September 8, 1961

electronics

Applications of Hall-effect devices in servomechanisms. See p 59

How to generate random noise for high-speed analog computers, p 66

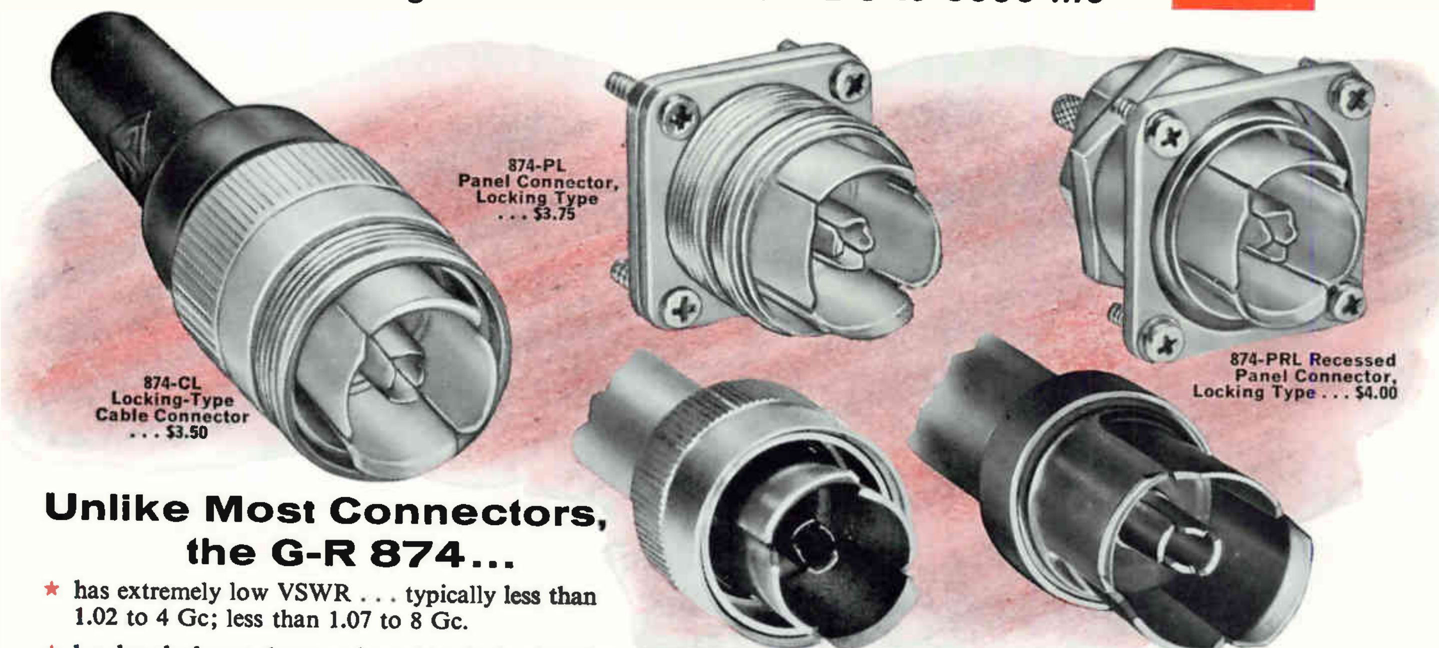
Error-detecting systems for phase-shift-keyed communications, p 76

A McGraw-Hill Publication 75 Cents

Testing magnetic materials at 30-nanosecond pulse widths. p 72

NEW LOCKING CONNECTORS

with Outstanding Characteristics from DC to 8000 Mc



874-BL Basic Locking Connector . . . $2.50
for rigid air lines

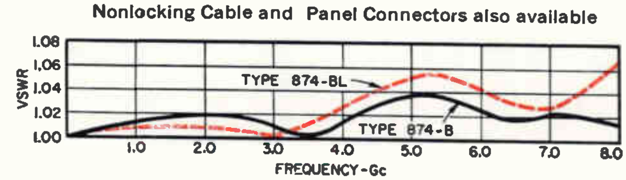
874-B Basic Connector (Nonlocking) . . . $1.60

Nonlocking Cable and Panel Connectors also available

Unlike Most Connectors, the G-R 874 . . .

- ★ has extremely low VSWR . . . typically less than 1.02 to 4 Gc; less than 1.07 to 8 Gc.
- ★ has low leakage; down at least 115 db for locking types at frequencies to 7 Gc.
- ★ is available in locking or non-locking types for semi-permanent or quick connect-disconnect setups.
- ★ forms a rigid, uniform 50-ohm section when connected; provides strong friction-grip contact through multiple-spring fingers.

Quantity and O.E.M. Discounts Available.



Any 874 Connector Mates with any other . . . Eliminating continual searches for Male or Female Counterparts.

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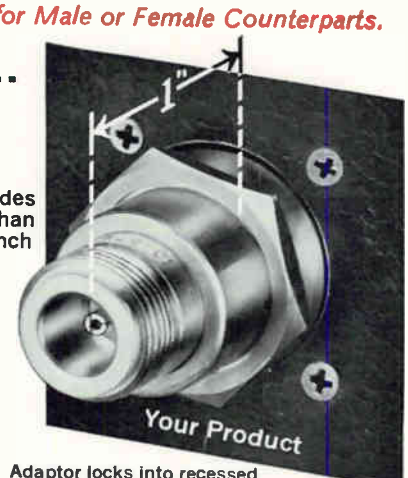
yet conveniently give your customer any popular output connection he wants

Pick the Termination You Need.
Adaptor Prices, $5 to $10. Other types soon to be available.



Adaptor locks into recessed G-R 874 Panel Connector to form low-VSWR connection. Panel Connector is completely hidden. Resulting fitting can be permanent, or readily changed . . . is electrically excellent, trim in appearance.

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

Please Send Me

- ☐ Complete specifications for the 874 Coaxial Connector.
- ☐ Engineering Papers: (1) Methods for high precision measurement of VSWR of coaxial connectors (2) Design techniques for improvement of connector VSWR and repeatability of characteristics (3) RF leakage characteristics of popular coaxial cables and connectors, 500 Mc to 7.5 Gc.

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Senptember 8, 1961

electronics

A McGraw-Hill Publication 75 Cents

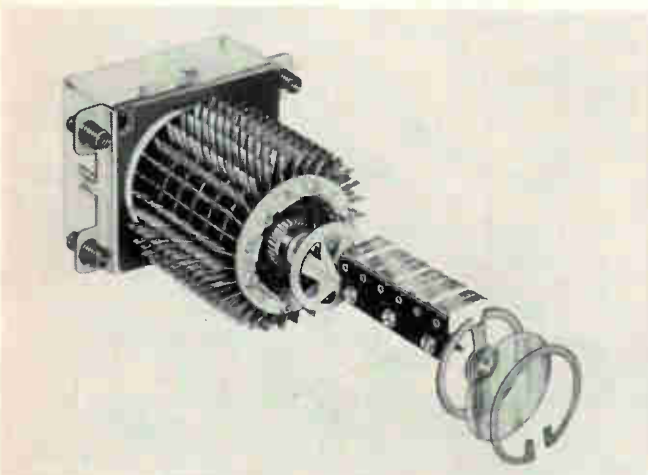
W. W. MacDONALD, Editor

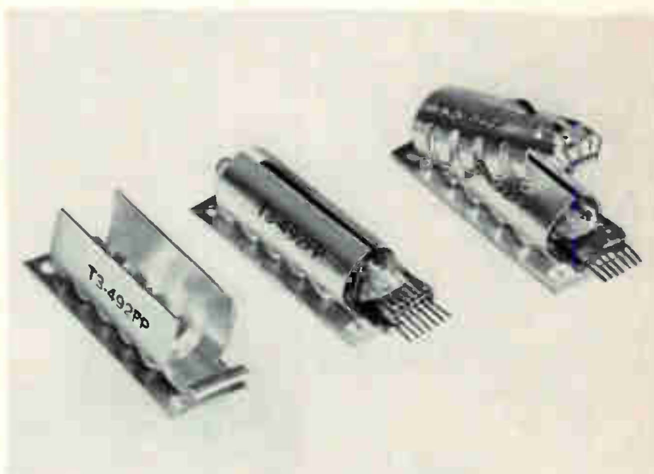
2 WAYS

(AND THEN SOME) HANDY & HARMAN CAN HELP YOU WITH ELECTRONICS APPLICATIONS

...Take Rotary Stepping Switches—The single wiper for this rotary stepping switch is made of Handy & Harman Consil 995. This silver-magnesium-nickel alloy possesses extremely high thermal and electrical conductivity and retains its spring properties and excellent conductivity even at high ambient temperatures. The bank contacts are silver plated from Handy & Harman anodes—available in a range of finenesses including the standard 999+ fine. Switch components courtesy of North Electric Company, Galion, Ohio

...Take Heat Dissipating Tube Shields—Handy & Harman Consil 995B and Fine Silver are helping to meet the critical problems of vibration and heat in subminiature tubes. The shield assembly makes use of pure silver which, being extremely soft, conforms to tube irregularities and conducts heat away with an efficiency unmatched by any other commercially produced metal. The shield base, or heat sink, is made of Consil because of the alloy's excellent thermal conductivity and ability to stay rigid at elevated temperatures. The Consil and Fine Silver are joined with EASY-FLO, a Handy & Harman silver brazing alloy. Photo courtesy of International Electronic Research Corporation, Burbank, California.





...And Then Some—These two examples are indicative of the ways in which the electronics and electrical industries are solving their problems with Handy & Harman precious metals: gold and silver and their alloys in wire, strip and foil; silver powders, flake and paint; silver chlorides and oxides; bi-metals; silver sintered metals; anodes, etc. The "etc." is our invitation to you to contact us in reference to any of your projects—present or future—that may involve the use of precious metals. We'll be glad to advise you, without obligation on your part.

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CROSSTALK

THE AUTO-BEATNIK. In view of widespread technical interest in development of machines to duplicate human intelligence, we are reporting today on some experiments conducted recently by personnel of the Laboratory for Automata Research at the Librascope division of General Precision, Inc. You might consider it a sidelight on cybernetics.

The Librascope people have devised a computer program which produces free verse. Some samples of the work of this auto-poet are reproduced at right. Our brief dip into the anthology convinces us that even Ezra Pound's laurels are safe.

CHILDREN

Sob suddenly, the bongos are moving.
Or could we find that tall child?
And dividing honestly was like
praying badly,
And while the boy is obese,
all blast could climb,
First you become oblong,
To weep is unctious, to move is poor.

COMPUTERS

Ah, that song at beat poems
is quite bored.
This song is very dumb,
as this beat chair goes,
Otherwise few shakes become like
simple pillows, and
Kissing loudly is like holding gaily,
Have them,
While movies are seeing,
this fat song dances calmly.

Actually, it's no gag, but a serious research effort to synthesize the structure and meaning of our language. The ultimate purpose, we are informed, is verbal instruction of a computer. One of the immediate returns of the research is the discovery that classic rules of grammar are not sufficient to construct a meaningful sentence. Pat formulas can produce near gibberish. A human, on the other hand, over-rides the rules, drawing on his intuitive feeling for the delicate shades of meaning inherent in words and phrases.

Thus, poets and editors everywhere can breathe easily—at least for the time being. Librascope is setting up a program for a more powerful and perhaps more lucid computer.

HALL-EFFECT SYNCHROS. The Hall effect, known since 1879, had little exploitation until the comparatively recent development and understanding of semiconductor materials and phenomena. Semiconductors can multiply the effect several thousand times, making practical its use in a wide variety of components and instruments. One of the most promising applications is in solid-state versions of rotating devices. Synchros and motors can be made without coils and brushes, reducing size, improving versatility and reliability. Such devices would be especially suited to space systems. Problems of designing Hall-effect generators have been studied and prototype devices have been made by Kearfott division of General Precision, Inc., under Navy sponsorship. A thorough analysis of these problems and their solutions is given in the report, beginning on p 59, by Z.R.S. Ratajski, chief of Kearfott's research and advanced development department.

Coming In Our September 15 Issue

UNCONVENTIONAL DETECTORS, capable of receiving signals as weak as 10^{-16} watts, are the topic of an unusual article by James Q. Burgess, of the University of Ohio's antenna laboratory. A dozen approaches, covering the range from microwave to near infrared, are reported. Another outstanding article in this issue describes experimental computer logic circuits which combine tunnel diodes and thin films. The authors are T. A. Smay and A. V. Pohm, of Iowa State University of Science and Technology.

