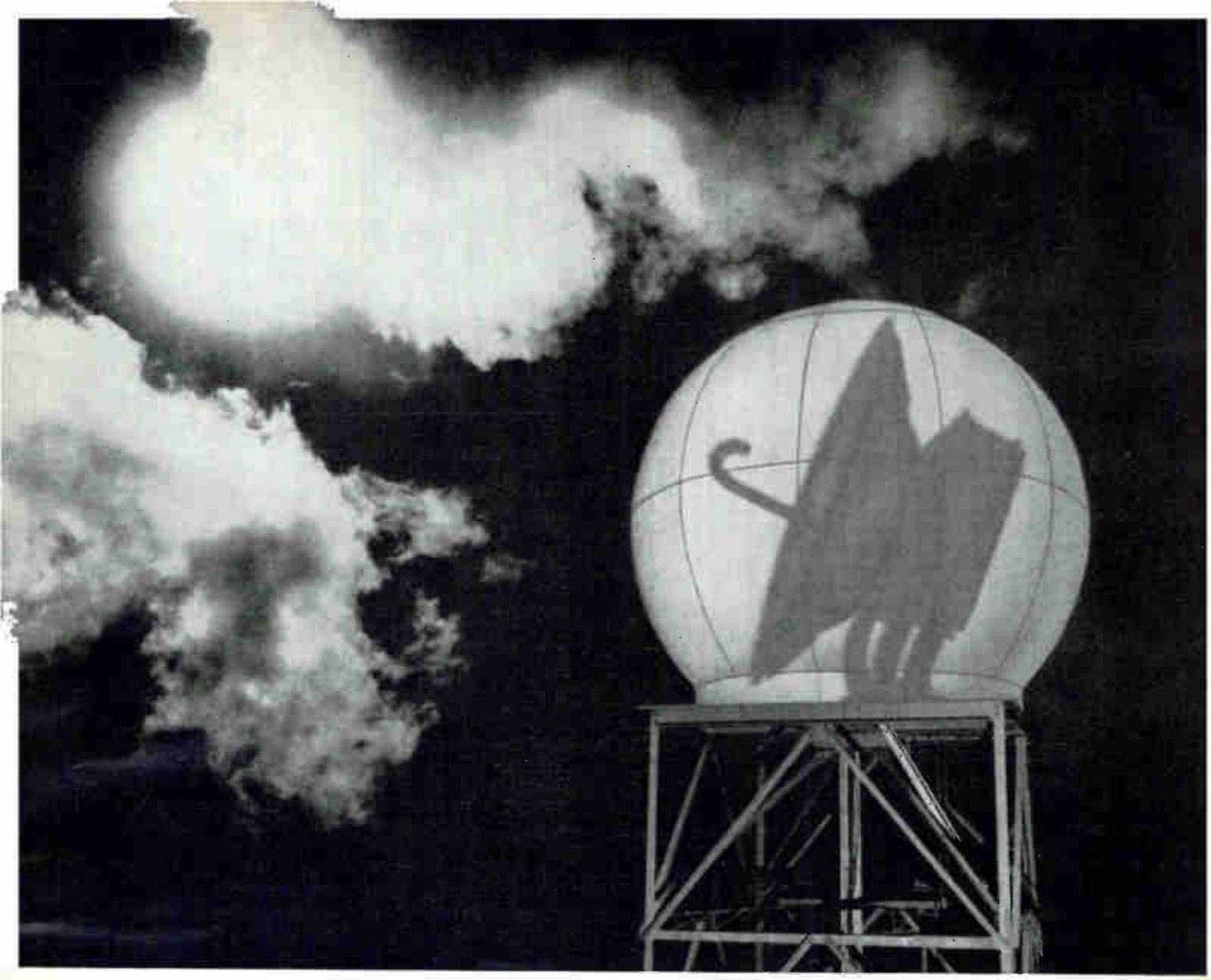

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Frequency	2.7 — 2.9 kmc	
Beamwidth	2.2°	
Elevation	−10° to +45°	@ 6 scans/min
Azimuth	360°	@ 1-4 scans/min

*from testimony before a House Appropriations subcommittee, January 18, 1960.

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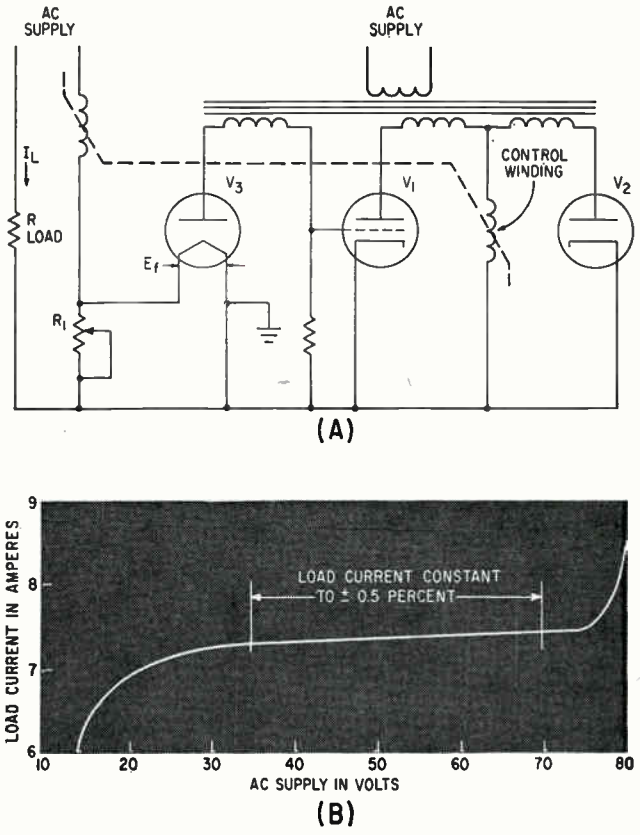
Reactor Controlled Current Regulator

Root-mean-square current level is sensed by saturated diode whose output regulates the control current of a saturable reactor. Circuit dispenses with bridge arrangement for greater simplicity

By H. J. FRASER,
Sperry Gyroscope Co. Ltd.,
Salisbury, South Australia



Rectifier triode grid voltage varies as a high-slope function of diode filament current (A); variations in output current are anchored to within ± 0.5 percent over the working range 35 to 70 volts (B)

MANY regulator circuits using saturable reactors have been published and those that use a saturated diode as a sensing element are not new. However, when saturated diodes have been used in the past, they have invariably been connected in a bridge circuit for maximum sensitivity. In this article, the control current for the saturable reactor is adjusted by varying the control rectifier between half and full-wave operation. Considerable sensitivity is achieved and the output rms current is stabilized to ±0.5 percent for either an input voltage change or load resistance change of 50 percent.

Alternating current regulators which use a saturable reactor in series with the load have been described by Denco[1], Ledward[2] and Helterline[3].

When the above regulators use a saturable diode error detector in a bridge circuit, the bridge is unbalanced by a change in diode filament current (the diode filament current forms part of the load current) and the resulting bridge output is passed through a d-c amplifier to control the reactance of a saturable reactor. The reactor then restores the output current (or voltage) to its correct level.

In the new circuit, current in the reactor control winding is not pure d-c and the output distortion is considerable higher than in the above regulators. However, since it is the rms value of current that is being stabilized, poor output waveshape is not important.

The regulator circuit (illustration) shows that the output of the saturated diode is applied to the grid of a triode rectifier, where it varies the effective configuration of the control rectifier between full and half-wave. Because the load on the rectifier is highly inductive the effective gain of this section is large[4].

Detailed circuit operation is as follows: load current I_L develops a voltage across the measuring resistor R_1 and part of this voltage (E_f) is tapped off to feed the tungsten filament of the control diode V_3. A high alternating plate voltage applied to the diode ensures that diode current i_p quickly reaches saturation during positive half cycles so that diode output approximates a square wave whose output is dependent only upon the filament current.

The negative going square wave produced by the diode is applied to the grid of V_1 where it adjusts the average value of current in the control winding of the reactor.

The tungsten-filament diode V_3, the rectifier triode V_1 and the saturable reactor contribute to the overall gain; in particular, the diode has a slope of about 8.3 in its relation between filament voltage and plate current[5]. If the open-loop gain of the control path is G, changes in input are reduced by a factor of $1/(1 + G)$ on closing the regulator loop.

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(2) T. A. Ledward, A-C Voltage Stabilizer, *Wireless World*, 49, p 106, 1943.
(3 L. Helterline, Diode Controlled Voltage Regulators, ELECTRONICS, p 166, June, 1947.
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(5) F. A. Benson and M. S. Seaman, Saturated Diodes, *Electronic Engineering*, p 360, Aug., 1955.

measure rf to 1000 mc without replacing plug-ins

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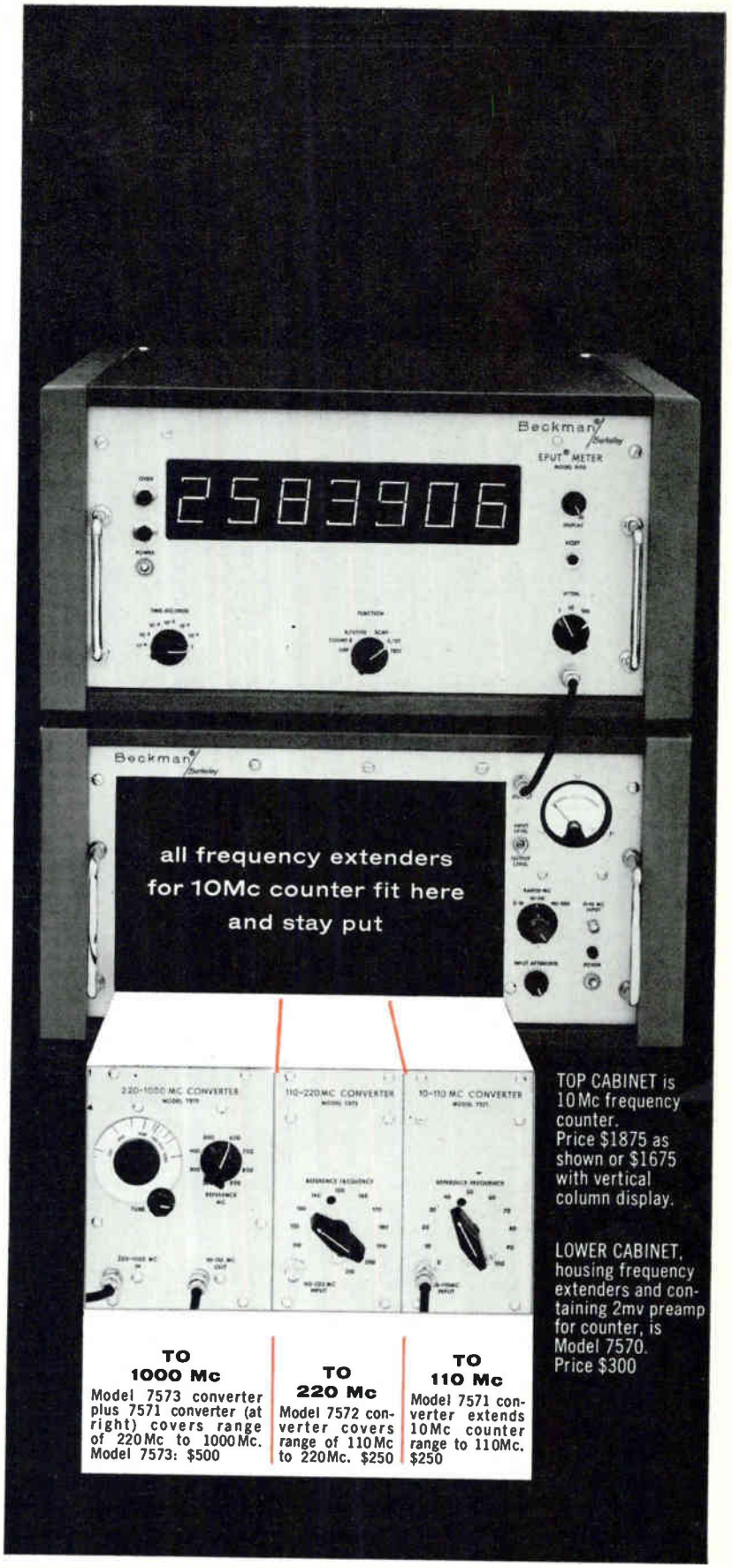

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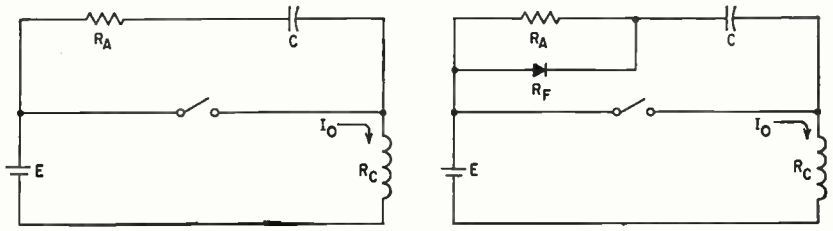
Three-Component Arc-Suppression Network

By P. N. BUDZILOVICH,
Senior Engineer, ITT Labs,
Nutley, N. J.

SIMPLICITY of design is a feature of a three-component network that provides high-quality arc suppression for contacts operating into inductive loads such as relay coils. It offers protection for relay and similar contacts without requiring a compromise in quality of suppression to limit decay time.

Conventional RC networks across contacts or one or two diodes across an inductive load increase the time that would otherwise be required for load current to decay after the contacts have been opened. However, the increase in decay time with the circuit to be described is not appreciable.



Network at left requires compromise in value of R_A. Adding diode at right limits voltage across contacts at instant of opening but permits large R_A to limit current through contacts at instant of closing

In the following descriptions, it is always assumed contacts have been in their original position long enough for steady-state conditions to exist before they are switched. The relationships indicated as existing at the instant of opening or closing are distinguished from transient conditions that may immediately follow as well as from later steady-state conditions.

In the standard RC arc-suppression network at the left of the figure, steady-state current with the contacts closed is $I_o = E/R_c$, where R_c is coil resistance. At the instant of opening, voltage across the contacts is $V_c = E(R_A/R_c)$, where R_A is the resistance in the arc-suppression network. If R_A were zero at the instant of opening, voltage across the contacts would also be zero.

Steady-state voltage across the open contacts is $V_c = E$. At the instant of closure, current through the contacts is $I_c = E/R_A$. Therefore, R_A should be large to limit contact current, the opposite of that required at contact opening. Thus three basic requirements for arc suppression are minimum voltage across contacts at the instant of opening, minimum current through contacts at the instant of closing and minimum load-current decay time.

At the right of the figure, a diode with small forward resistance compared to R_A has been added. At the instant of opening, $V_c = E(R_F/R_c)$, where R_F is diode forward resistance. Since R_F is usually less than R_c, voltage across the contacts at the instant of opening will usually be less than E.

At the instant of closing, current is again $I_c = E/R_A$ because the diode does not conduct in this direction. Therefore, the only requirement on R_A is that it permit complete capacitor discharge during the time that the contacts are closed. This time in most applications will be long enough so that R_A can be considered a bleeder.

A basic function of an arc-suppression network is to provide a sink for energy stored in an inductive load to prevent the energy from being dissipated in an arc between the contacts when the contacts are opened. With an RC network across the contacts, some energy is dissipated in load and arc-suppression resistances and some is stored in the capacitor. With a single or back-to-back diodes across the load, the energy is dissipated in load and diode resistances.

In the circuit at the right of the figure, some energy is dissipated in load resistance but most is stored in the capacitor. Therefore, peak voltage across the contacts may greatly exceed that at the instant of opening. Because the same total amount of energy must be transferred for a given inductive load, peak voltage and the time of its occurrence are inversely proportional to capacitance. Thus energy transfer is faster and peak voltage higher as capacitance is reduced. The value of the capacitor can easily be selected experimentally to avoid arcing.

The diode must sustain current surges equal to steady-state load current and withstand the peak inverse voltages it will encounter after the switch is opened.

This network may also be applied to static-switching devices.

Displaying Variables Of Power Transistors

By B. J. GERSHEN, Resident Engr.,
East Coast Appl. Lab., Delco Radio,
General Motors, Newark, N. J.

PROPER application of power transistors requires knowledge of the range of interacting voltage-current combinations that it would experience in the final circuit. Dynamic tests have been evolved that provide a visual display of two variables simultaneously so that their interaction can be observed. By adding time information to the display, combinations of operating conditions that exceed transistor ratings are revealed.

The test setup requires only one oscilloscope and a pulse generator. The transistor can usually be operated in the circuit for which it is intended. Occasionally a current-viewing resistor may be required to

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HB-6	0–325	0–0.6	<0.1	0.2	<0.1	3 Mv.	1.0	1.0	19"	3½"	14⅜"	$365.00
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HB-40	0–325	0–0.4	<0.01	0.02	<0.01	1 Mv.	0.2	0.2	19"	3½"	14⅜"	$520.00
HB-60	0–325	0–0.6	<0.01	0.02	<0.01	1 Mv.	0.1	0.1	19"	3½"	14⅜"	$565.00

STABILITY: (for 8 hours) 0.2% or 0.2 volts, whichever is greater, after 1 hour warmup. *Depth behind panel.
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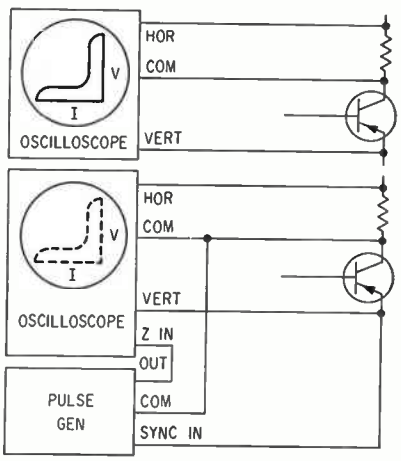
provide voltage for an oscilloscope display of current.

To find a suitable transistor for a particular circuit application, characteristics might be displayed individually on separate oscilloscopes as functions of time. A synchronizing signal would be required to allow comparisons. A more practical approach would be to display the range of values of each variable successively on a single oscilloscope as functions of time. However, their interdependence would not be as apparent.

The test setup at the top of the figure provides a combined display of two variables, such as the important quantities V_{CE} and I_C on the vertical and horizontal axes, respectively. This display includes maximum voltage across the transistor and maximum collector current. It also indicates maximum power dissipation in the transistor.



Voltage-current combinations displayed at top indicate dissipation in power transistors, while bottom arrangement also provides time information

Important quantitative information is added to such a display by applying a train of square waves from the pulse generator at the bottom of the figure to the Z-axis input of the oscilloscope. The pulses intensity modulate the presentation so that the trace is broken up into alternate blank spaces and visible segments. By selecting a pulse repetition frequency ten or twenty times transistor operating frequency, the display is synchronized so that the same segments of the trace are made visible throughout each cycle of transistor operation.

Significance of intensity modulating the display in this manner is that lengths of visible and invisible segments of the presentation are inversely proportional to time. Thus a shorter blank space or visible segment indicates that conditions at that part of the trace are existing for a longer time. From the known relationship between pulse repetition frequency and transistor operating frequency, the time that a combination of conditions is maintained can be determined from the display.

An example of the value of this type display is power dissipation. If a period of high power dissipation is so long that the rating of the transistor is exceeded, it will be apparent from the presentation.

This testing technique can be applied equally well to a variety of other transistor characteristics. In many applications, collector and emitter currents are sufficiently near to being equal so that they can be used interchangeably.

Transistor Sequence Timer For Automatic Washers

EXPERIMENTAL electronic sequence timer has been installed in a conventional automatic washer. The transistor circuits are mounted behind push buttons at the back of the machine. The timer eliminates all moving parts.

The high-speed, silent timer, developed by P. R. Mallory & Co., is expected to provide significantly higher reliability. Size can easily be reduced, offering designers greater styling freedom.

The unit controls fill, agitate, spin, rinse and spin-dry, although the mechanisms for these functions are virtually unchanged. Major portions of the system include an electronic clock, solid-state switches, power amplifiers and program selector switches. A wide variety of programs is available. Parts of programs can be eliminated entirely.

The timer may be the forerunner of other electronic techniques in appliances. A likely possibility is a laundry sensing system to wash fabrics until soil has been removed and dry them until moisture has been eliminated.

Reliability of Precision Potentiometers

AN ANALYSIS USING PROBABILITY THEORY

By H. H. ADISE
Computer Instruments Corp.
Hempstead, New York

ONE MEASURE of reliability of a component or system of components is the inverse of the calculated probability of its failure under actual operating conditions. The greatest reliability of a system can be found by computing the greatest failure probability among its components.

Failure of a component can be defined as the inability to perform its intended function to a satisfactory degree. The primary function of a precision potentiometer is to provide a continuous voltage output, proportional to the shaft or wiper position.

From a purely practical viewpoint, however, unless continuity of output is maintained, the question of failure in terms of deviations from performance tolerances, becomes quite academic.

Therefore, determination of the reliability of a precision potentiometer begins with a study of the probability of continuity failure. Reliability, as defined above, is a prediction measured in terms of the probability of occurrence of an event. When events occur in a random manner, predictions of occurrence can be made by logical analysis.

When events are not of a random nature, or if every effort in design and construction is made to avoid a certain event, such as failure of a system or component, appropriate corrections must be made.