CIRCLE 5 ON READER SERVICE CARD→

RAYTHEON DECADE COUNTER TUBES

TYPES	CK6909 CK6910*	CK6476* CK6802	CK6476A* CK7978*
DC Supply	450 volts	425 volts	425 volts
Anode Resistor	0.27 meg ohms	0.82 meg ohms	0.82 meg ohms
Nominal Tube Drop	235 volts	187 volts	187 volts
Cathode Resistor	24 K ohms	100 K ohms	100 K ohms
Output (Across Cathode Resistor)	15 volts	30 volts	30 volts
Speed	to 100 kc	to 5 kc	to 5 kc
Maximum voltage between Electrodes (excluding Anode)	140 volts	140 volts	200 volts

*All ten cathodes brought out independently for electrical readout.

More efficient equipment for precision counting and control of high-speed production machines can now be designed with Raytheon decade counter tubes. Because these tubes provide both visual *and* electrical readout, the functions of counting and stopping machinery at preprogrammed intervals can be combined with less circuitry and components.

The new Raytheon 13-pin CK7978 offers the advantages of small size, economical socket requirements, rugged construction, long life—and outstanding cost reductions both in lower initial purchase price and simpler circuitry requirements.

Frequency dividing, matrixing, telemetering, sampling, timing, and coding are other applications for Raytheon decade counter tubes. For full information please write: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

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COMMENT

Ions and Health

I want to question certain of the statements made in the course of your remarks printed along with my letter in the December 9, 1960, issue (Comment, p 6). In particular, I would like to ask that you recheck the facts concerning the polarity of the predominant ionization in fair-weather outdoor air. My own information is that in such air, small positive ions outnumber small negative ones by a ratio averaging about 1.22 to 1. (In the case of large ions the ratio is close to unity.) If this is true it directly contradicts your statement about fresh air being slightly negative.

If you'd care to settle the matter, all it takes is an electrometer and a leaky bucket. Plot potential against altitude close to the ground. According to the laws of electrostatics, any curvature in the plot indicates the presence of charge and the direction of curvature gives the polarity of charge. Whenever I've tried this, outdoors on open ground, the presence of positive ionization has been distinctly indicated.

Your attributing of the supposed negative balance to ionization by sunlight challenges common sense. If ions are created in the atmosphere by sunlight or any other agency, they certainly obey the laws of electrostatics; the negative ion of any pair will be attracted upward to the positively charged ionosphere, and the positive ion will be attracted downward toward the earth, where the people are.

WARNER CLEMENTS
BEVERLY HILLS, CALIF.

Some salient points recently made by Dr. I. H. Kornblueh, one of the country's foremost researchers in this field, on this still controversial subject:

Distribution of ions in the atmosphere close to the ground varies according to local conditions, altitude, weather, season, electrical discharges, time of day, volcanic eruptions, intensity of ultraviolet and cosmic radiation, and the amount of radioactive substances in the earth and the air. There is a direct relationship between the conductivity of air and the level of small ions; and apparently an inverse relationship between air conductivity and the number of large ions of both polarities.

Researchers have observed an increase of positive-ion concentration during snow storms, a slow rise of small ions of both polarities during showers, and rapid variations of ion density, especially of negative ions, during a thunderstorm. The increases are not lasting, occur during short periods of a few minutes and decrease rapidly. Direction and velocity of wind, and relative humidity, have a direct influence on ion levels. Amplitude of variations of ion density is greater during summer than winter.

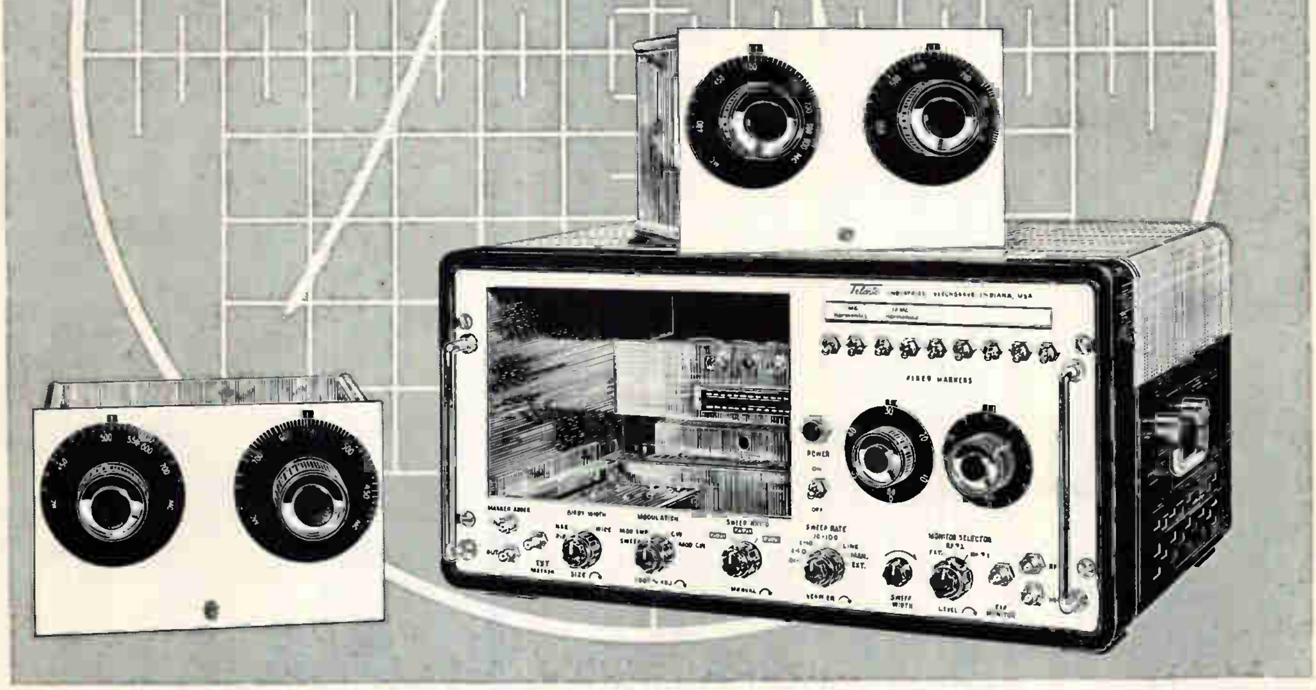
In the less-polluted air of the country there are more small negative and positive ions and fewer large ones than in the cities (the larger positive ions are the ones which most seriously affect health adversely). In the clean air of high altitudes, the stronger ultraviolet and cosmic radiation produces small ions in far greater concentrations than at sea level.

Considerable data on biological and clinical effects exists in the literature. Inhibitory influence on cell growth in cultures exposed to positive ions has been noted. Changes in the alpha brain wave have been noted in a large proportion of persons exposed to positive and negative ionization. Positively ionized air causes a temporary nasal obstruction, dryness of the throat and reduction in breathing capacity. Therapeutic effects have been obtained with negative ionization in nasal and paranasal infections; many patients suffering from hay fever and certain forms of allergic asthma responded favorably after 25-30 minutes exposure to negatively ionized air; positive ionization aggravated such conditions.

We erred in ascribing the generation of negative ionization to sunlight; continual sunny weather increases the positive ionization. And negative ions, especially the smaller, more active ones, do indeed head for high altitudes, leaving positive ionization levels down where the people are. Reader Clements' comments were quite reasonable. We can only say what most of the researchers whom we polled said: we don't know.

This is TELONIC Versatility...

A Sweep/Signal Generator for Audio to 3000 MC



As a major designer and manufacturer of RF instruments and components, Telonic once again leads the field with the introduction of the SM-2000 Sweep and CW Signal Generator. New from every standpoint, the SM-2000 provides unmatched versatility for laboratory or production operations. Now, with one instrument and several, interchangeable plug-in oscillators, an engineer can cover a frequency range from audio to 3000 mc.

Telonic has designed 19 different oscillator heads for specific and general purposes that enable the user to change range of the SM-2000 in a matter of seconds. For general applications, only two plug-in units are necessary to cover frequencies from .5 to 2000 mc. And, in addition, the operator may select four different functional modes with the SM-2000—swept RF, modulated swept RF, CW, and modulated CW. He can set attenuation from 0 to 60 db in 1 db steps with the two built-in attenuators. He also has provisions in the instrument for use of an external marker, or for adding up to eight fixed, plug-in markers if desired.

All these features are combined with the fine basic performance that has made the name Telonic synonymous with the best in RF instrumentation—low VSWR, high display linearity and excellent workmanship. If you would like more complete details on this new sweep generator please write for Technical Bulletin T-233.

Telonic Industries, Inc.
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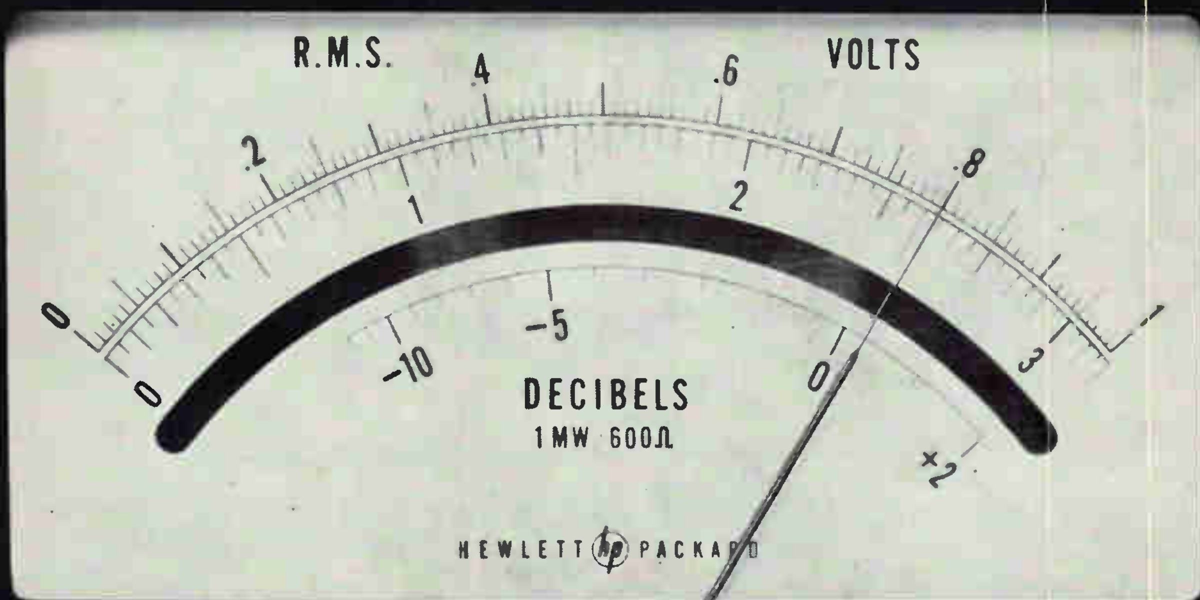
...IS!



Now! Individually calibrated meter scales give you highest accuracy–at no increase in cost!

New individual calibration of meter scales used in standard hp instruments gives you commercial instrument accuracy approaching that of lab standards! Through a servo system, *each* calibration line on *each* instrument's meter face is located precisely and *then* printed. *What the voltage actually is—you read!* No preprinted *approximate* scales are used.

This new standard of hp accuracy assures you that *each* voltmeter scale is calibrated to the exact characteristics of its *individual* meter movement. Scale tracking error is eliminated, and you get improved performance at the same moderate price.

Further, this calibration and inspection procedure at hp automatically rejects faulty meter movements. Tracking characteristics of each meter movement are determined over its entire range, and rigid tolerance control assures optimum performance.

These are the first commercial voltmeters wherein the meter tracking error is eliminated. Check the specifications below for the meter which meets your requirement. You are assured of improved performance, with this source of error eliminated—*plus* all the other advantages you expect in hp instruments: dependability, ruggedness, convenience. They're yours at no increase in cost.

This new standard of calibration is another part of hp's continuing effort to produce more accurate, more dependable, more useful instruments for measurement . . . and to produce them at moderate cost for highest value to the user.