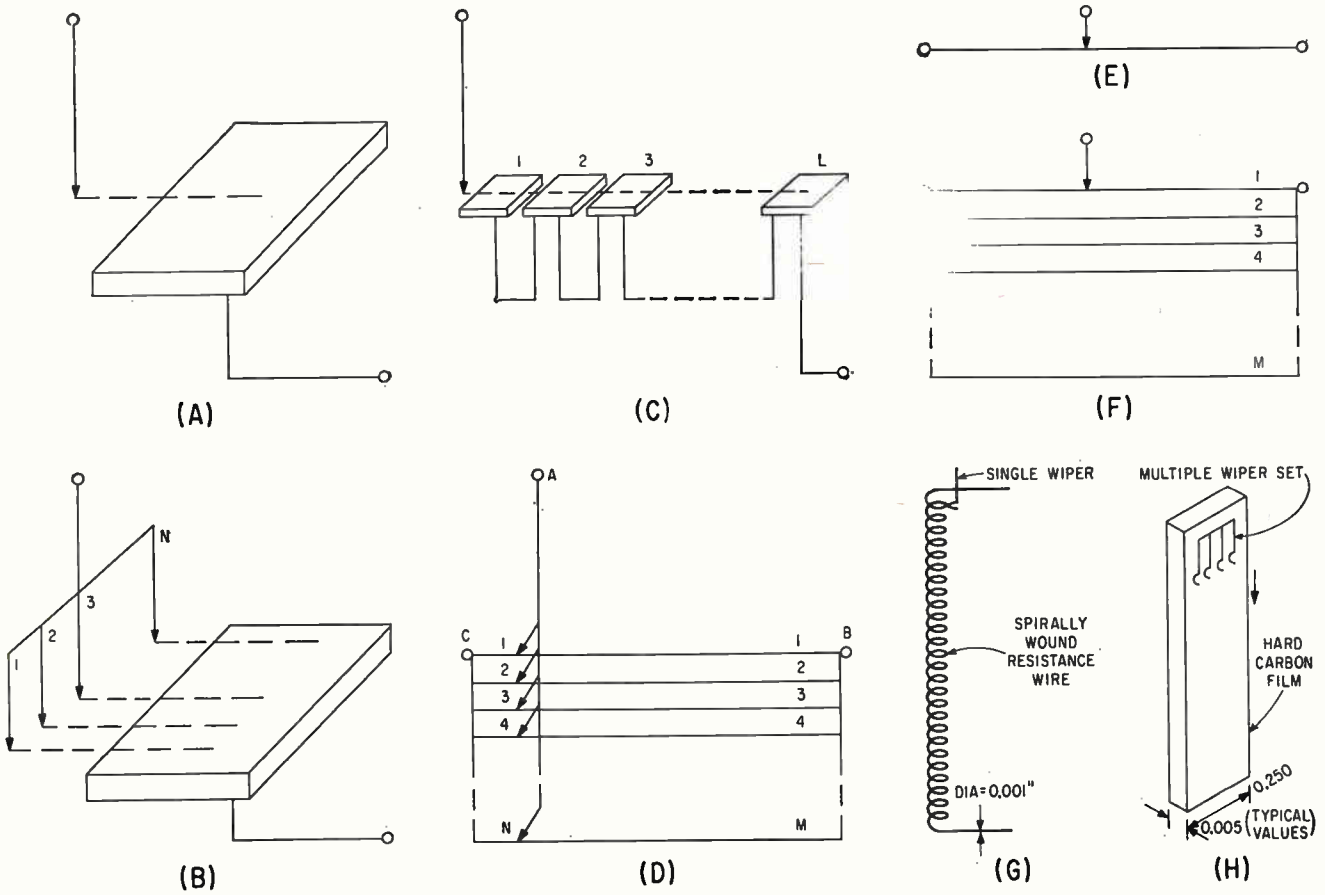
The following basic probability concepts are useful:

1. The probability that an event will occur is defined as the ratio of the number of favorable cases to the total number of possible cases, provided all cases are equally likely to occur, and the cases are mutually exclusive.

2. The probability of two independent events occurring simultaneously, whose respective probabilities are a and b, is equal to $a \times b$.

3. The probability of occurrence of one or the other or both of two mutually exclusive events, whose respective probabilities are a and b, is equal to $a + b$.

Single and multiple sliding



Idealization of the various design steps in the development of a precision potentiometer. Figs. G and H represent a typical wire-wound pot and deposited film pot respectively

contacts are illustrated in Figs. A and B. There are two possible cases for the single sliding contact shown in Fig. A: the slider will make contact; the slider won't make contact.

The number of failure cases is given by the number of failure events, 1, (the slider doesn't make contact), multiplied by failure reducing factor K. K is due to the intent of design and materials of construction, and is a number much smaller than 1.

From concept (1) above the probability of failure equals $K(\frac{1}{2})$. The probability of failure of each of the sliders in the multiple slider contact shown in Fig. B equals $K(\frac{1}{2})$. Therefore, from concept (2) above, the probability of simultaneous failure of all sliders equals

$$K(\tfrac{1}{2})_1 \times K(\tfrac{1}{2})_2 \times K(\tfrac{1}{2})_3 \times \ldots \times K(\tfrac{1}{2})_n = K^n(\tfrac{1}{2})^n$$

where n is the total number of sliders.

The failure probability ratio of multiple wipers versus single wiper equals

$$\frac{K^n(\frac{1}{2})^n}{K(\frac{1}{2})} = K^{n-1}(\tfrac{1}{2})^{n-1}$$

Since reliability is the inverse of the failure probability, multiple wipers are K^{1-n} $(\frac{1}{2})^{1-n}$ times as reliable as a single wiper.

When a single wiper, operating make-before-break, traverses a string of contacts connected in series, as shown in Fig. C, the probability of continuity failure is greater since each "make" constitutes a possible failure point. Probability of failure equals

$$K(\tfrac{1}{2})_1 + K(\tfrac{1}{2})_2 + \ldots + K(\tfrac{1}{2})_L = KL(\tfrac{1}{2})$$

where L equals number of contacts in series.

The failure probability ratio of a single contact verses the multiple series contacts equals

$$\frac{K(\frac{1}{2})}{KL(\frac{1}{2})} = \frac{1}{L}$$

A single long contact is L times as reliable as L series contacts of equal total length.

Single long stationary contact, and multiple parallel stationary contacts are shown in Figs. E, F.

The probability of failure of a single stationary contact, Fig. E, is equal to $K(\frac{1}{2})$, and the probability of simultaneous failure of all contacts in a bank of parallel sta-

tionary contacts, Fig. F, equals K (1/2M).

The failure probability ratio of multiple paths versus single path is equal to 1/M. Therefore, a resistance element having M multiple wiper or current paths is M times as reliable as a resistance element having one wiper path.

The probability of simultaneous continuity failure of paralleled wipers combined with parallel resistance elements, as shown in Fig. D, from concept (2) above, equals

$$\frac{K^{n+1}\left(\frac{1}{2}\right)^{n+1}}{M}$$

The failure probability ratio of an assembly of multiple wipers and multiple paths, versus an assembly of a single wiper and single path, equals

$$\frac{\frac{K^{n+1}\left(\frac{1}{2}\right)^{n+1}}{M}}{K\left(\frac{1}{2}\right)} = \frac{K^{n}\left(\frac{1}{2}\right)^{n}}{M}$$

The failure probability ratio of an assembly of multiple wipers and multiple paths, versus an assembly of a single wiper and series contacts, equals

$$\frac{\frac{K^{n+1}\left(\frac{1}{2}\right)^{n+1}}{M}}{K^{2}\left(\frac{1}{2}\right)^{2} L} = \frac{K^{n-1}\left(\frac{1}{2}\right)^{n-1}}{ML}$$

From the view point of reliability, wire-wound potentiometers can be likened to the single wiper series contact situation analyzed above.

The reliability of film potentiometers can be analyzed similarly to the multiple wiper, multiple path situation.

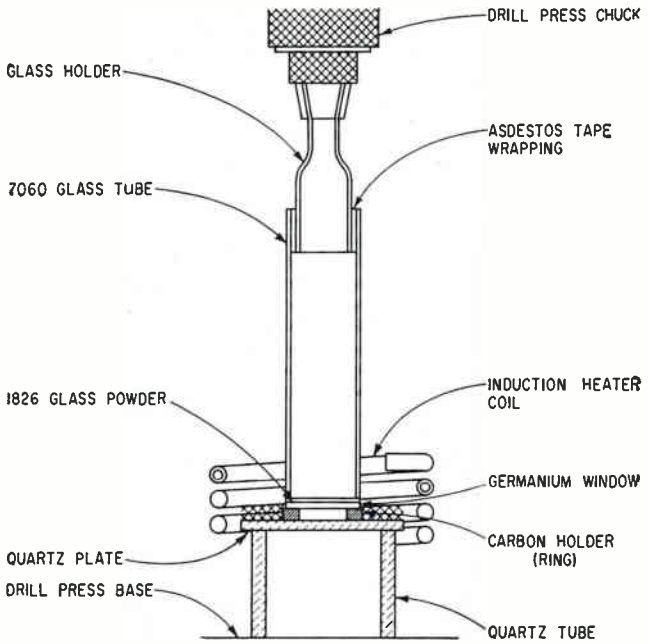
Figs. G, H illustrate a basic wire-wound and basic film potentiometer.

In a typical wire-wound potentiometer, n = 1, M = 1, L = 2,000, and the diameter of the resistance wire is .001 in. A typical film pot consists of a deposited carbon film .250 in. by .005 in., and N = 4, M = .250/.001 (approx.) = 250 (theoretically infinite), L 1.

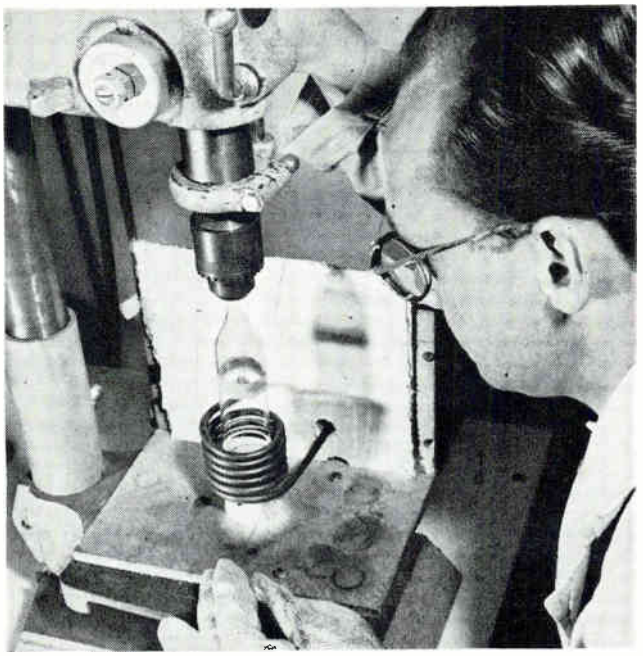
The failure probability ratio of film potentiometers versus wire wound potentiometers equals

$$\frac{K^{n-1}\left(\frac{1}{2}\right)^{n-1}}{ML} = \frac{K^{3}\left(\frac{1}{2}\right)^{3}}{250 \times 2000} = \frac{K^{3}}{4 \times 10^{6}}$$

By the probability analysis method, film potentiometers appear to be over 4×10^{6} as reliable as wire-wound units.

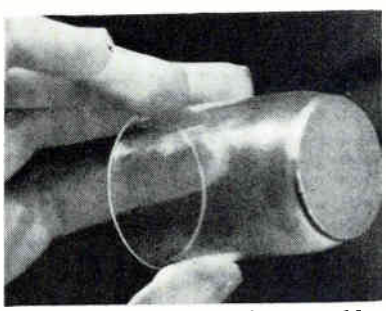


Setup for sealing window to glass tube of infrared detector



Drill press is convenient for lowering tube onto window

Glass Frit Seals Germanium IR Windows



Completed window-tube assembly

GERMANIUM INFRARED windows are being sealed to detector tubes with glass frit at Philco Corporation's Lansdale Division, Lansdale, Pa. The technique enables the firm to produce infrared detectors receiving radiation beyond 25 microns, since germanium can be coated to peak in that range. Glass sealing provides a permanent vacuum-tight seal. Epoxy resin or solder seals eventually leaked or had outgassing effects, the firm reports.

Germanium has a melting point of about 937 C and a coefficient of thermal expansion of 60×10^{-7}. The glass selected for the frit, Corning 1826 powder, has a reasonably close thermal expansion coefficient of 49×10^{-7} and a softening point of 585 C. The detector tube is 7060 glass. Glasses 7052 or 7056 may also be used for the tube.

Powdered glass of 100 mesh is mixed with amyl acetate. A small artist's brush is used to paint the frit in a ring on the sealing surface of the germanium crystal disk. The disk is placed on a carbon ring and transferred to an induction heater coil. The mating edge of the tubing is cut square, etched with hydrofluoric acid and polished with a fine abrasive or flame.

When the parts are positioned in the drill press, the carbon ring is heated to approximately 750 C. As the ring of powdered glass begins to soften, the tube is pressed slowly onto the ring. The seal is allowed to set at this temperature for 20 seconds to insure good wetting of the glass. After 15 minutes annealing in an oven at 454 C, the seal is cooled to room temperature over a period of 3 hours.

A dilute solution of hydrofluoric acid removes germanium oxide from the glass wall. Oxide is removed from the germanium by fine abrasives and polishing compounds.