Brief Specifications of the hp individually calibrated voltmeters

hp 400H Vacuum Tube Voltmeter

Voltage Range: 0.1 mv to 300 v, 12 ranges
Frequency Range: 10 cps to 4 MC
Accuracy: With nominal line voltages from 103 to 127 v, overall accuracy is within
±1% of full scale, 50 cps to 500 KC
±2%, 20 cps to 1 MC
±3%, 20 cps to 2 MC
±5%, 10 cps to 4 MC
Price: Cabinet, $325.00; rack mount, $330.00

hp 400L Logarithmic Voltmeter

Voltage Range: 0.3 mv to 300 v, 12 ranges
Decibel Range: –70 to +52 db, 12 ranges
Frequency Range: 10 cps to 4 MC
Accuracy: At nominal line voltage ±10%, overall accuracy is within
±2% of reading or ±1% of full scale, whichever is more accurate, 50 cps to 500 KC
±3% of reading or ±2% of full scale, 20 cps to 1 MC
±4% of reading or ±3% of full scale, 20 cps to 2 MC
±5% of reading 10 cps to 4 MC
Price: Cabinet, $325.00; rack mount, $330.00.

hp 425A DC Microvolt-Ammeter

Voltage Range: Pos. and neg. voltages 10 μv to 1 v full scale, 11 ranges
Accuracy: ±3% of full scale.
Ammeter: Current range, pos. and neg., 10 μμa to 3 ma, full scale, 18 ranges; accuracy ±3% of full scale.
Price: Cabinet, $500.00; rack mount, $505.00.

hp 412A DC Voltmeter-Ohmmeter-Ammeter

Voltage Range: Pos. and neg. voltages 1 mv to 1,000 v full scale, 13 ranges
Accuracy: ±1% full scale on any range
Ammeter: Current range, pos. and neg. currents from 1 μa to 1 a full scale, 13 ranges; Accuracy ±2% of full scale on any range.
Ohmmeter: Resistance range, 1 ohm to 100 megohms center-scale, 9 ranges; accuracy ±5% of reading, 0.2 ohm to 500 megohms ±10% of reading, 0.1 to 0.2 ohm and 500 megohms to 5,000 megohms.
Price: Cabinet, $400.00; rack mount, $405.00.

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ELECTRONICS NEWSLETTER

EIA Asks Congress to Restrict Imports

WASHINGTON—Restrictions on electronic imports should be imposed through quotas on "specific products or industry sectors", Robert C. Sprague, chairman of Electronic Industries Association's imports committee, told a House subcommittee studying the import impact on employment.

Sprague complained that the Tariff Commission and the President have frequently denied relief allowed under the Reciprocal Trade Agreements Act even after substantial damage has been shown. He asked for a "truly reciprocal policy on international trade in lieu of what is now often a one-way street". Many countries shipping electronics to the U. S. exclude American producers from their market, including Japan. Japan, he said, anticipates tremendous exports to the U. S. in the next few years.

He indicated that increasing Japanese exports to the U. S. would contract the U.S. electronics industry at a time when it should be growing to alleviate unemployment problems in other industries. Canada, Sprague said, is an "example of what Japan can do when it invades an electronic market which lacks the cushioning effect of large-scale defense buying". Between 1956 and 1960, Canadian electronics employment dropped 28 percent and it lost half its radio receiver market and 29 percent of its electron tube sales, he said.

NASA Orders More Ranger Moon Probes

SATISFIED WITH performance of Ranger I, National Aeronautics and Space Administration last week added four more Rangers to its lunar exploration program. This gives the initial program nine of the spacecraft (ELECTRONICS, p 20, Aug. 4, 1961).

The four will be equipped to transmit high resolution tv pictures of the moon's surface. They'll go into the moon at 6,500 mph, taking pictures up to impact. Jet Propulsion Lab will provide the craft and RCA is to develop the tv system.

Ranger I, which failed to orbit toward the moon and reentered the atmosphere Aug. 29, demonstrated that its orientation, communication and instrument systems worked well. Radio contact was maintained five days. All eight scientific experiments telemetered data, but because of the low orbit, six of these are probably meaningless. The radiation counters and a micrometeorite experiment supplied "very good new data".

Several commands, including roll, antenna hinge override and antenna switching were executed successfully. Telemetry received indicates that all 10 commands issued by the airborne controller system were performed as scheduled. The attitude control system stabilized the ship in pitch and yaw but not in roll. The earth was too close for the earth sensor to accomplish roll stabilization. Considering the strange environment, it functioned as designed.

Assignment of the additional Rangers helps accelerate the program to land a man on the moon by 1970. Ranger II will be fired late this year on a mission identical to Ranger I. Ranger III is to land an instrument capsule on the moon next year. Ranger IV and V will be like Ranger III, carrying a seismometer, temperature measuring devices, radio and antenna.

Laser-Twt Combination Acts Like Receiver

STANFORD RESEARCHERS report a microwave difference signal was observed when laser output was focused on a traveling-wave-tube cathode. Signal resulted from the photomixing of laser spectrum components. The twt can be considered an optical superheterodyne receiver with the cathode acting as a mixer, the helix as an l-f amplifier and a laser beam component as the local oscillator. A true receiver would use a second laser as the local oscillator and focus its output and the received signal simultaneously on the cathode.

Photovoltaic Cells Are Thin Films on Plastic

PHOTOVOLTAIC CELLS using thin films of cadmium sulfide were reported last week in Rome, at a United Nations conference on new sources of energy. The films are evaporated onto Mylar or other thin substrates. Being developed at Itek Laboratories, the films reportedly yield one to 10 watts per square meter. Direct conversion of solar energy is believed economical in the 10 to 100-watt range for unspecified military applications. Other possible applications are low-signal telemetering of coded beams from gas pipelines, meteorological stations and radar sites.

Mercury Orbital Trial Postponed Indefinitely

NASA REPORTED late last week that the orbital trial of the Mercury spacecraft which was scheduled over two weeks ago has been postponed indefinitely. The postponement was caused by difficulties with electronic components of the programming system. The components were being tested, NASA said.

Plan Tracking Antennas 250 Feet in Diameter

NATIONAL AERONAUTICS and Space Administration plans to beef up its Deep Space Instrumentation Facility (DSIF) with 250-foot space tracking antennas. A $250,000 contract for a second phase feasibility study has been awarded the Blaw Knox Equipment division. Plans are to complete the study next July and have an antenna operational at the Goldstone, Calif., tracking station by 1965. DSIF now has three tracking stations, spaced 120 degrees apart around the world. Goldstone has two 85-foot antennas; Woomera, Australia, and Johannesburg each have one. The system is overloaded by lunar program requirements, according to CalTech's Jet Propulsion Lab, which operates DSIF. The larger antennas will increase system capacity while improving communication with spacecraft by a factor of 10.

Helix Antenna Is Made From a Continuous Wire

HELIX ANTENNA with performance characteristics similar to a Yagi has been developed at Air Force Cambridge Research Laboratories. It is reported to be more broadband than a Yagi, more rigid, only 60 percent as wide for a given frequency and simpler to build, store and transport. Linearly polarized, it would be used primarily for tracking and communications.

Two helices, each with half the diameter of a conventional helix, are mounted side-by-side, touching each other. Or, the helices can be wound together in a single structure from a continuous wire to form a series of linked figure eights. The center of the figure eights is supported by a rod. The antenna can be stored with the spirals contracted, then extended to the desired length for operation.

Acoustic Thermometer Measures Upper Air

ACADEMY OF SCIENCES of the USSR reports development of an acoustic thermometer for remote metering of air temperatures at high altitudes. It makes use of the variation with temperature of the rate of sound propagation in air. The instrument consists of a generator, transmitter with two transducers and a velocimeter.

Army Tests Ammunition By Digital Computers

BINARY BATTLEFIELD is what the Army Ordnance Special Weapons-Ammunition Command calls its new computer installation at Picatinny Arsenal. Ammunition will be evaluated by simulating as many as 1,000 battles per ammunition item. Tactical situations will be simulated by introducing such variables as troop placement, wind effects, atmospheric conditions, range, elevation angles and warhead killing power. The computers will also be used in design and management studies for such projects as Nike-Zeus and Davy Crockett, a portable atomic weapon. The installation consists of an IBM 709, with a 1401 handling input and output.

Societies Occupy New Home in New York City

LAST WEEKEND 19 engineering organizations moved into the new, 20-story, $12 million United Engineering Center at United Nations Plaza, New York. The center, built by United Engineering Trustees, replaces the 50-year-old Engineering Societies Building, also in New York. World-wide membership in the societies totals some 300,000.

The Engineering Societies Library, one of the prime repositories of technical information in the United States, began moving two weeks earlier. The new building will expand the capacity of the free public engineering library to 250,000 volumes. Andrew Carnegie financed the original building with a $1.5 million gift. Funds for the new building were contributed by society members, industry and others.

Radio Control Moves Materials in Hot Lab

RADIO-CONTROLLED car on rails will tote radioactive materials, containment boxes and experimental equipment through a multilevel working cell complex under construction at Argonne National Laboratory.

The radio is a modified model airplane control, with eight channels in the citizens' band. Signals through relays direct 28-volt battery power to motors, which discharge or rotate pallets and propel low flatcar "mules". The cars can be moved back and forth on tracks and on and off elevators between levels.

In Brief . . .

SENATE Small Business Committee will hear FCC recommendations on private satellite communications systems at a hearing Oct. 17, before a subcommittee on monopoly investigations.

CIVIL AERONAUTICS Board has revoked, as of Oct. 1, minimum rates on air cargo shipments. The move is expected to lower rates. Electronic equipment moves in large volume by plane.

EXPLORER XIII reentered the atmosphere after a flight lasting three days. NASA says it telemetered considerable data on micrometeoroids.

DEVELOPMENT of a National Nuclear Rocket Development Center advanced a step with award by NASA and AEC to Vitro Engineering. Vitro will design a nuclear rocket engine maintenance and disassembly building.

AEC HAS AWARDED $6 4 million in physical research contracts, including $525,000 to Princeton University, cyclotron and associated research; $390,000 to MIT, precision encoder and pattern recognizer, and $165,000 to Yale, electron accelerator. Others were mainly for materials studies.

ADLER ELECTRONICS has a $475,000 contract for three transportable Army communications centers. Each will have one telephone and eight teletypewriter channels, with a range of 2,500 miles.

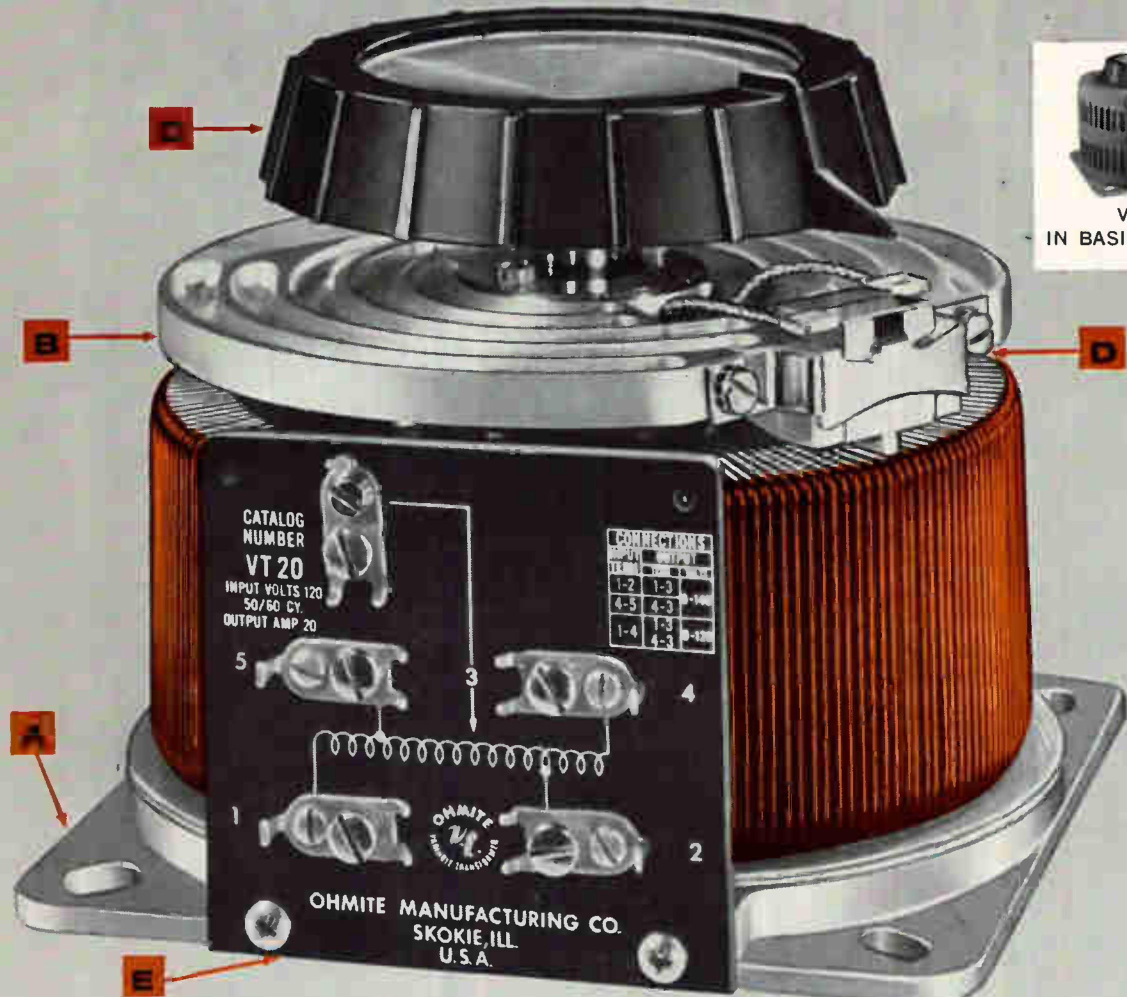
BENDIX will provide 11 transistor numerical controls, at $¾ million, for machine tools to be installed at Douglas Aircraft under Air Force Industrial Modernization Program.

HALLICRAFTERS has established a maintenance and logistic division, after receiving an open-end maintenance contract from Dayton Air Force Depot.

ITALY is liberalizing or eliminating import restrictions on some 90 Japanese products, including a number of electronic products.

SWEDEN is ordering fourteen weather radar stations, costing $800,000, from Selenia, an Italian affiliate of Raytheon.

NEW 20-AMP Variable Transformer



VT20B—
IN BASIC ENCLOSURE

OHMITE SERIES VT20

SHOWN ⅔ ACTUAL SIZE

FEATURES

A Base has elongated mounting holes and other features which give the VT20 universal mounting capabilities. Can be used as a *direct replacement for other popular transformers* of comparable size.

B Radiator plate is counterbalanced in conjunction with the brush assembly for smooth operation and stability under vibration.

A & B Unusually fast heat dissipation results from carefully designed base and radiator plates.

C Adjustable shaft extends from either end of the transformer as required for panel or horizontal surface mounting. *Unique, collet-type lock permits repositioning without scoring or defacing the shaft.*

D Extra large brush assembly gives a big margin of heat dissipation . . . is accurately counterbalanced by radiator plate design.

E Terminal panel allows quick arrangement of *clockwise or counterclockwise* increase of voltage for "line" (120 V) or "overvoltage" (140 V) maximum output.

VT20 VARIABLE TRANSFORMERS CURRENTLY STOCKED

Cat. No.	Input (Sing. Ph.)		Output		Rot. Ang.
	Volts	cps	Volts	Amps	
VT20 VT20B	120	50-400	0-120/140	20	317°

WRITE FOR BULLETIN 165

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois

Rheostats Power Resistors
Precision Resistors Variable
Transformers Tantalum Capacitors
Tap Switches Relays R.F. Chokes
Germanium Diodes Micromodules

OHMITE

NOW 4 SIZES

CIRCLE 13 ON READER SERVICE CARD

WASHINGTON OUTLOOK

LABOR DEPARTMENT'S case to set Walsh-Healey Act minimum pay rates for production workers in plants which sell electronic end-items to the government is nearing completion. Electronic industry management and labor representatives have been called to a September 18 meeting in Washington to debate the official wage scale.

Starting point for the discussion will be the findings of the Department's industry survey made in June, 1960. This showed an average hourly minimum pay for electronic end-item equipment production workers of $1.45 when estimated by numbers of plants, and $1.60 when determined by numbers of workers. The survey covered about 332,000 workers in 425 plants. Walsh-Healey wage rates have already been set for workers in electron tube and electronic component plants.

NATIONAL CAPITAL Transportation Agency is asking for ideas that will help it develop a new type of rapid transit system for the 2,000-square-mile Washington, D.C., metropolitan area. The agency has invited proposals from more than 100 electronics manufacturers and other types of manufacturers. It is interested in new design and systems concepts as well as hardware.

Letters have gone out to manufacturers in 25 categories, ranging from vehicle builders to seating designers. Among the groups contacted are makers of electronic headway recorder systems, electrical controls and propulsion, automatic guidance, automatic train control, automatic fare collection, remote-controlled destination signs and public address systems.

NEW GROUND-TO-AIR communications system designed to cut in half the present voice communications required between pilots and air traffic controllers has been proposed by Motorola and General Precision. Dubbed Access (for Aircraft Communications Electronic Signaling System), the new system is based on time-sharing of voice channels by digital communications. All routine communications such as aircraft identification, weather information and flight clearances—now handled verbally—would be handled electronically with the push of a button. Voice contact, where needed, would still be possible and could be accomplished more rapidly and conveniently than at present, the developers say.

Motorola and General Precision have discussed the new system with officials of the Federal Aviation Agency and hope for a go-ahead to develop a prototype which would be ready for evaluation within 18 months. The estimated development cost: $2 million; the study program cost $100,000.

Access is designed for use with present air communications equipment without modification. By using phase-shift keying, transmission could be made within the audio bandwidth available on vhf, uhf and hf. Inputs would be made directly into microphone lines, and outputs taken from the receiver audio line. Inputs would vary from simple manual key depressions to sophisticated automatic data transductions. Outputs would be labeled to operate automatically certain aircraft functions or to display data on monitors in the aircraft.

NORTH AMERICAN Air Defense Command reports that its space detection and tracking system will have to be expanded "within one to four years" to include "the means to provide warning of hostile activity in space." The system now tracks all known space vehicles, maintains a catalog of known space launchings by the U. S. and the Soviet Union, determines orbits and schedules of satellite positions. To supplement this capacity, NORAD wants the means to "determine the purpose and capability of unfriendly space objects, to provide space traffic control, to provide operational support to anti-satellite weapons".

nearly everybody in electronic laboratories reads Video Instrument catalogs... get yours!

When your mind gets back to amplifiers, remember that Video Instruments now provides four types of laboratory and field tested solid state amplifiers—chopper stabilized, sub-miniature airborne, galvanometer driver, and "pure" direct coupled. Complete specifications are available in Vi's latest catalog—and, as a reward for promptness, we will also send you a technical discussion of common mode rejection. Write Video Instruments—then get back to work.

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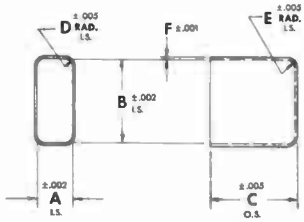
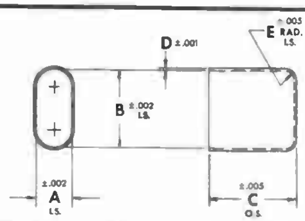
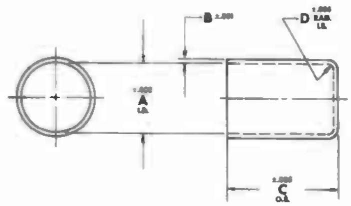


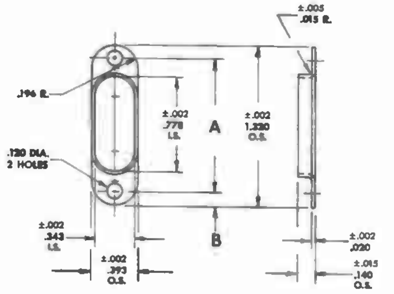
TC NO.	A	B	C	D	E	F
29-1	.359	.759	.852	.080	.020	.012
29-2	.359	.759	.870	.080	.020	.012
29-3	.359	.759	.977	.080	.020	.012
29-4	.359	.759	1.000	.080	.020	.012
29-5	.359	.759	.687	.080	.020	.012
29-6	.359	.759	.360	.080	.020	.012
29-7	.359	.759	1.375	.080	.020	.012
40-1	.359	.759	.877	.030	.020	.012
40-2	.359	.759	1.035	.030	.020	.012
40-3	.359	.759	.885	.030	.020	.012
41-1	.356	.756	.485	.080	.032	.005
42-1	.450	.700	.843	.047	.015	.016
42-2	.450	.700	.781	.047	.015	.016
43-1	.387	.787	.865	.093	.032	.010
44-1	.365	.765	.870	.077	.015	.012
44-2	.365	.765	1.141	.077	.015	.012
46-1	.354	.766	.326	.015	.015	.006
47-1	.363	.767	.870	.030	.030	.010
47-2	.363	.767	.977	.030	.030	.010
47-3	.363	.767	1.276	.030	.030	.010
47-4	.363	.767	.880	.030	.030	.010
47-5	.363	.767	1.312	.030	.030	.010
47-6	.363	.767	1.250	.030	.030	.010
48-1	.370	.782	.835	.026	.025	.008
49-1	.366	.770	.867	.035	.015	.012
49-2	.366	.770	1.437	.035	.015	.012
50-1	.344	.534	.383	.088	.025	.005
51-1	.179	.379	.595	.040	.040	.010
51-2	.179	.379	.775	.040	.040	.010
52-1	.550	.983	1.252	.061	.015	.012
53-1	.358	.768	.833	.015	.025	.014
54-1	.362	.767	.875	.032	.015	.012



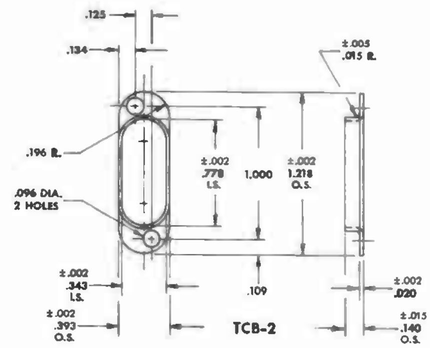
TC NO.	A	B	C	D	E
25-1	.318	.755	.850	.012	1/64
25-2	.318	.755	.870	.012	1/64
25-3	.318	.755	1.162	.012	1/64
25-4	.318	.755	1.175	.012	1/64
25-5	.318	.755	.881	.012	1/64
25-6	.318	.755	1.375	.012	1/64
25-7	.318	.755	1.152	.012	1/64
25-8	.318	.755	.988	.012	1/64
25-9	.318	.755	1.437	.012	1/64
25-10	.318	.755	.865	.012	1/64
26-1	.378	.881	1.175	.012	1/64
26-2	.378	.881	1.230	.012	1/64
30-1	.293	.698	.750	.010	1/64
30-2	.293	.698	1.640	.010	1/64
30-3	.293	.698	2.500	.010	1/64
30-4	.293	.698	3.000	.010	1/64
30-5	.293	.698	1.375	.010	1/64
30-6	.293	.698	1.500	.010	1/64
30-7	.293	.698	.572	.010	1/64
30-8	.293	.698	.969	.010	1/64
30-9	.293	.698	1.984	.010	1/64
30-10	.293	.698	1.750	.010	1/64
30-11	.293	.698	.322	.010	1/64
34-1	.298	.732	.483	.008	1/64
39-1	.350	.842	.785	.010	1/64

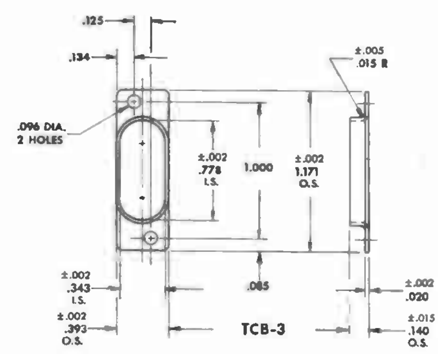


TC NO.	A	B	C	D
TC-3-1	.196	.010	.300	.015
TC-3-2	.196	.010	.340	.015
TC-4-1	.222	.010	1.000	.015
TC-7-1	.217	.008	.375	.015
TC-8-1	.290	.010	.562	.015
TC-9-1	.347	.008	.875	.015
TC-10-1	.109	.012	.235	.015
TC-11-1	.2065	.010	.400	.015
TC-13-1	.229	.006	.375	.005