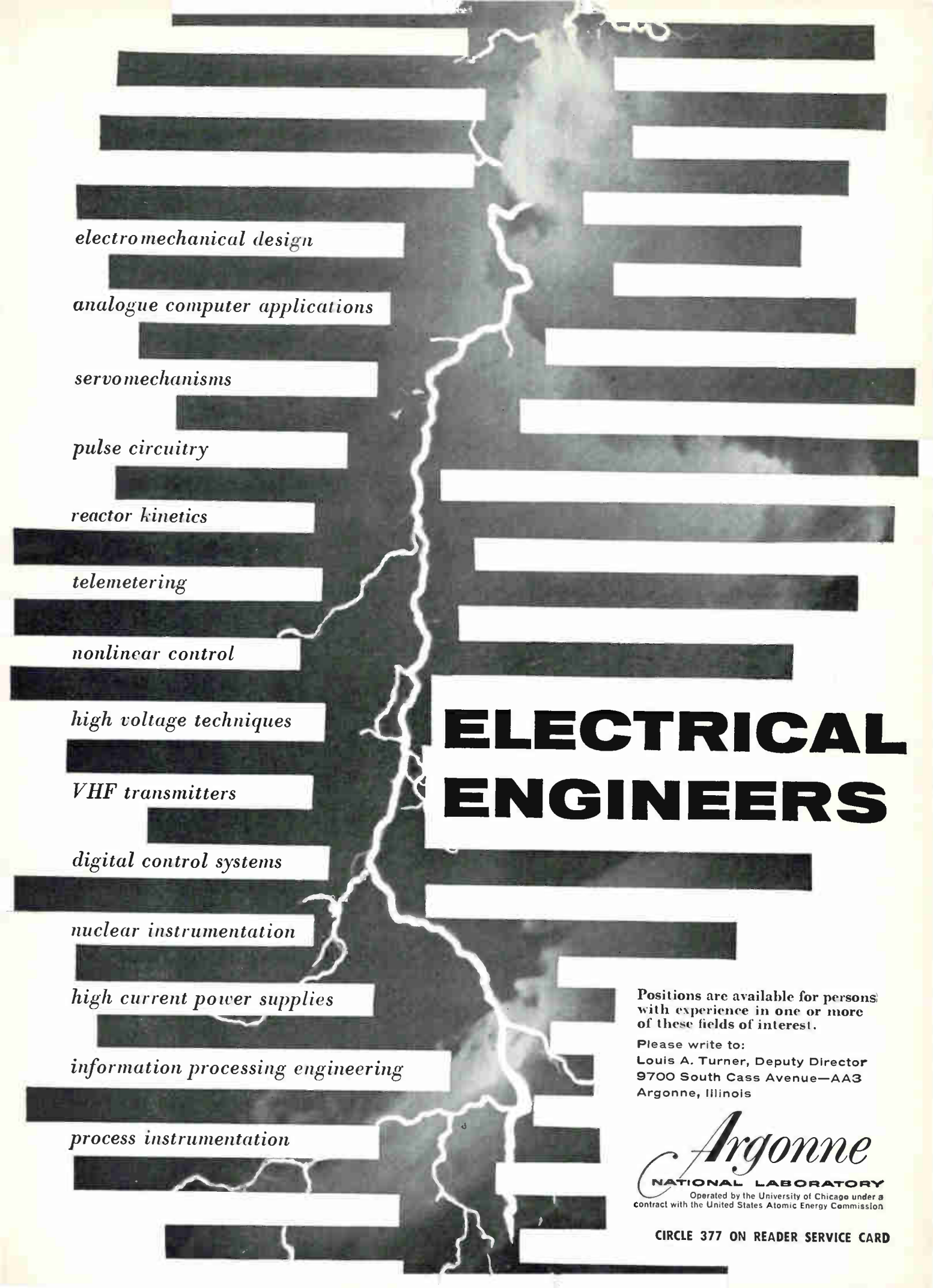
Tests indicate no leakage at a vacuum of 10^{-6} mm Hg. The seal withstands thermal shock of room temperature to liquid nitrogen and back to room temperature. Carl R. Snyder, glass shop supervisor, special products operation, is credited with developing the technique.

Simple Tools Shape K_A-Band Waveguide

BENDING FIXTURES like those shown in Fig. 1 are used by John Gombos Co., Inc., of Clifton, N. J. to bend the small, silver, rectangular tubing used in K_A-band assemblies. The company says that for simple bends the fixture is faster than a bending machine and does not waste material.

The tubing, cut to length, is slipped between the backstop and mandrel with the end at the desired distance from the bend point. The slotted bending bar is placed over the tubing and drawn by hand down to the stop, forming the tube around the mandrel. The waveguide is filled with Cerrobend to prevent its collapse during bending.

Another K_A-band production



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method is the use of punch presses rather than broaches to finish the cavities of flanges. Flanges of the type illustrated in Fig. 2 have a cavity about 1⅜ inches high, ¼ inch long and ⅛ inch wide. As cast in aluminum bronze, the cavity is tapered slightly and is undersized.

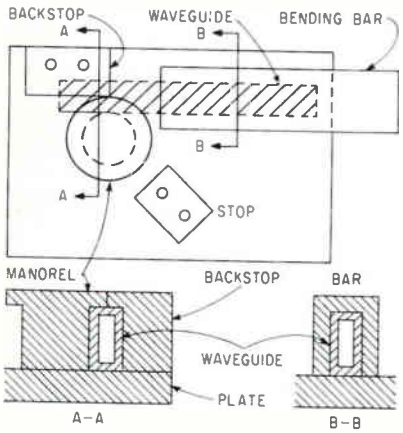


FIG. 1—Waveguide bending fixture

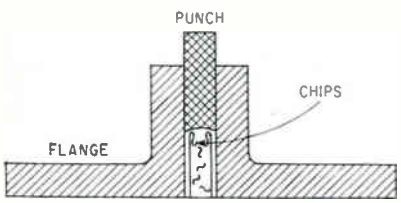


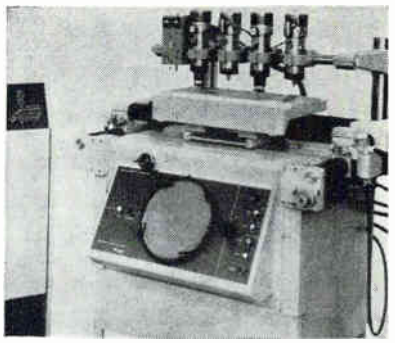
FIG. 2—Punch finishes flange cavity

The punch is prepared of tool steel with the dimensions of the cavity. The bottom surface is ground so that there is a concave hollow within the 4 cutting edges. The hollow is made with a small grinding wheel which has been ground to size.

As the cutting edges shave the sides of the cavity, the chips turn into the hollow and fall through a hole in the press table. The sides of the tool burnish the walls of the cavity to a finish of about 8 to 16 microinches. A tolerance of about 0.0005 inch (0.001 inch overall) can be maintained with this method, Gombos reports.

Optical Comparator Is P-C Driller Programmer

OPTICAL PROGRAMMING method is employed in a new, high-speed circuit board drilling machine. The



Tape is prepared by comparator, without logging X-Y coordinates

machine is controlled by magnetic tape.

The programmer is essentially a comparator with a large viewing screen. The operator inserts a master board or contact printing negative into a viewing slide located beneath the drill's positioning table. A portion of the board, magnified 20 times, is projected on the screen.

A joy stick control enables the operator to center the image of individual holes within a tolerance circle superimposed on the screen. When the hole is centered, the operator enters a "drill down" command on the recording tape. The operator proceeds from hole to hole, following a colored path previously marked on the board. To check the program's accuracy, the tape is rerun and the screen observed to see that all holes are in the circle.

The joy stick is a velocity control having exponential response. Relatively large movements from its vertical position produce slow movements of the drilling table. Maximum speed is 100 inches a minute. The comparator design is standard, except that the image is focused on the screen by moving the lens rather than the part or viewing slide.

The machine can also rout contours or divide multicircuit boards into individual boards. A contour stylus programmer is used for the routing operations.

The manufacturer, Micro-Path Inc., Los Angeles, Calif., a subsidiary of United Industrial Corp., reports that the machine's hole-positioning accuracy is 0.001 inch. Each of 4 heads can drill 40 holes a minute, for a rate of 640 hpm with 4 stacks of 4 boards. First installation is reported at AC Spark Plug Division, General Motors, Milwaukee, Wis.

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REPRINT SERVICE

The Reprint Service Department will use this page for the first issue of each month and for Special Issues during 1960 that contain Special Reports.

The Reprint Service Department offers 4 types of reprints: 1 — Reprints of Special Reports as they appear with definite costs for varying quantities; 2 — Reprints of Special Reports that have appeared in past issues; 3 — Reprints of other editorial material in the current issues (minimum order is 100); and 4 — Reprints of editorial that, has appeared in past issues (minimum order is 100). On other than Special Reports we cannot publish prices because the order may involve any number of editorial pages depending upon the length of the article.

Actual reprint costs, handling charges, postage, etc. bring the costs for Special Reports to: 75 cents for a single reprint; 60 cents for quantities of 10; 50 cents each for 25 or more.

For list of Reprints of past Special Reports available see reverse side of this page.

Name
Numb

Reprints Available on Past Special Reports and Feature Articles

(Order by Key No. in form on reverse side):

Electronics Handbook,
June Mid-Month, 1959
Key No. **R-1**

Instruments for Design and Production,
Sept. 11, 1959; Key No. **R-2**

Materials for Environmental Extremes,
Dec. 4, 1959; Key No. **R-3**

1959 electronics Article Index,
Dec. 25, 1959; Key No. **R-4**
10¢ each.

Electronic Markets Special Report
Jan. 1, 1960; Key No. **R-5**

Designing High-Power Transistor Oscillators
Jan. 8, 1960; Key No. **R-6**
50¢ each.

Electronics Research and Development Around the World
Feb. 12, 1960; Key No. **R-7**

Graphical Extensions of Transform Techniques
Apr. 1, 1960; Key No. **R-8**
50¢ each.

What's New in Electron Tubes
Apr. 29, 1960; Key No. **R-9**
50¢ each.

Electronics in Japan
May 27, 1960; Key No. **R-10**

Modern Microwaves
June 24, 1960; Key No. **R-11**

1960 Semi-annual Index
Jan.-June issues; Key No. **R-12**
50¢ each.

Electronics Probes Nature
July 29, 1960; Key No. **R-13**

Price: Reprints on items above are 1-10 copies, 75¢ each; 11-24 copies, 60¢ each, 25 copies or more, 50¢ each unless otherwise noted.

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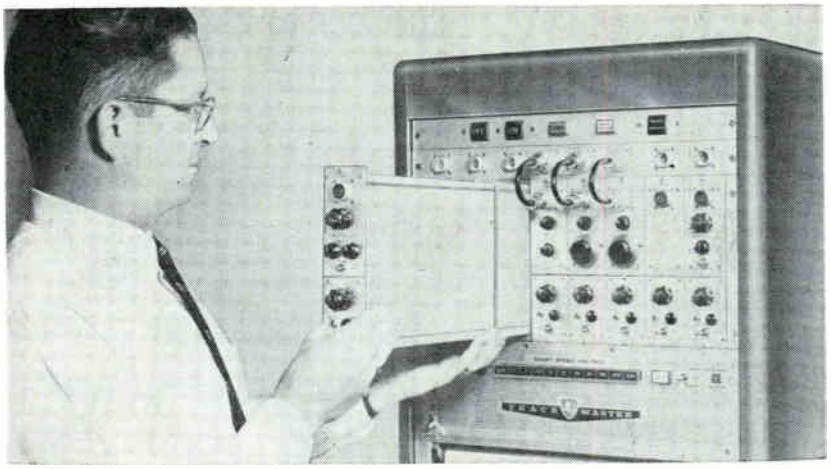
Reprints can be made up with the original cover of the magazine and your advertisement or other merchandising message on the back page. Please write to Reprint Service Dept., **electronics**, 330 West 42nd St., New York 36, N.Y., LO 4-3000, Ext. 3140 for all information pertaining to reprints.