TCB NO.	A	B
TCB-1	1.078	.121
TCB-7	1.062	.129

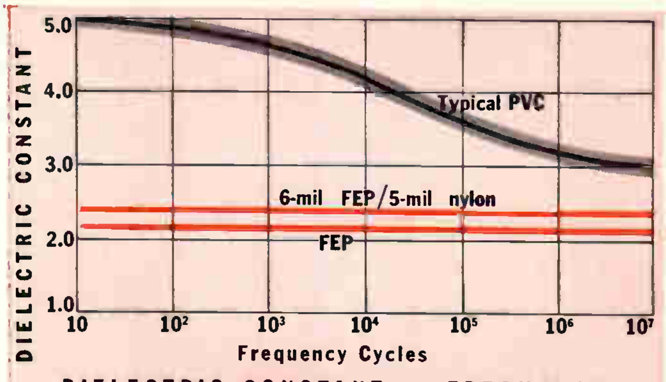




Why Honeywell picked TEFLON® 100 FEP for computer hook-up wire insulation

After extensive testing of various hook-up wire insulations, Honeywell has chosen a combination of primary insulation of Du Pont "TEFLON" FEP with a jacket of Du Pont "Zytel" nylon resin. This insulation will be used in the "H 800" and "H 400" computer series, and in other series to be developed by the company. Major reasons for this choice are as follows:

Low electrical capacitance: High-speed circuits of the "H 800" and "H 400" series demand minimum capacitance—therefore, a low dielectric constant. Furthermore, this value must be unvarying over the range of frequencies encountered in computer operation. TEFLON FEP resin has as low a dielectric constant as any known solid insulating material. And, unlike most other insulating materials, it maintains this low value at all frequencies involved in the operation of data-processing equipment. The chart at the right shows that the 6-mil FEP/5-mil nylon combination provides an unvarying dielectric constant only slightly higher than that of FEP alone.



DIELECTRIC CONSTANT vs. FREQUENCY

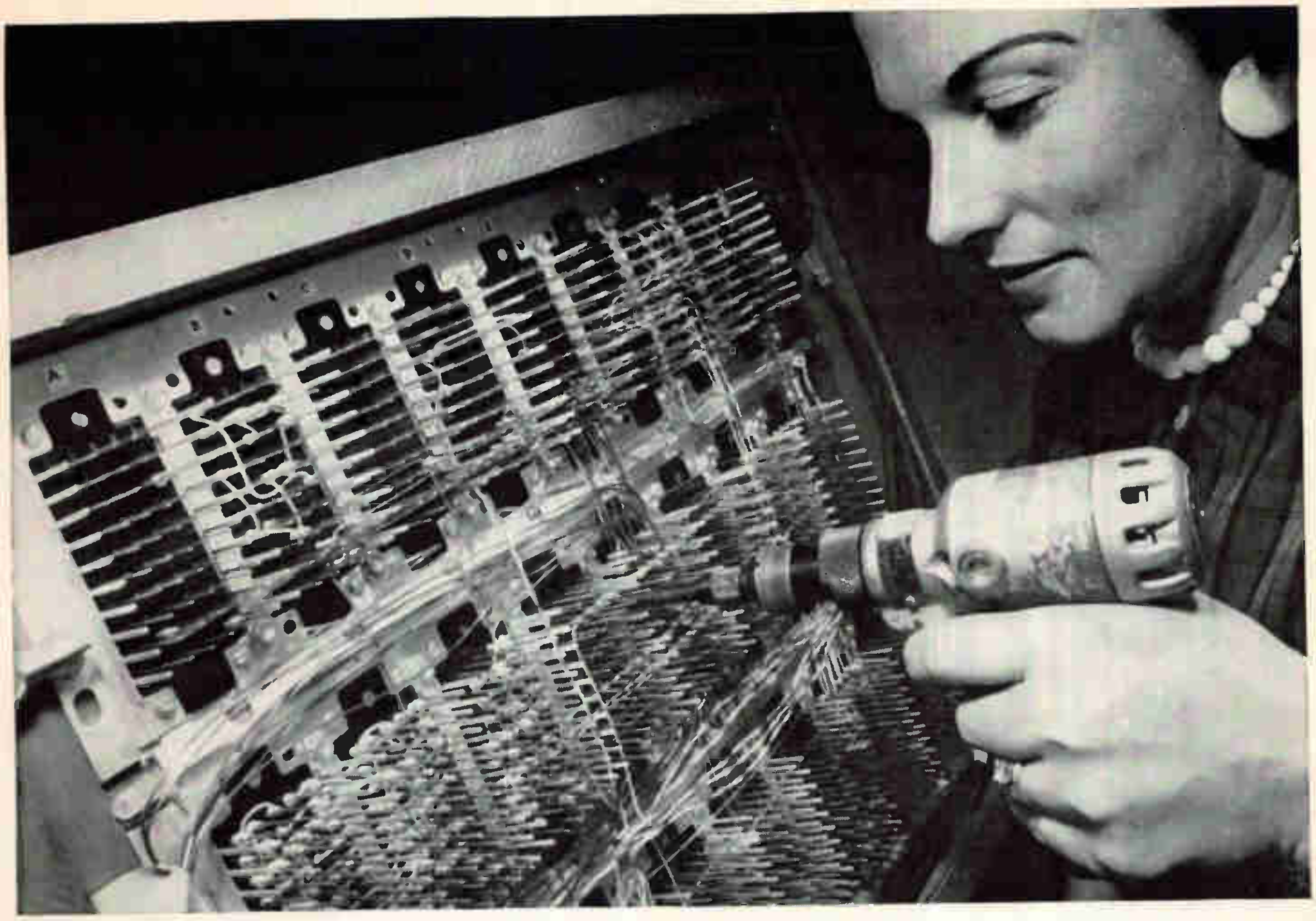
Heat resistance, heat aging and other considerations:

Honeywell designers were also concerned with the effects of aging, flammability and the working temperature range of the wire insulation. In all tests conducted on these characteristics, design limits were met or exceeded by the combination of TEFLON FEP and "Zytel" nylon.

TEFLON FEP, both alone and in combination with nylon jackets, has excellent heat-resistance and heat-aging properties. TEFLON FEP alone is completely nonflammable. Tests showed that the combination of FEP and nylon had adequate flame resistance.

Ease of handling was another important consideration. The FEP-nylon construction proved sufficiently flexible for automatic wrapping operations. And, because of the degree of close control feasible for wall thickness and concentricity, difficulties during automatic stripping operations were minimized.

As still another plus point, the processing temperatures that were involved in the application of a TEFLON FEP primary with a nylon jacket were sufficiently low to permit the use of a tinned conductor, preferred by Honeywell.

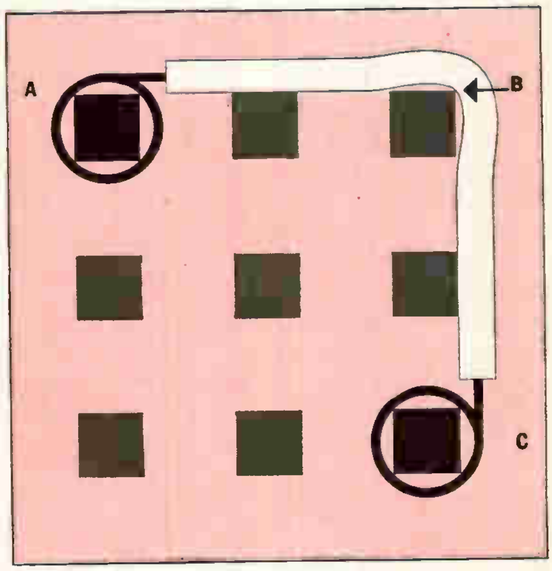


Suitability to automatic wire wrapping:

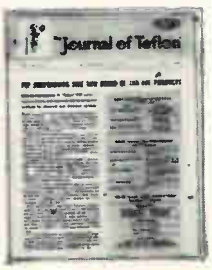
Resistance to cut-thru becomes particularly important when wire-wrapped terminations are used. And Honeywell has decided to go to wire wrapping for the "H 800" and "H 400" series because of increased speed and greater reliability.

The diagram at right illustrates a connection in which the wire is bent through 90° to complete a circuit. While Honeywell production techniques assure slack in the wire between points A-B and B-C, the path of the wire may involve contact with other connector pins. Insulation must be sufficiently resistant to cut-thru to prevent short circuiting. The combination of TEFLON FEP and nylon jacketing has proved outstanding in this respect.

Thus, as Honeywell discovered, the combination of TEFLON FEP primary and "Zytel" nylon jacketing provides the optimum balance of capacitance, cut-thru resistance and adaptability to modern production methods, plus economical wire costs.



The Journal of TEFLON, available to design engineers, presents the latest information on TEFLON fluorocarbon resins from Du Pont and users. In recent issues, you will find additional information on the use of TEFLON FEP insulations for computer hook-up wire and many wire constructions now available—plus data on the companion products, TEFLON TFE-fluorocarbon resins. To add your name to the mailing list, write: E. I. du Pont de Nemours & Co. (Inc.), Dept. ED-8-30, Room 2527T, Nemours Building, Wilmington 98, Delaware. *In Canada:* Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.



TEFLON®

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

DU PONT

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

CIRCLE 21 ON READER SERVICE CARD

Halfway Earnings Irregular

SALES AND EARNINGS of electronics companies for the first half of this year show an irregular pattern. While a good many companies are showing slight increases, some firms have not so far come up to last year's levels.

ZENITH RADIO CORP. reports profits of $5,393,244 on sales of $116,698,673 for the January-June interval. Last year's first half profits were 1.6 percent lower totaling $5,309,465 on slightly higher sales of $118,263,821.

TENNEY ENGINEERING, Union, N. J., in the six-month period, earned $10,736 on sales of $3,272,861. At this time last year, the company had a deficit of $55,822 on sales of $2,359,989.

SILICON TRANSISTOR CORP., Carle Pl., N. Y., had sales of $956,000, earnings of $69,000 for the first half of the year. Last year's figures were $513,000 in sales yielding $53,000 in earnings.

ATLANTIC RESEARCH CORP., Alexandria, Va., reports earnings of $606,036 on sales of $9,039,071 at the half-year mark. Last year company earnings were in excess of $374,000 on sales of $5,985,215.

VITRAMON INC., Bridgeport, Conn., records sales and earnings for the January-June interval this year below those of last year. Earnings this year were $45,000 on sales of $1,308,000. Last year they were $125,000 on sales of $1,443,000. The company expects an overall improvement as its backlog is more than $400,000 higher now than last year.

C-E-I-R, New York, data processors and analytical researchers, reports net sales of $5,364,581 for the first half of its present fiscal year as compared with $2,027,477 in the same interval a year ago. Last year in the first six months, the company had a net loss of $277,948,- reduced this year to $154,088. This was due in both years to nonrecurring costs connected with start-ups of new data processing centers and with mergers.

AUDIO DEVICES, INC., for the first half of the year had profits of $212,023 before taxes on sales of $3,677,088. The figures last year were $283,012 profits and $3,251,954 sales. Total company sales were up 13 percent, while sales on magnetic-tape recording products rose 19 percent.

TEXAS INSTRUMENTS' first six months of this year saw increased sales over last year, but a dip in earnings. Sales billed for the 1960 period were $116,051,000 with earnings of $7,921,000. This year sales were $119,860,000 with earnings of $6,374,000. Main area of decline was in semiconductor sales, which were affected by tighter competition.

CONTINENTAL CONNECTOR CORP., New York, recorded a drop in earnings in the first half of this year as compared to 1960. Amounts were $145,916 and $304,185 respectively. Sales also declined, going from $3,989,546 last year to $3,498,079 this year.

G B COMPONENTS, Van Nuys, Calif., reports net earnings for the first half of this year were equal to total net profits earned in all of 1960. After-tax earnings for the period ended June 30, 1961 were $26,953 as compared to $27,558 for the twelve months of 1960. Sales for the first half of this year were $425,951 as against $636,797 for the full year of 1960.

LING-TEMCO, Dallas, reports a drop in profits for the first half of this year as compared with last year. This year's figure was $827,379; last year's was $1,437,076. Sales in the 1960 interval were $76,120,306. This year they were $70,847,881. Decline was due primarily to drop-out of the Corvus missile program. Last week the company combined with Chance-Vought Corp., and believes the new entity will result in improved sales and earnings.

INSTRUMENTS FOR INDUSTRY, Hicksville, N. Y., reports sales of $1,594,688 for the six months ended June 31 this year. In 1960 the comparable figure was $758,940. Profits declined, going from $22,393 to $7,768.

CLEVITE CORP., Cleveland, O., saw a drop in sales and earnings for the first half of the year. Sales went from $51,410,000, in 1960 to $46,701,000 for the period. Income went from $3,930,000 to $2,424,000.

RAYTHEON reports six-months earnings of $3,009,000 this year as against last year's $4,187,000. Net sales rose slightly going from $277,564,000 in 1960 to $280,180,000 this year. The decline is attributed to price deteriorations in several component lines.

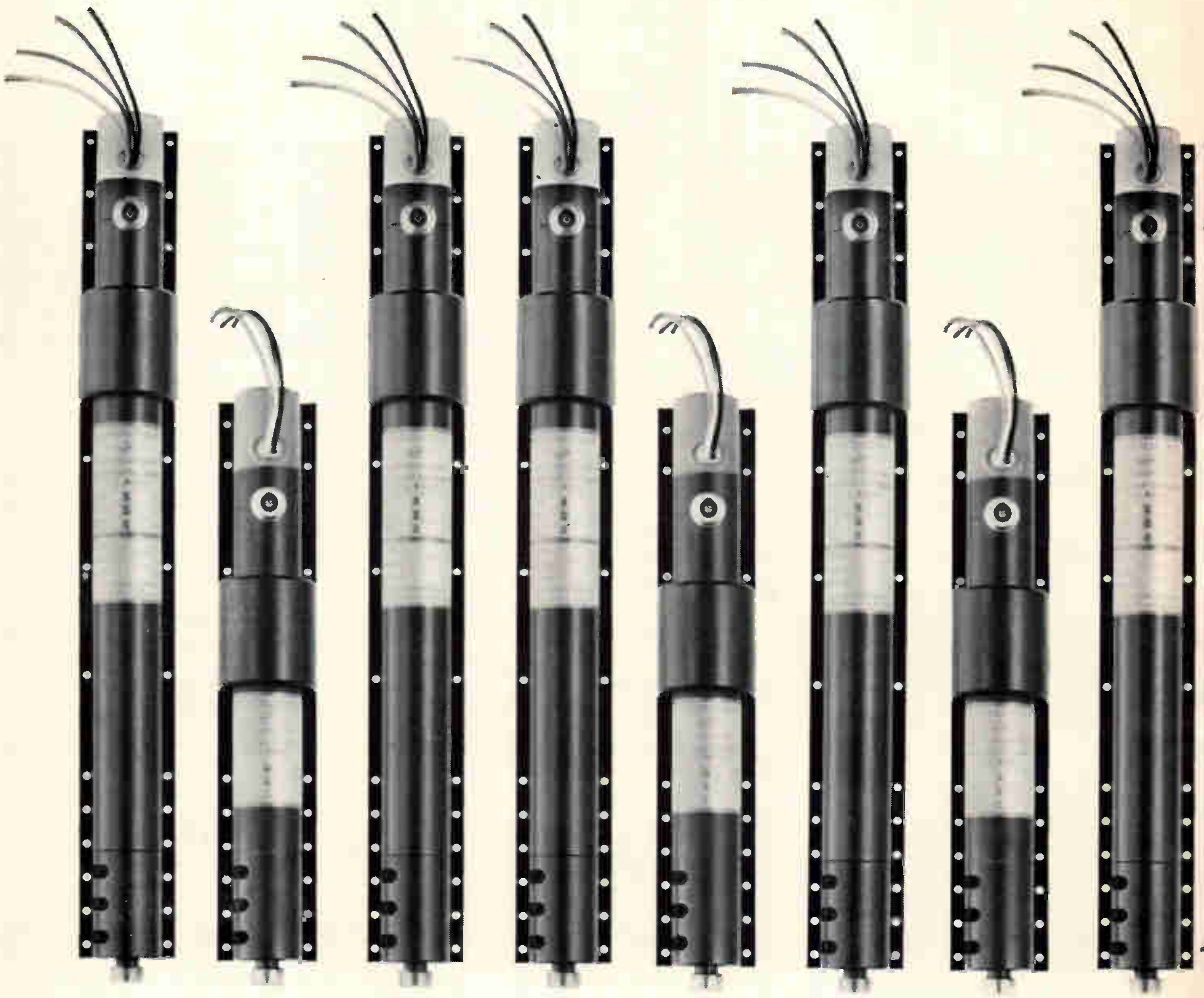
AMPHENOL-BORG ELECTRONICS saw a dip in net sales for the first half of this year as compared with the same period of 1960. Figures were $34,641,054 and $35,226,005 respectively. Net income fell from $1,532,948 to $463,470.

25 MOST ACTIVE STOCKS

WEEK ENDING AUGUST 18, 1961

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	2,671	27¼	25⅜	26⅛
Raytheon	2,212	44½	40⅜	43⅛
Avco Corp	2,002	26¼	24⅜	24⅝
Magnavox	1,468	39⅜	34⅛	38½
Gen Dynamics	1,310	33⅞	32	32¼
Lockheed	975	51⅞	49¼	50¾
Gen Elec	935	69¼	67½	68⅝
Ling Temco Vought	915	35½	31⅛	32⅜
Ampex Corp	823	21½	19⅝	20⅝
Sperry Rand	817	29½	27¾	27¾
Zenith Radio Corp	631	178½	169⅝	178½
Philco Corp	563	22⅝	20⅛	21¼
Westinghouse Elec	532	44	42⅞	43¼
Martin Co	448	37	35⅜	35¾
RCA	402	61¼	58⅞	59⅜
Int'l Tel & Tel	397	60	58½	56⅝
Standard Kollsman	377	49	46⅛	47¾
Universal Controls	365	12⅜	11⅛	11¼
Burroughs Corp	342	30⅞	30¼	30½
U S Industries	342	16¾	15½	16⅜
Texas Inst	296	153¾	142	144¼
Gen Inst	282	40¾	38¾	38⅞
Dynamics Corp of Am	275	15⅜	14½	14½
Elec & Mus Ind	267	5⅝	5⅜	5½
Transitron	266	24¾	23	23⅛

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.



EM-778
Frequency:
5-11 Gc
Gain: 60db
Power:
1 watt

EM-779
Frequency:
5-11 Gc
Gain: 30db
Power:
1 watt

EM-1006
Frequency:
2-4 Gc
Gain: 40db
Power:
1 watt

EM-1010
Frequency:
4-8 Gc
Gain: 60db
Power:
1 watt

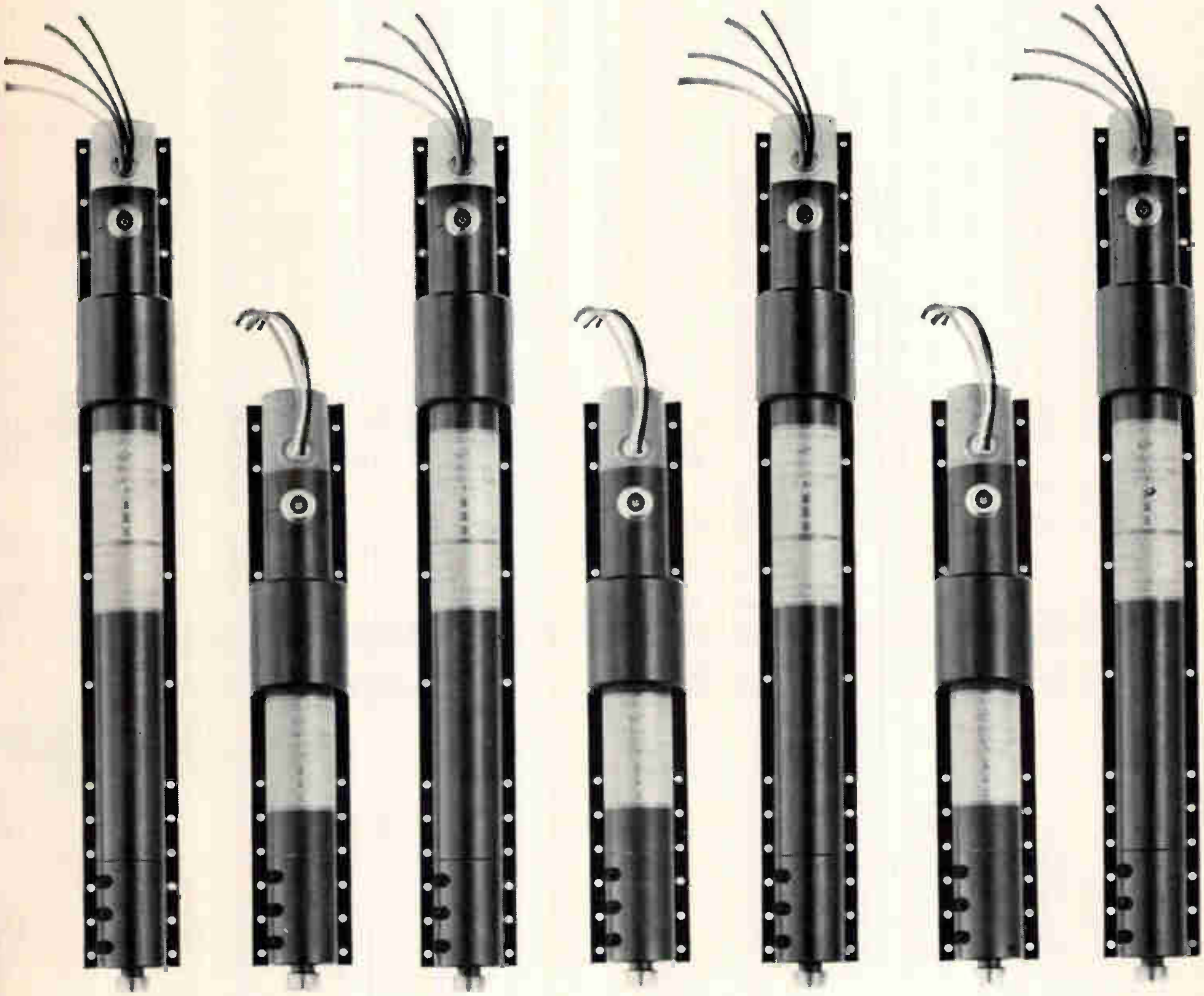
EM-1011
Frequency:
4-8 Gc
Gain: 30db
Power:
1 watt

EM-1015
Frequency:
4-8 Gc
Gain: 60db
Power:
3 watts

EM-1016
Frequency:
4-8 Gc
Gain: 30db
Power:
3 watts

EM-1025
Frequency:
4-12 Gc
Gain: 40db
Power:
1 watt

Now a new family of high-performance



EM-1030
Frequency:
7-11 Gc
Gain: 60db
Power:
5 watts

EM-1031
Frequency:
7-11 Gc
Gain: 30db
Power:
5 watts

EM-1045
Frequency:
8-12 Gc
Gain: 60db
Power:
1 watt

EM-1046
Frequency:
8-12 Gc
Gain: 30db
Power:
1 watt

EM-1050
Frequency:
8-12 Gc
Gain: 60db
Power:
3 watts

EM-1051
Frequency:
8-12 Gc
Gain: 30db
Power:
3 watts

EM-1060
Frequency:
2.5-11 Gc
Gain: 30db
Power:
1 watt

TWT's from Eimac!

Today: fifteen traveling-wave tubes (and more on the way) built with Eimac's know-how, Eimac's dependability. Each one is ruggedized to take even the toughest military environment in its stride. And each one is available in only 30 to 60 days delivery time! For more details, more technical data, write today to: Microwave Marketing, Eitel-McCullough, Inc., San Carlos, California.