New On The Market



Recording System

DIRECT-CARBON TRANSFER

A DIRECT-WRITING recorder for industrial instrumentation has been introduced by American Optical Co., Buffalo, New York.

The recorder, called the Trace-Master, operates over a frequency band-width from d-c to 110 cps with ±1 percent response and from d-c to 140 cps with ± 3 percent response. The recorder operates at an amplitude of 4 cm. The unit employs the direct-carbon-transfer writing. The carbon trace actually grows darker with age. The trace is written through Mylar-base carbon ribbon on translucent chart paper, and may be reproduced by conventional processes. Chart speeds from 0.1 to 500 mm a second are available.

As the stylus moves along the trace it is dithered.

There are eight independent recording channels. The user can select input without amplification, d-c differential amplifiers or carrier amplifiers.

Depending upon mode of operation, selected maximum sensitivity can vary from 10 μv per cm to 100 mv per cm; input range from 0 to ± 25 v to 0 to 500 v; and input impedance from 2,500 ohms to one megohm.

All amplifiers are transistorized, and are provided with vernier for overlap between attenuator steps. All amplifiers are self-calibrating, by integral preaged mercury cell and precision divider network.

The system is installed in a rack cabinet, and requires input power of 115 v a-c ± 10 percent, 60 cycles (nominal) single-phase, 15 amp.

CIRCLE 301 ON READER SERVICE CARD

Tunnel-Diode Oscillator

MICROWAVE SIGNALS

A SOLID-STATE tunnel diode produces microwave signals in a tunable oscillator developed by Radio Corp. of America, 30 Rockefeller Plaza, New York.

The diode is combined with a microwave circuit as in a tunable oscillator that can be designed to telemetry and satellite systems. It is available on a sampling basis.

The oscillator, designated the RCA developmental type SS-100, is approximately 6 by 3 by $\frac{5}{8}$ inches exclusive of tuning dial and connectors, and less than one pound in weight. Application of 0.2 volt to the oscillator produces a power output of several tenths of a milliwatt, tunable over the 100 to 1,400-Mc band.

CIRCLE 302 ON READER SERVICE CARD

Wirewound Resistor

VERTICAL MOUNTING

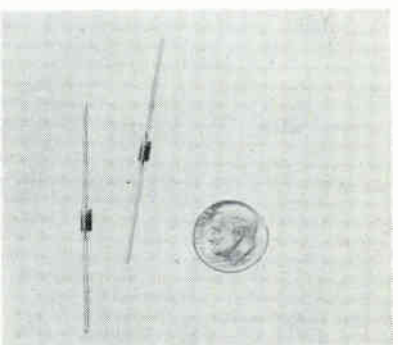
ONLY $\frac{17}{64}$ in. in diameter by $\frac{31}{64}$ in. long exclusive of leads, a new precision wirewound resistor developed by Shallcross Manufacturing Company, Selma, North Carolina, employs the 0.2-in. lead spacing required by printed wiring boards in computer and other military electronic circuits.

Known as type P-2W, the miniature resistor exceeds MIL-R-93B and MIL-R-9444 requirements for operation at 125 C. Noninductively wound and sealed in epoxy resin, all resistors are temperature cycled

and subjected to short time overloads. Good load life characteristics are obtained at high power dissipations because of the heat sink effect of the No. 20 Awg wire leads.

The precision wirewounds are available with resistances up to 1 megohm and tolerances as close as 0.05 percent. Power rating for 1 percent tolerance is up to 0.5 watt for a 125 C ambient.

CIRCLE 303 ON READER SERVICE CARD



Silicon Rectifier Diodes

HERMETICALLY SEALED

HERMETICALLY sealed silicon rectifier diodes, featuring high stability, versatility, miniature design and rugged construction at low cost have been announced by Diodes, Inc., 7303 Canoga Avenue, Canoga Park, California. Designated DI-52, DI-54, DI-56, DI-58 and DI-510, these diodes have peak inverse voltage ratings of 200, 400, 600, 800 and 1,000. All five types handle 750 ma at 25 C and 500 ma at 100 C. One hundred percent output extends beyond 100 Kc, with the 3-db point at 250 Kc. Ambient temperature range is −65 to +150 C.

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FM/FM TELEMETERING TRANSMITTER 4 Watts
MODEL 1483

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- Replaceable modular construction
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- Very low spurious emission
- Plug-in tubes
- −55°C to +100°C
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1463 Series — Transmitter

5 1/32" x 3 1/16" x 4"
15 to 30 Watts

Model 1460-M RF Amplifier

3.37" x 3.25" x 2"
2 Watt input; 10-30 Watt output

Heat sink cooling

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1466 Series — RF Amplifier

6.5" x 4" x 3.25" RF Amplifier
2 watts in — 100 watts out

1462 Series — Transmitter

6" x 4¼" x 3¾"
50 to 80 Watts

800C—Sub Carrier Oscillator

1.5" x 1.9" x 2.45"
Dev. Stab: + 1% band width
Dev. Linearity: Less than 1% band width

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Diode bodies are EIA color coded and cathode-end marking is provided. Leads are solid silver. They measure 0.110 in. diam. by ¼ in. length, plus leads.

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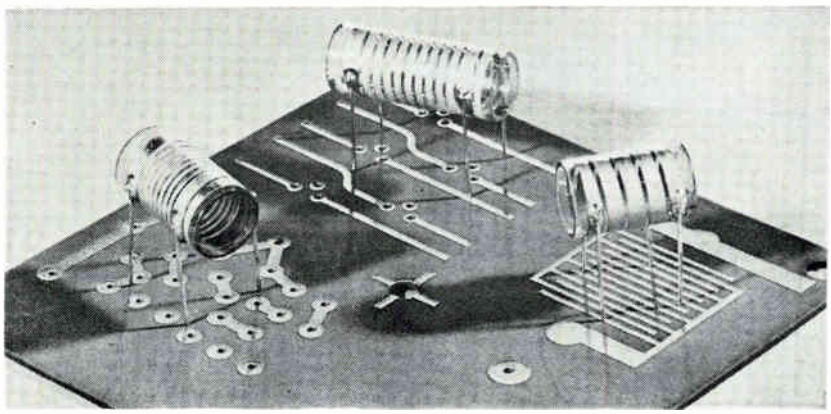


Fixed Inductors

FOR PRINTED CIRCUITS

TWENTY-SIX models of fixed inductors with wire leads for mounting on printed circuit boards are being marketed by Corning Electronic Components, Bradford, Pa.

The initial application in sonobuoy oscillators has shown their stability under physical shock, vibration and temperature change.

The models complement a line of inductors with pan terminals. Both types have outside diameter of 0.460-inch.

Stability is achieved by firing silver metalized conductors into glass coil forms. The inductors reportedly do not deteriorate under salt-spray corrosion testing.

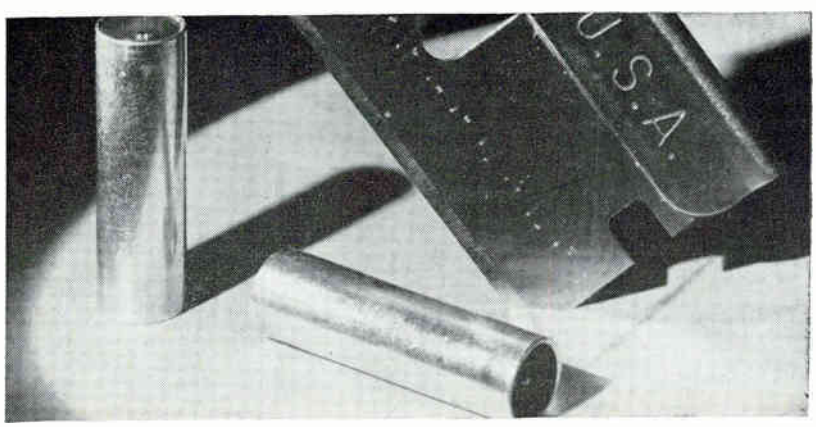
Leads are No. 22 Awg tinned copper. Either manual or automatic soldering methods can be used.

Temperature coefficient is less than +20 ppm per deg C.

Range of inductance of 0.05 to two microhenries; Q values range from 120 to 250. Operating temperature range is −55 to 125 C.

The inductors are useful at frequencies from 10 to 250 Mc. Production quantities are available.

CIRCLE 305 ON READER SERVICE CARD



Ga-As Mixer Diode

MICROWAVE TYPE

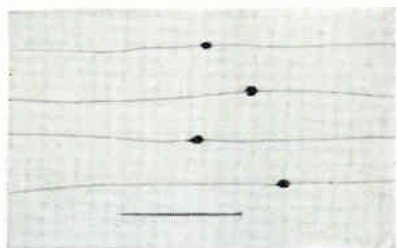
A GALLIUM arsenide microwave mixer diode type IN3096R introduced by Philco Corp., Lansdale Div., Lansdale, Pa., is specified for 24,000 Mc (K-band) first detector operation. The unit has a coaxial package identical to that used for silicon K-band diodes.

The IN3096R features a band-gap energy value of 1.40 electron volts and is capable of high temperature operation in excess of the upper limit capabilities of germanium and silicon components. Higher mobility values achieved by the IN3096R permit greatly increased sensitivity at 24 Gc.

The diode exhibits an overall noise figure of 10.5 db. Changes in noise figure of less than 2 db have been noted for temperature ranges of 300 C.

Design quantities (one to nine) of the IN3096R are immediately available at a unit price of $75.00. Matched pairs, designated IN3096-RM, are also available at a per pair price of $187.50.

CIRCLE 306 ON READER SERVICE CARD



Microminiature Capacitor

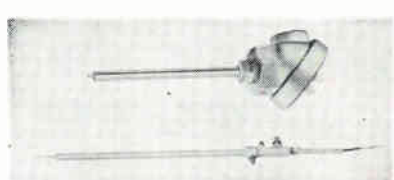
AXIAL-LEAD, CERAMIC

USEFUL in airborne and ground station equipment, either packaged conventionally or potted, are microminiature axial lead ceramic capacitors by King Electronics, 915 Meridian Avenue, South Pasadena, California.

The capacitors are available in values from 47 $\mu\mu$f through 0.01 μf; they are usable at full rated voltage of 200 v to +150 C. Sizes start from 0.100 by 0.125 by 0.075 in.

The units come in 5, 10, 20 percent and GMV tolerances; they offer high moisture resistance and stability over their full −55 to +150 C range.

CIRCLE 307 ON READER SERVICE CARD



Temperature Sensors

MEASURE 4,000 F

A COMPLETE line of thermocouple temperature sensors for use up to 4,000 F has been developed by Aero Research Instrument Corp., 315 Aberdeen Street, Chicago, Illinois.

These are of noncooled and cooled types to measure liquid, solid and gaseous temperatures. Some of the sensors are usable in oxidizing atmospheres up to 4,000 F and intermittently higher.

The temperature sensors use refractory metals such as tantalum and molybdenum with special CR oxidation resistant coatings. Insulation is magnesia and beryllia and thermocouple wires are iridium, tungsten, rhenium and alloys.

These probes are designed for measuring the temperatures of exhaust gas in an afterburner, molten glass, fuel pins of a nuclear reactor, missile nose cone, combustion processes, flue gas and crystal growing ovens.