Eimac

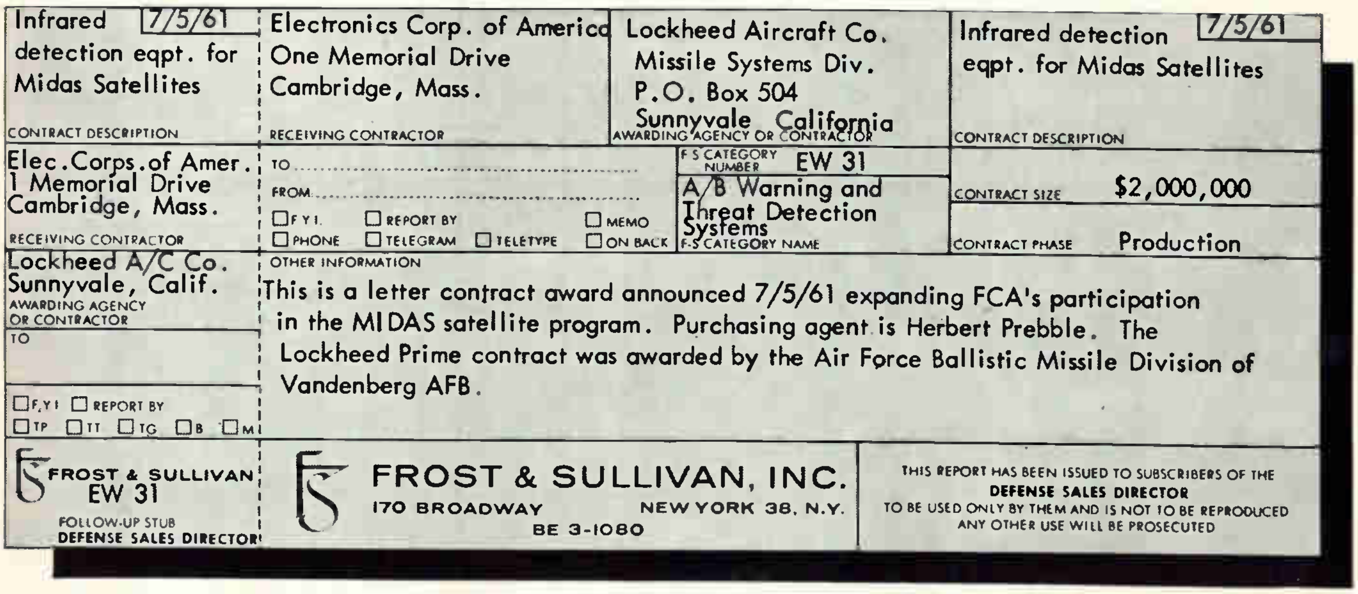
Several key positions are open now for senior level microwave design engineers. Address inquiries to Personnel Department.

NEW DEFENSE MARKETING TOOL

Unlock your firm's full sales potential by *knowing WHEN* a specific company has a demand for your specific product. Insure yourself of the maximum opportunity to increase sales.

Now you can actually follow the daily-changing defense industry market. You can know which of the many companies comprising your market are ready-to-buy because they have the money to buy and the requirement for your product.

The DEFENSE SALES DIRECTOR is designed to give you complete and timely information on your specific selling opportunities—and it is tailor-made to your specific selling requirements. Gathering full information about your ever-changing market is always costly, often impossible. It means night work for you, many trade reports to read, and frequent blind and unproductive calls by your salesmen. The DEFENSE SALES DIRECTOR supplies *in one service* your intelligence requirements. And the information is supplied at the *Time* you need it—the time your selling opportunities exist. If it is important that you have this type of information, the DEFENSE SALES DIRECTOR is important to your sales effort.



Infrared detection eqpt. for Midas Satellites 7/5/61
CONTRACT DESCRIPTION
Electronics Corp. of America
One Memorial Drive
Cambridge, Mass.
RECEIVING CONTRACTOR
Lockheed Aircraft Co.
Missile Systems Div.
P.O. Box 504
Sunnyvale California
AWARDING AGENCY OR CONTRACTOR
Infrared detection eqpt. for Midas Satellites 7/5/61
CONTRACT DESCRIPTION
Elec. Corps. of Amer.
1 Memorial Drive
Cambridge, Mass.
RECEIVING CONTRACTOR
TO ....
FROM ....
☐ F.Y.I. ☐ REPORT BY ☐ MEMO
☐ PHONE ☐ TELEGRAM ☐ TELETYPE ☐ ON BACK
F S CATEGORY NUMBER EW 31
A/B Warning and Threat Detection Systems
F-S CATEGORY NAME
CONTRACT SIZE $2,000,000
CONTRACT PHASE Production
Lockheed A/C Co.
Sunnyvale, Calif.
AWARDING AGENCY OR CONTRACTOR
TO
☐ F.Y.I ☐ REPORT BY
☐ TP ☐ TT ☐ TG ☐ B ☐ M
OTHER INFORMATION
This is a letter contract award announced 7/5/61 expanding FCA's participation in the MIDAS satellite program. Purchasing agent is Herbert Prebble. The Lockheed Prime contract was awarded by the Air Force Ballistic Missile Division of Vandenberg AFB.
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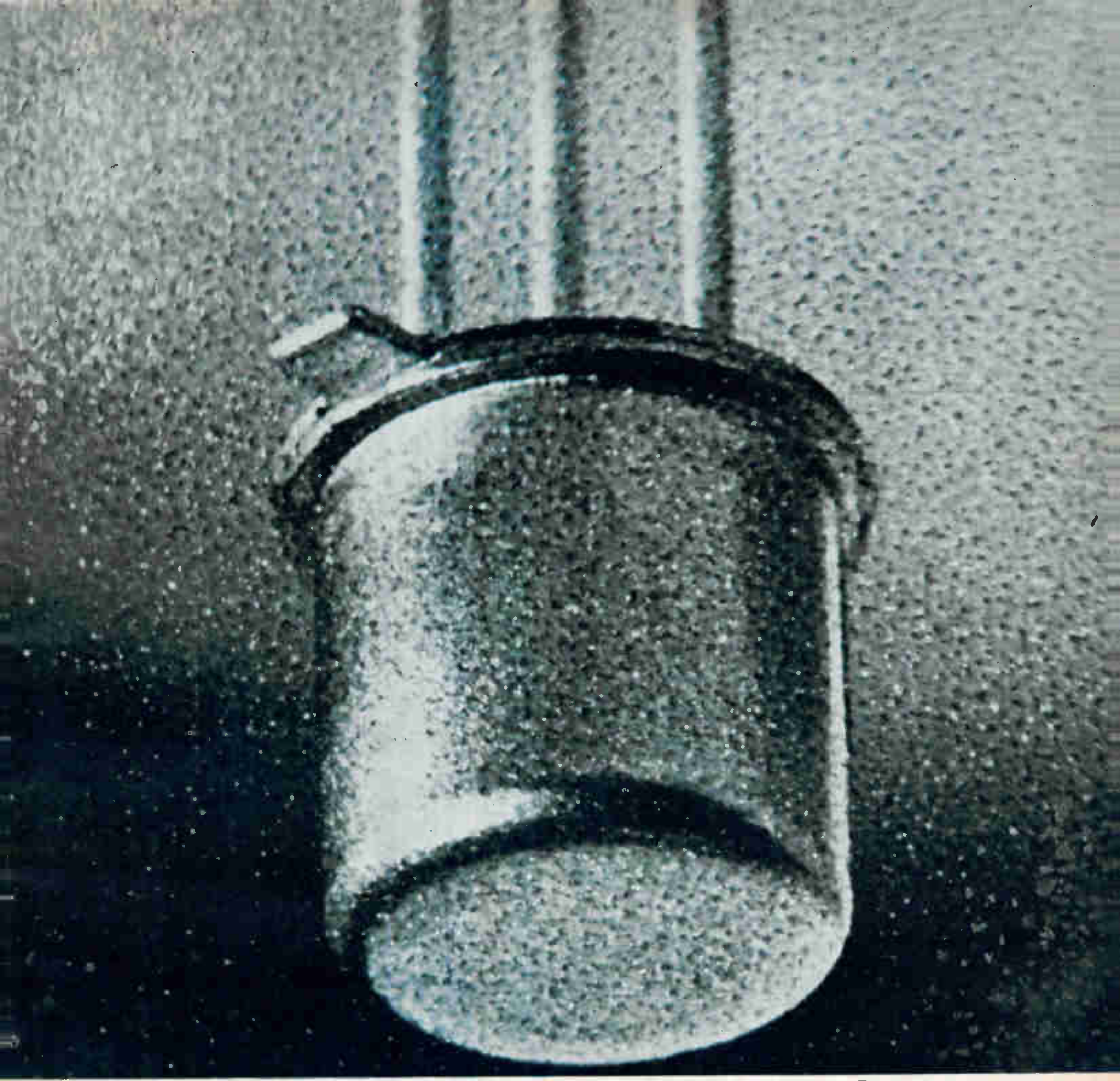

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New Antenna Patterns Improve

Radio astronomers see widespread arrays of small antennas, rather than larger single antennas, as the answer to the need for better resolution and further range of radiotelescopes.

By DON WINSTON,
McGraw-Hill World News

BERKELEY, CALIF.—Methods of increasing the sensitivity and resolution of radiotelescopes received much attention at the triennial general assembly of the International Astronomical Union, meeting here.

Radio astronomy is increasing in importance, because most astronomers are satisfied that the best optical devices now in existence have reached their theoretical limit in penetration of space, about six billion light years. Radio telescopes, however, can go farther. Their theoretical limit is not yet known.

Present top resolution achievable by radiotelescopes is one source in ten square degress of sky; that is, they can differentiate from about 25 sources in a piece of sky the size of the full moon. Astronomers would like to see resolution increased 1,000 times or more, a goal felt to be fully feasible with new techniques.

The feeling is that present large-dish antennas, notably the Sugar Grove, W. Va. project, have just about reached the economic limit in size. In fact, dishes of 500 and 600-foot diameter may not be worth the cost of construction, according to S. von Hoerner, of the University of Heidelberg.

Based on the premise that doubling the diameter of a dish increases its cost 10 times von Hoerner believes that a 200-foot diameter may be the optimum size, although it is possible that even smaller sizes may prove out. Because a single 200-foot dish cannot provide enough resolution and sensitivity to satisfy the needs of radio astronomy, von Hoerner called for new concepts in antenna theory.

The Mills Cross type of antenna has already been used successfully by Australian and English astronomers. It consists of a series of large dishes spread across a wide area. This simulates the effect of a single dish of extraordinary size. Although inferior side-lobe behavior is a major disadvantage of this type of antenna, many astronomers believe that its advantages outweigh the difficulties.

Plans are currently underway to construct an antenna three miles in diameter on the Belgian-Dutch border, but political considerations are bogging down the project.

Configurations far more exotic than the Mills Cross were also discussed. The interferometer concept, consisting basically of a stationary antenna and a mobile one, has been tried at Cambridge University. In this configuration, the mobile dish was mounted on rails. Although this concept is inherently economical, it has one great disadvantage. Heavenly conditions can change during the down-time brought about by movement of the mobile dish. Thus the usefulness of this arrangement is limited.

J. P. Wild, of Radio Physics Laboratories in Sydney, Australia, described a ring of 100 small dishes about six kilometers in diameter, which could produce resolution equal to that produced by a 6-Km paraboloid, or down to about 1/20 degree. By pulling out the interference pattern electronically, the array could be made to produce detailed radio photographs of the surface of the sun at the rate of several per hour. In effect, this would

Torture tests on North American Aviation's B-70 are viewed from a safe distance by closed-circuit tv, while taped observations are recorded

Radiotelescope Range and Sensitivity

be brought about by hooking into the dishes in sequence by a scanning pattern.

Wild also theorized a system by which the same configuration might produce an instantaneous—and possibly a moving picture—of the sun's surface. The concept calls for connection of each dish to a crystal transducer immersed in water in a pattern identical to the dish array.

An ultrasonic wave pattern created in the water could be made visible by direct optical means, although surface tension of water may distort the image. By floating another crystal transducer on the water surface, it may be possible to detect varying pressures and simulate a visible pattern on a readout screen.

Other astronomers are proposing even more ambitious configurations. Refinement of computer techniques for phasing of antenna units might enable dishes to be emplaced randomly rather than in rigid patterns. In such a case, radio telescopes with useful receiving surface nearly the size of a hemisphere of the earth could be developed.

Beyond antennas, some attention was paid to receiving techniques, with papers on parametric amplifiers and maser receivers.

A cloud on the horizon of radio astronomy, in the eyes of many astronomers, is the increasing degree of man-made radio signals in the spectrum. Outgoing IAU president J. H. Oort said in his welcoming address that "communication services, television and broadcast transmitters are rapidly filling the ether with so much noise that it becomes impossible for the radio astronomers to hear the extremely weak signal coming from the outer limits of the universe". Oort also criticized the planned project West Ford, which would put a reflecting screen of dipoles into orbit around the earth.