Prices range from $200 to $600 for thermocouples that can be used intermittently or continuously at temperatures to 4,000 F in oxidizing, reducing or inert atmospheres. If atmosphere is inert or vacuum only and temperatures to 4,000 F, thermocouples are available from $100 to $205.

CIRCLE 308 ON READER SERVICE CARD

Coaxial Attenuators

BROADBAND

MAURY & ASSOCIATES, 1073 Mills Ave. Montclair, Calif., introduces a new series of fixed coaxial attenuators. These are bidirectional units constructed in pi-type circuits and feature broadband application, low vswr and compact size. The rugged units will withstand severe handling and are not affected by temperature or humidity changes. These attenuators cover a frequency range from d-c to 2,000

Mc; they can be obtained at any value of attenuation from 1 to 40 db; and are furnished with either type N, C, BNC, or TNC connectors. Vswr is 1.15 max. to 1,000 Mc and 1.35 max. to 2,000 Mc. Power handling is 1 wc-w and impedance is 50 ohms. All units are supplied with individual calibration charts.

CIRCLE 309 ON READER SERVICE CARD

Frequency Converter
DELIVERS 100 VA

TEL-INSTRUMENT ELECTRONICS CORP., 728 Garden St., Carlstadt, N. J. The inexpensive model 4010A frequency converter delivers 100 va. It features a wide selection of frequency ranges from 50 to 4,000 cps with fixed frequency accuracies up to 0.001 percent capability of handling resistive or reactive loads, nominal 1 percent harmonic distortion, zero output impedance and zero recovery time. Unit is designed for use with guided missile check-out systems, mag-amp testing, servo systems, aircraft instrumentation testing and other applications requiring power at fixed or variable frequencies.

CIRCLE 310 ON READER SERVICE CARD

Microwave Triodes
EXTENSIVE LINE

GENERAL ELECTRIC CO., 3325 Wilshire Blvd., Los Angeles 5, Calif., has announced an extensive line of microwave triodes. Primary among these lighthouse tubes is the GL-6299, which has a bogie gain of 17.5 db and a noise figure of 4.5 db at a frequency of 450 Mc and 9 Mc bandwidth. The frequency range of the GL-6299 and its close derivatives extends to 10,000 Mc where a few milliwatts of power can be obtained. The GL-6299 is well suited for front-end applications which require low-noise, high-gain bandwidth tubes.

CIRCLE 311 ON READER SERVICE CARD

Literature of

POWER SUPPLIES Sprague Engineering Corp., 19300 So. Vermont Ave., Gardena, Calif. Bulletin SE-102, 2 pages, describes a line of silicon regulated d-c power supplies, magnetic amplifier controlled.

CIRCLE 350 ON READER SERVICE CARD

MAGNETIC COMPONENTS Magnetics Research Co., 255 Grove St., White Plains, N. Y., has published a booklet on magnetic components for computers, business machines and electronic systems.

CIRCLE 351 ON READER SERVICE CARD

WIRING DEVICES Kulka Electric Corp., 633-643 So. Fulton Ave., Mt. Vernon, N. Y. A new enlarged catalog contains technical data on terminal blocks, switches and accessories.

CIRCLE 352 ON READER SERVICE CARD

AMPLIFIER AND CONTROL UNIT Westrex Corp., 6601 Romaine St., Hollywood 38, Calif. An illustrated 4-page brochure describes the RA-1593-A amplifier and RA-1594-A control unit, which together form a compressor-limiter amplifier for general audio-frequency use.

CIRCLE 353 ON READER SERVICE CARD

FACILITIES FOLDER Antenna Systems, Inc., Hingham Industrial Center, Hingham, Mass., has released a 4-page file folder that briefly describes its area of interest and capabilities for designing and manufacturing antennas. It also gives brief biographical sketches and qualifications of the principals in the firm.

CIRCLE 354 ON READER SERVICE CARD

FILTERS Deltronics Inc., 100 Manton Ave., Providence 9, R. I., has prepared catalog D1, a four page folder giving general specifications for a line of low pass, high pass and band pass filters. Select-A-Filter curves and an explanation of their use are included.

CIRCLE 355 ON READER SERVICE CARD

DECADE COUNTER TUBES Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y. A new counter tube handbook describes the construction, operating principles and applications of a wide variety of decade counter tubes used in computers and tabulating

machines, radiation measuring instruments, frequency dividers, and other electronic equipment.
CIRCLE 356 ON READER SERVICE CARD

SPRING MOUNT Barry Controls Inc., 700 Pleasant St., Watertown 72, Mass. Bulletin 60-04.2 describes the series SM spring mount which is designed for high impact shock and large deflections.
CIRCLE 357 ON READER SERVICE CARD

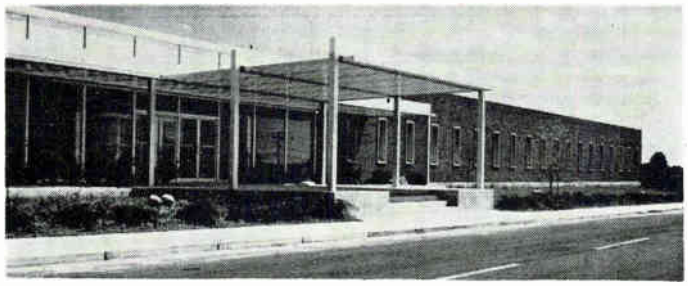
MAGNETIC CORES Telemeter Magnetics Inc., P. O. Box 329, Culver City, Calif., announces a series of data folders giving complete specifications for a line of storage cores providing a wide range of characteristics. The data sheets describe both physical and magnetic characteristics with information concerning applications.
CIRCLE 358 ON READER SERVICE CARD

ANALOG COMPUTER Computer Systems, Inc., Culver Road, Monmouth Junction, N. J., has available a 16-page technical report entitled "Mathematical Applications of the Dynamic Storage Analog Computer."
CIRCLE 359 ON READER SERVICE CARD

LOW NOISE CHOPPERS Airpax Electronics Inc., Cambridge Division, Cambridge, Md. Bulletin C-79 describes series 2300 low noise choppers. Specific applications are detailed and seven basic procedures for reduction of circuit noise signals are listed.
CIRCLE 360 ON READER SERVICE CARD

SSB RECEIVER Wilcox Electric Co., Inc., Fourteenth and Chestnut, Kansas City 27, Mo. A 4-page folder illustrates and describes the model 605A single sideband "Strip" receiver.
CIRCLE 361 ON READER SERVICE CARD

FACILITIES BOOKLET Nu-Line Industries, Inc., 1015 South Sixth St., Minneapolis 4, Minn., manufacturer of high reliability electrical connectors for use in electronic equipment, has published a facilities booklet that describes its capabilities to design and manufacture intricate miniature plastic and metal products.
CIRCLE 362 ON READER SERVICE CARD



Raytheon: 7 New Facilities in Year

THE SEVENTH major Raytheon Company facility to be completed and become operational within the past year is this modern plant (photo) in Sudbury, Mass.

A new airborne equipment center, the 160,000-sq-ft building brings under one roof facilities for manned space vehicle studies, design, development and torturous testing of advanced airborne electronic equipment. In addition, there are administrative, engineering and marketing offices. The center houses more than 800 men and women.

Airborne equipment operations, for which the new center is headquarters, is managed by Robert E. Sonnekson. Here and in manufacturing plants in Waltham, Mass., the operation is devoted to developing and producing high-speed bombing radars for the Air Force's B-52 bombers, search and navigational radars for the globe-circling B-58 bomber, Navy equipment sensitive enough to measure missile "misses", and other electronic devices for the military.

The building's unique heating system draws heat from the atmosphere, processes it, and distributes it throughout the building, yet requires no fuel. The process is reversed in summer months for air-conditioning. Raytheon believes the building is New England's first to incorporate the air-source heat pump principle.

Other new Raytheon facilities which became operational during the past 12 months are situated in Westwood, Norwood, Waltham, Burlington (two) and Bedford, Mass.

GE Promotes Edwin Suuronen

EDWIN SUURONEN has been named manager-business operations evaluations and developments in the operations research and synthesis section at General Electric's light military electronics department in Utica, N. Y. Before accepting his present assignment, he was engineer-business systems in the OR & S section.

Suuronen began his career with GE in 1929. He came to LMED in 1953 with duties in manufacturing engineering and an assignment to the automation task force. He joined the operations research and synthesis section when it was formed in 1958.

Electronic Materials Laboratory Formed

A NEW electronic materials laboratory, Solid State Materials Corp., has been formed in Needham Heights, Mass.

The laboratory's experienced staff of solid state specialists is headed by its president, Joseph F. Wenckus, formerly associated with the Ewen-Knight Corp. He is known in the materials field for his work in the growth of single crystal semiconductors, and as a codeveloper of the flame-spraying technique for the preparation of ferrites and garnets while at Lincoln Laboratory, MIT.

Solid State Materials Corp. is engaged in research, development and production of single crystal intermetallic compounds, doped silicon and germanium, paramagnetics such as doped sapphires, spinels and silicates and single crystal and polycrystalline ferrites and garnets. To provide a complete materials service to the electronics industry, SSM also makes available a variety of furnace equipment which it has developed specifically for crystal growth.

Polarad Advances Robert Saul

APPOINTMENT of Robert Saul as director of manufacturing of Polarad Electronics Corp., Long Island City, N. Y., has been announced. He was previously chief engineer and manager of the test department.

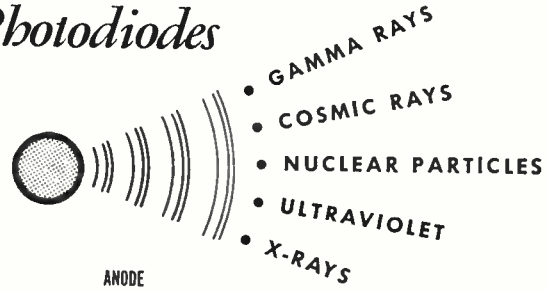
In his new position, Saul will be responsible for all aspects of production including planning, manufacturing engineering, quality control, test, and shipping and receiving. These production facilities are housed in a newly renovated 100,000 sq ft building which is adjacent to Polarad's engineering and executive buildings.

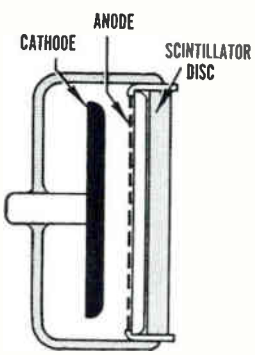
Polarad designs and manufactures microwave test instrumentation. It engages also in defense

NEW

For Radiation Detection—

ITT *"FW" Bi-Planar Photodiodes*





ITT Laboratories "FW" series of "bi-planar" photodiodes are an entirely new approach to radiation detection. Close coupling of the scintillator disc to the diode cathode provides maximum utilization of light. Exclusive arrangement and configuration of tube elements provide almost unlimited linearity—from a billionth of an ampere to 25 amperes and beyond. Small sizes and convenient shape simplify installation and application engineering.

ITT designs and produces a complete line of photodiodes and other specialized tubes for all types of electronic systems. Unequalled experience, staff qualifications, experimental equipment and production facilities enable ITT to offer the most knowledgeable services available for the creation of new tube types.

SEND FOR COMPLETE "FW" PHOTODIODE DATA

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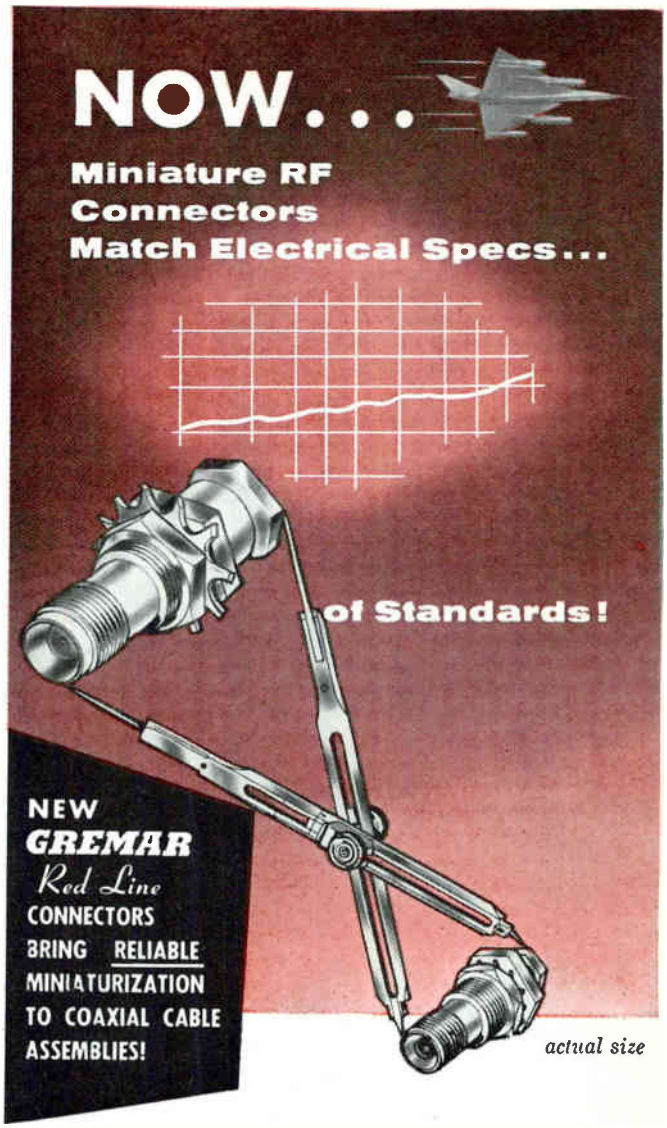
CIRCLE 211 ON READER SERVICE CARD



REPLACE STANDARDS WITH MINIATURES! Now, because of GREMAR CONNECTRONICS (T), it is possible to miniaturize your RF cable assemblies and still maintain rigid electrical specs.

Red Line Miniatures, identified by their red Teflon insulation, are half the size and weight of the reliability-proved GREMAR TNC Connectors.

DESIGNED FOR USE WITH MIL-TYPE SUBMINIATURE COAXIAL CABLES, Red Line Miniature Connectors and adapters feature:

- A new patented metal-to-metal cable clamping method which saves up to 80% of your cable assembly time while assuring a lower, more constant VSWR.
- Nominal 50 ohm characteristic impedance, 500 volts rms peak and 10,000 megacycles practical frequency limit.
- Operating temperature range: −65F to +350F.
- Meets or exceeds all applicable requirements of MIL-STD-202A and MIL-E-5272B.
- Configurations for all typical applications including adapters to BNC and TNC connectors.
- Metal parts are heavily silver plated for maximum corrosion-resistance . . . protected with Iridite to retard tarnishing. All contacts are gold-plated.
- Standard *Red Line* adapters and connectors are stocked for *immediate* delivery.

WRITE FOR BULLETIN 9 containing complete data on Gremar *Red Line* T Miniatures. Literature on all other RF connectors is available for the asking.

GREMAR

GREMAR

MANUFACTURING COMPANY, INC.
RELIABILITY THROUGH QUALITY CONTROL
Dept. A Wakefield, Mass., CRystal 9-4580

CIRCLE 83 ON READER SERVICE CARD

work involving countermeasures, klystron tubes, communication, navigation and missile ground control and test equipment.

Sanders Promoted At Teleregister Corp.

MILTON SANDERS has been elected assistant vice president, engineering, of the Teleregister Corp., Stamford, Conn.

Sanders has been with Teleregister as manager of customer projects since October 1958. Prior to that time he was with American Machine and Foundry for five years where he served as manager, electronics laboratory.

John Fluke Company Expands Seattle Plant

THE JOHN FLUKE MFG. CO. is constructing a 19,000 sq ft addition to its recently completed electronics plant in Mountlake Terrace, north of Seattle, Wash.

The new addition, the company's fifth expansion in eight years, will more than double the area of the plant. This will be in addition to a separate plant unit which will house manufacturing equipment and other assets recently purchased from Rinco Corp., Inc., a Portland, Ore., electronics firm.

Burnham Elevated To Division Manager

APPOINTMENT of Robert D. Burnham as manager of the new small transformer division of Electro Engineering Works, San Leandro, Calif., is announced.

Burnham, formerly a senior engineer with the company, will head a new division of the firm that will concentrate on small and miniaturized transformers primarily for aircraft and missile application. The division will be located in a plant recently purchased by EEW in Forestville, Calif.

A specialist in system applications of small transformers, Burnham headed his own firm—Hi Frequency Systems, Inc.—prior to joining the engineering staff of Electro Engineering Works.

Danielson Heads Up GB Electronics

AUGUST A. DANIELSON has been named vice president to head up GB Electronics, Inc., a wholly owned subsidiary of General Bronze Corp., Garden City, N. Y.

He was formerly vice president in charge of the General Bronze Brach Division, Newark, N. J. He joined the organization in 1926 and became its chief engineer in 1937.

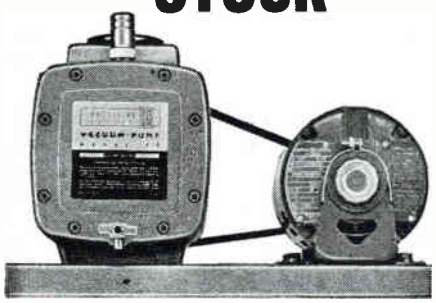
GB Electronics, Valley Stream, N. Y., is engaged in the field of antennas for guided missile, space and satellite tracking.

Motorola Appoints Hogan a V-P

C. LESTER HOGAN, general manager of Motorola's Semiconductor Products division, has been named a vice president of the corporation. He will continue to manage the Phoenix-based semiconductor activity.

Hogan has been with Motorola since 1958. At that time he was a Gordon McKay professor of applied physics at Harvard University. He formerly was with Bell Laboratories where he distinguished himself through research work on the application of solid state materials to microwave techniques.

RIGHT FROM STOCK



Model 25 Model 75 Model 150

VACUUM PUMPS

A new series of two stage, internal vane vacuum pumps offering...guaranteed ultimate vacuum of 0.1 micron... compact design... modern styling... three sizes and 31 types ... Write today for Bulletin 610... 12 pages of information... Immediate delivery on all pumps... Contact us for the name of your nearest stocking distributor.

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Local Offices in: Chicago • Cleveland • Houston New York • Philadelphia • San Francisco

CIRCLE 213 ON READER SERVICE CARD

McGraw-Hill Mailing Lists Will Help You

- Merchandise your advertising
- Conduct surveys
- Get inquiries and leads for your salesmen
- Pin-point geographical or functional groups
- Sell direct
- Build up weak territories
- Aid dealer relations

Direct Mail is a necessary supplement to a well rounded Business Paper advertising program.

Most progressive companies allocate a portion of their ad budgets to this second medium at the same time as they concentrate on the best business publications.

600,000 of the top buying influences in the fields covered by the McGraw-Hill publications make up our 150 mailing lists. Pick YOUR prospects out of our Industrial Direct Mail catalogue.

Write for your free copy.
It contains complete information.

CAREER OPPORTUNITIES IN THE FEDERAL SERVICE

with Federal Aviation Agency—for duty in Alaska

ELECTRONIC ENGINEERS—ELECTRONIC TECHNICIANS

Perform professional engineering or technical duties on installation, modification and maintenance of electronic systems on Federal airways.

Liberal benefits include paid moving costs, comprehensive retirement system, cost of living allowance, extensive training on full pay, liberal leave (annual, sick, military), low-cost life insurance, travel allowances, health benefits program, home leave travel, job satisfaction, stability of employment, good promotion prospects.

Engineers must show BSEE degree from accredited engineering school or demonstrate comparable background through Civil Service engineering examination. Technicians must show progressively responsible training and experience reflecting ability to perform advanced technical duties. Grades and salary commensurate with qualifications.

Annual salaries, ranging from $5335 to $8955, supplemented by 25% cost of living allowance exempted from Federal income tax. Overtime pay as authorized.

CONTACT

Federal Aviation Agency, P. O. Box 440, Anchorage, Alaska

CIRCLE 382 ON READER SERVICE CARD

More than a Century of Engineering Tradition

The connecting factor between bobbins and broadband preamplifiers is the engineering tradition that brought them to fruition. Since 1850, the Singer Manufacturing Company has evolved a habit of alert engineering skill and steady business growth. These inherent factors for your professional success are now a part of the new Military Product Division at Singer-Bridgeport.

Openings exist for:

- **ELECTRONIC ENGINEERS**
- **ELECTRICAL ENGINEERS**
- **MECHANICAL ENGINEERS**

Singer-Bridgeport assures you the rare combination of security and genuine ground-floor opportunity that is vital to your professional growth. Your projects receive strong support from Singer-Bridgeport's integrated organization which has the advantages of development, production, assembly and environmental test facilities.

Send your resume in strict confidence to Mr. Fred Corbett, Supervisor of Employment

SINGER-BRIDGEPORT
A DIVISION OF THE SINGER MANUFACTURING COMPANY
915 Pembroke Street Bridgeport 8, Conn.

CIRCLE 383 ON READER SERVICE CARD

DISENCHANTED ENGINEERS

If your present employer has failed to utilize your full potential, why not permit us to explore the parameters for your personal qualifications with the many dynamic young companies in aviation, electronics, missiles and rockets. We now have in excess of 4,000 openings in the $8,000 to $40,000 bracket, all of which are fee paid. Why wait? Send resume in duplicate at once indicating geographical preferences and salary requirements.

FIDELITY PERSONNEL
1530 Chestnut Street, Philadelphia 2, Pa.
Established 1943

CIRCLE 384 ON READER SERVICE CARD

POSITIONS VACANT

Engineers wanted, degree preferred, experience required to do research and development in airborne communication and solid-state application. Also, engineer of similar qualification who shows aptitude and desire towards sales engineering. SunAir Electronics, Inc., P. O. Box 8053, Ft. Lauderdale, Fla.

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(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. BOX NUMBERS count as one line additional in undisplayed ads.

OSCILLOSCOPES

Special Sale—Laboratory Used—Checked Out—Perfect

TS28 Synchroscope..$95
TS34 Synchroscope..100
TS34A Synchroscope..150
TS239 Oscilloscope..795
Tektronix 511A....350
Tektronix 511AD...375
Tektronix 514D....425
Tektronix 524D....475

Many other types

See 1959 & pages 594, 95 of 1960 Electronics Buyers' Guide for a more complete listing.

Phone: WAlker 5-6000
Cables: TELSERSUP

LIBERTY ELECTRONICS, INC.
582 BROADWAY
New York 12, N. Y.

CIRCLE 460 ON READER SERVICE CARD

LOOKING FOR

USED/SURPLUS ELECTRONIC EQUIPMENT/COMPONENTS?

For an up-to-date listing of such equipment see Searchlight Section of August 12th.

SEARCHLIGHT Equipment Locating Service

NO CHARGE OR OBLIGATION

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used Electronic equipment and components not currently advertised. (This service is for USER-BUYERS only).

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below or on your own company letterhead to:

Searchlight Section Locating Service
c/o ELECTRONICS,
P.O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
c/o ELECTRONICS, P. O. Box 12, N. Y. 36, N. Y.
Please help us locate the following equipment components.

.....
.....
.....

NAME .....
TITLE .....
COMPANY .....
STREET .....
CITY 9/2/60

INDEX TO ADVERTISERS

Audited Paid Circulation

* See Advertisement in the July 20, 1960 issue of Electronics Buyers' Guide for complete line of products or services.

■

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

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CRIMEA AND PUNISHMENT

At the height of the famous Charge of the Light Brigade, no less than 23 of the radar's tubes malfunctioned simultaneously. (And no wonder — for this was the year 1856 — 91 years Before Bomac.) The calamity not only left the Light Brigade totally in the dark, but it very nearly lost the battle and the radar unit itself. Only the heroic action of an anonymous radio operator, later reported missing, kept the unit from falling into Russian hands.*

Many years later, however, there appeared in England a man named Roland Stone, who claimed to be the missing radio operator of Balaklava. He was given a hero's welcome and was scheduled to receive the Victoria Cross for valor. He would have, too — except for a sharp-eyed, hawk-nosed man named Sheerluck Domes who happened to read about Stone in the newspaper.

Domes rushed to see the Queen and managed to gain entrance just as Stone was about to receive his reward.

Before the startled Queen could say a word, Domes was flashing a telegraph key under Stone's nose. "If you're a radio operator," he hissed, "send me some code!" Stone stammered for a moment. His hands dropped helplessly to his sides.

"You see, your majesty!" Domes said triumphantly. "This man is no radio operator. He wouldn't know a dot from a dash if he met them in Covent Garden. Off with his head, I say."

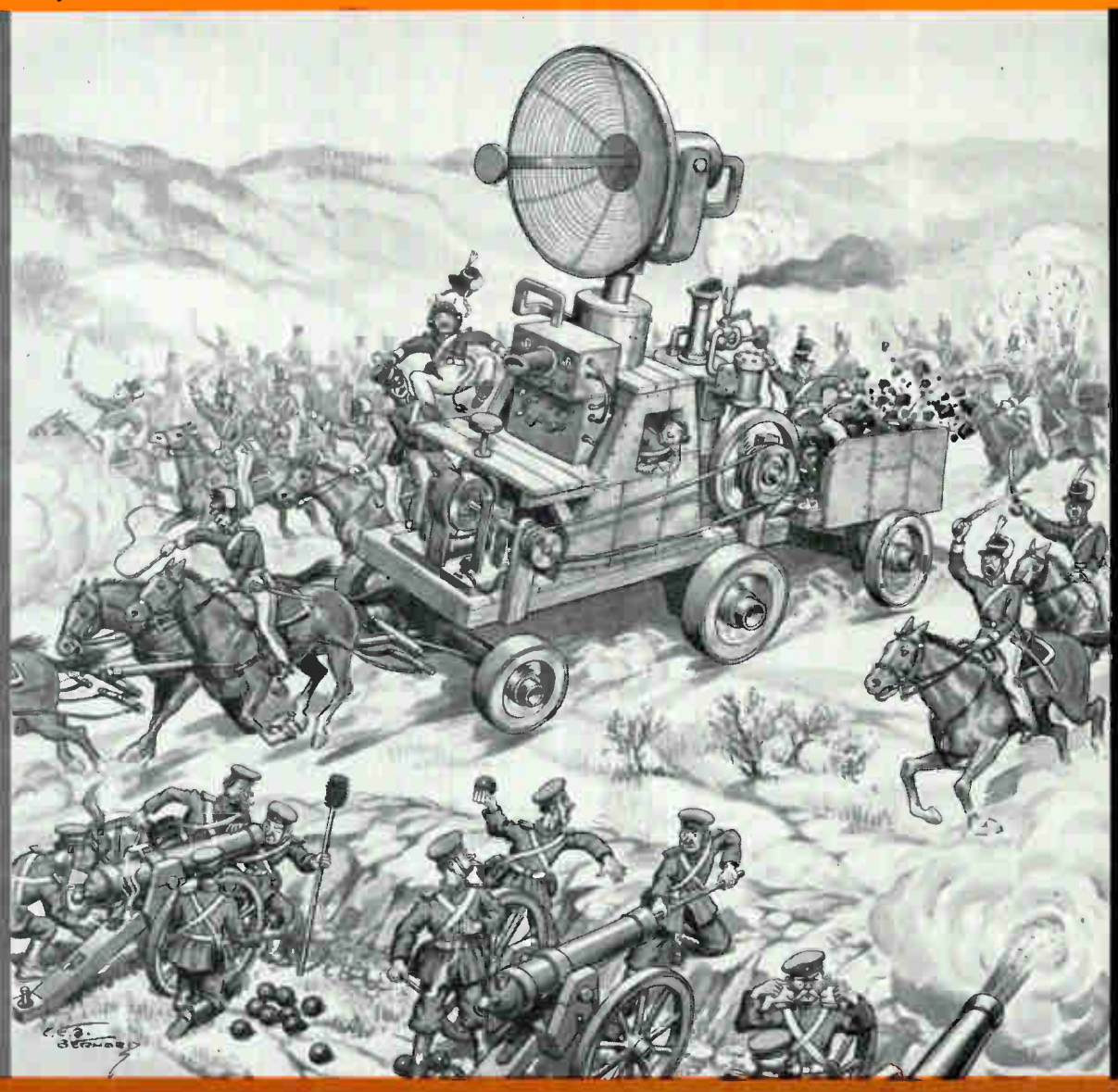
After they had led Stone away, the Queen marveled: "But Domes, how could you be sure this man was an impostor? All you knew was his name."

"That," said Sheerluck, "was all I had to know. After all," he went on, "a man named Roland Stone simply couldn't be a radio operator."

"Why not?" asked the Queen.

"Because," the great man said, "a Roland Stone gathers no Morse."

No. 21 of a series... **BOMAC LOOKS AT RADAR THROUGH THE AGES**



*Today Bomac makes the finest microwave tubes and components this side of the Crimea.

BOMAC laboratories, inc.

SALEM ROAD • BEVERLY, MASSACHUSETTS

A SUBSIDIARY OF VARIAN ASSOCIATES

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

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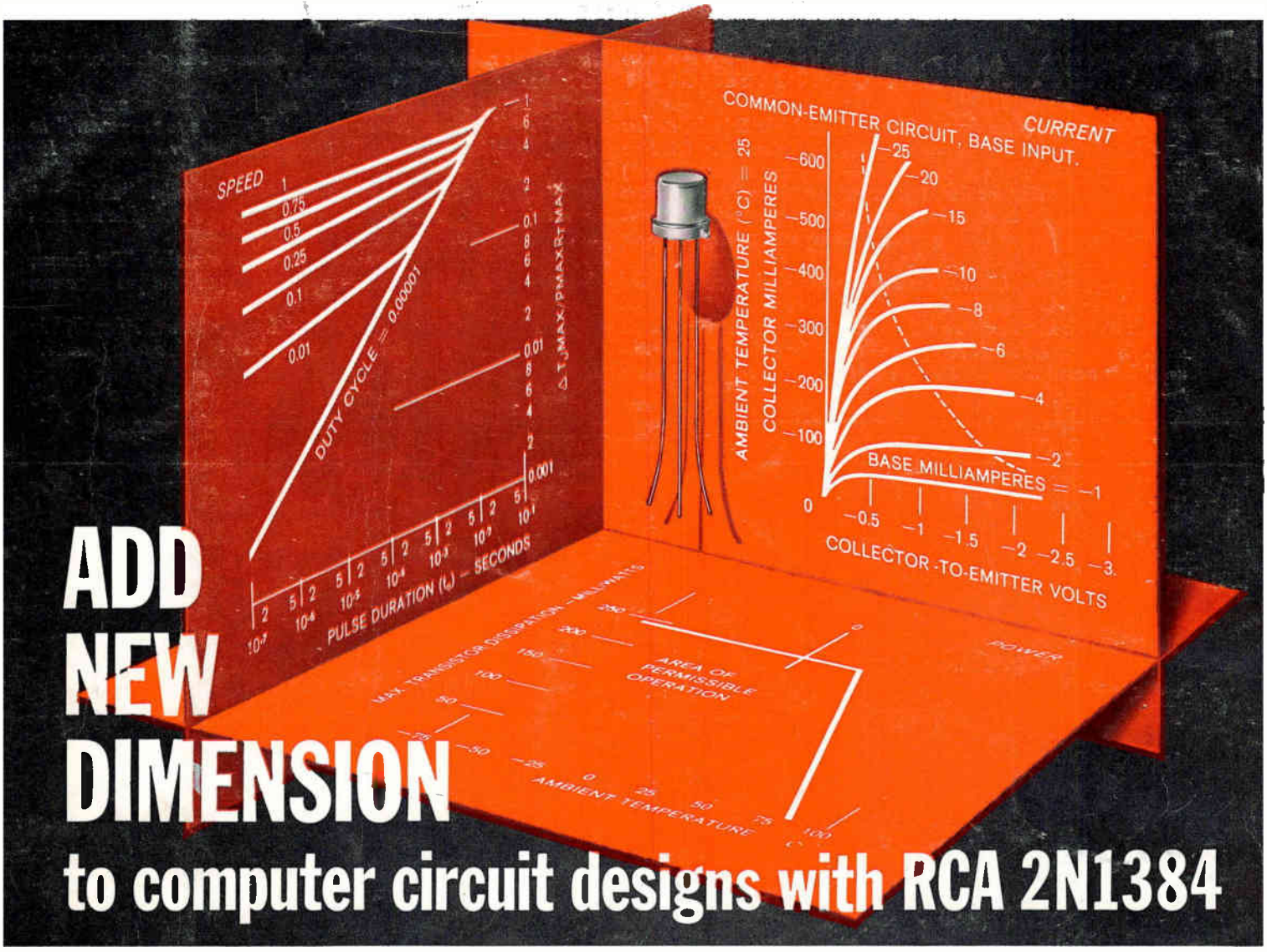

High current, high dissipation and high switching speed are combined in new germanium p-n-p drift-field transistor for use in saturating circuits in industrial and military data-processing systems

Now you can specify a germanium drift-field computer transistor designed to meet the stringent requirements of today's saturated switching circuits. The new RCA 2N1384 in the JEDEC TO-11 package, provides the following outstanding characteristics:

- *Exceptionally High Collector-Current Rating*—Maximum collector-current rating is 500 ma
- *High Dissipation Capabilities*—Maximum transistor dissipation rating is 240 mw at an ambient temperature of 25°C
- *Ultra High Speed*—Rise time of the 2N1384 in an inverter circuit at 25°C ambient is 0.08μsec. Typical gain bandwidth product of 35 Mc.
- *Broad Application*—New, high current, speed, and dissipation capabilities make the RCA 2N1384 applicable in a wide variety of saturated switching circuits such as memory-core driver, pulse-amplifier, inverter, flip-flop, and logic power gates.
- *Immediately Available*—and priced for your mass production requirements.

Call your RCA Field Representative today. Or write RCA Semiconductor and Materials Division, Commercial Engineering, Section I-19-NN-1, Somerville, N. J.

RCA 2N1384	
Maximum Ratings, Absolute-Maximum Values:	
COLLECTOR-TO-BASE VOLTAGE	−30 max. volts
COLLECTOR-TO-EMITTER VOLTAGE	−30 max. volts
EMITTER-TO-BASE VOLTAGE	−1 max. volt
COLLECTOR CURRENT	−500 max. ma
EMITTER CURRENT	500 max. ma
TRANSISTOR DISSIPATION:	
At an ambient temperature of 25°C	240 max. mw
At an ambient temperature of 55°C	120 max. mw
At an ambient temperature of 71°C	56 max. mw
AMBIENT-TEMPERATURE RANGE:	
Operating	−65 to +85 °C
Storage	−65 to +85 °C

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