Two resolutions were passed, one general, one specific. The first one reads in part:

"Viewing with great concern the grave danger that some future space projects might seriously interfere with astronomical observations as well as in the radio domain, and believing that a degree of contamination of space which at the present time would be hardly detectable might, if long-lived, well be disastrous to future observations with improved techniques . . . the IAU gives clear warning of the grave moral and material consequences which could stem from a disregard of the future of astronomical progress, and appeals to all governments concerned with launching space experiments which could possibly affect astronomical research, to consult with the IAU before undertaking such experiments and to refrain from launching until it is established beyond doubt that no damage will be done to astronomical research."

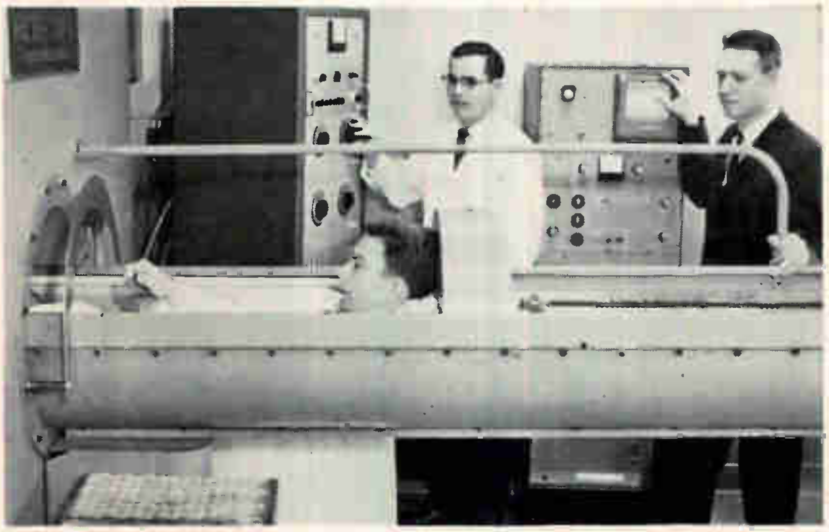
The second was more specific and dealt with West Ford. (As previously reported, ELECTRONICS, p 11, Aug. 25, 1961, the National Aeronautics and Space Council has approved the orbital scatter belt project. The council promised not to launch an operational system until analyzing its effect on astronomy and other sciences.

"The IAU views with the utmost concern the possibility that the band of dipoles proposed in Project West Ford might be long-lived and it is completely opposed to the experiment until the question of permanence is clearly settled in published scientific papers with adequate time being allowed for their study," the resolution stated.

The resolution further asked that astronomers be given full opportunity to make observations of the orbiting belt. In return, the IAU would coordinate and disseminate findings. Data on the belt, its properties, changes with time and location and impact on present and future astronomical research would be prepared by a group of astronomers acceptable to the U. S. government and the IAU.

Viktor A. Ambartsumian, of the Armenian Soviet Republic, was nominated without opposition to head IAU for the next three years. Turkey, Brazil, and North Korea were accepted as new members. Next meeting will be in Hamburg, Germany, during 1964.

Man-Sized Radiation Counter Detects Fat



Purdue University has a scintillation counter able to tell how much of the body is fat. Meat packers have shown interest

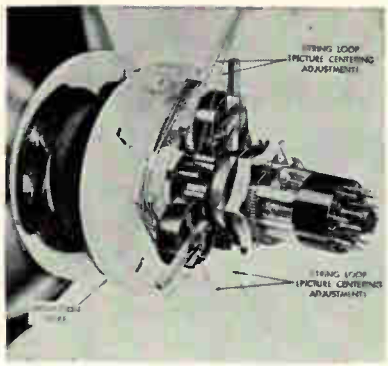
Color Demodulator Uses Beam Switching Tubes

NEW LINE of color television receivers was introduced last week in Chicago by Zenith Radio Corp. Among the design features of the sets are a simplified two-tube color demodulating circuit and an unusual convergence cloverleaf assembly. The company claims that the color circuits, outlined in the diagram, will improve receiver reliability and reduce to two the number of owner-operated color adjustments.

Retail price of the 10 models in the series will vary from $695 to $1,050. They differ chiefly in cabinet design and ultrasonic remote control provisions. All models use the conventional three-gun shadow mask cathode ray tube and have hand-wired chassis.

Heart of the circuit is the color demodulator using two 6JH8 sheet beam tubes. In these tubes electron flow takes the form of a planar beam or sheet from the cathode to either of two plates. In crt fashion a focusing system forms the sheet-beam which is then accelerated, and deflected to one of the plates by deflector electrodes. An internal shield suppresses secondary emission between the two plates.

The two tubes are used as red and blue luminance demodulators.



Convergence cloverleaf assembly is simplified mounting for static convergence magnets

Balanced outputs of both positive and negative polarities are developed on the plates of each tube, eliminating the need for additional phase inverter stages to recover the green luminance signal.

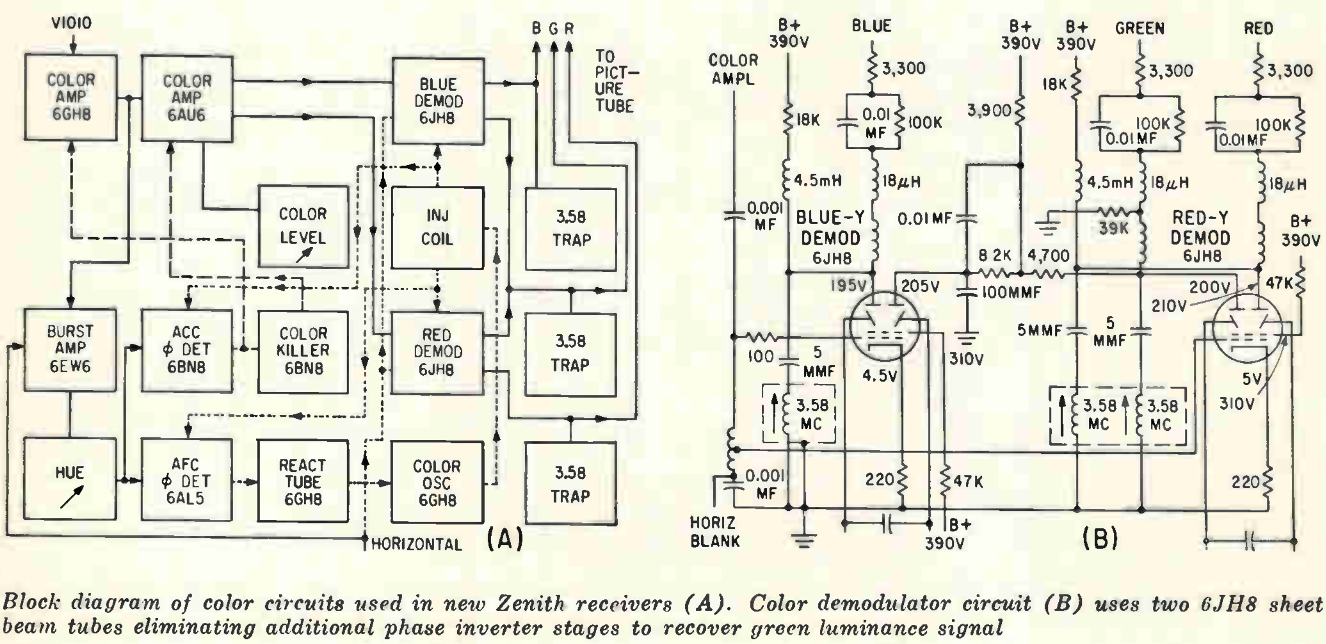
Output from the local 3.58-Mc color oscillator is coupled to the deflector plates of the 6JH8 blue luminance demodulator through a quadrature transformer, producing signals on the two deflectors that are 180 degrees out of phase with each other. Output from one plate will occur only when its associated deflector is receiving the positive cycle of the 3.58-Mc signal. In this manner, output at the plates switches alternately between the two as each becomes positive for one half cycle.

The color signal is applied to the control grid. As the deflectors are alternately positive every half cycle, the output signals on the plates will be of opposite polarity.

Operation of the red demodulator is identical to the blue circuit with two exceptions: a 90-degree phase shift is introduced to the 3.58-Mc color oscillator signal applied to the deflectors; and a lower amplitude color signal is fed to the control grid.

The green luminance signal is recovered from the negative outputs of the two demodulating tubes. Resulting color difference signals are applied to the respective color grids of the color crt. Matrixing occurs in the picture tube, producing the correct combination of red, blue and green for full color reproduction.

Another design feature of the new receivers is the convergence cloverleaf assembly shown in the photo. This consists of a one piece plastic mounting for three coils and three of the four static convergence magnets. Convergence adjustments are made in the center area of the picture tube only, even



Block diagram of color circuits used in new Zenith receivers (A). Color demodulator circuit (B) uses two 6JH8 sheet beam tubes eliminating additional phase inverter stages to recover green luminance signal though they affect the entire raster. A fourth magnet, for blue adjustment, is located near the base of the picture tube.

The picture centering system uses two ferrite rings mounted in the deflection yoke. Ring positions are controlled by two string loops accessible from the rear of the deflection yoke.

Also new is the focus voltage adjustment circuit which consists of a focusing coil, damping resistor and capacitor. A sine wave of approximately 2,000 volts peak-to-peak is developed at the horizontal frequency, with a pulsed voltage of 4,500 volts peak-to-peak added. Adjusting the coil causes a phase shift of the sine wave relative to the pulse, determining the overall peak-to-peak value of the voltage applied to the focus voltage rectifier. Approximately 4,900 v d-c is required for adequate focus. Temperature compensating capacitors are used to provide focus stability.

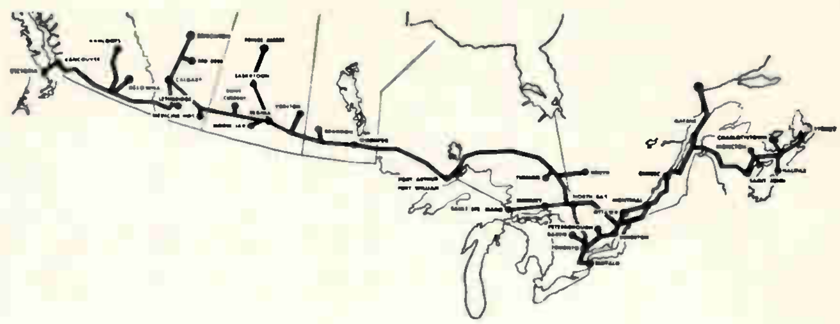
Tv Picture Tube Sales Show Rise

REPORT BY Electronic Industries Association shows a gain in television picture tube manufacturing for the first six months of this year, compared with 1960. The six-months gain was made despite a slump in sales during April and May.

June factory sales of picture tubes this year were up almost 85,000 over sales in April. A high point in factory sales was reached in March this year when 936,098 tubes valued at $18,725,011 were sold. The following month, the total dropped by 213,988 units to a level of 722,110 tubes worth $14,293,375. A further decline was reported in May when total unit sales fell to 673,315 with a factory sale value of $13,238,774.

The June rise has brought the volume level to 806,852 picture tubes at $15,887,776.

For the first six months of last year, total tv picture tube sales were 4,454,796. In the same period for this year the figures are 4,575,197 units, an increase of 120,401.



Trans-Canada Tv Net Starts

COAST-TO-COAST commercial television will be available to Canadian viewers through signing this month of an $11 million contract.

The pact between Bell Telephone Co. of Canada and CTV Television Network, Ltd. will bring commercial programming to more than 65 percent of the Canadian viewers. At present CTV broadcasts heading west from Quebec stop at Toronto because facilities for further westward signal traffic do not exist.

The agreement between CTV and Bell (which is acting in behalf of eight major telephone companies across the continent) calls for equipping a 3,900-mile microwave network to carry tv traffic. (See map). More than 130 of the telephone companies' relay stations will have to be re-equipped. In some cases, buildings at the bases of the microwave towers will be enlarged. In other instances, new antennas will be erected. Plans are to complete the Toronto-Vancouver section of the new facilities by next September. The Montreal-Halifax leg will go on the air by June, 1963.

The present contract calls for a reversible channel that will allow either easterly or westerly transmissions. When additional equipment is installed, however, the system will be capable of simultaneous transmissions in both directions.

MHD Power May Propel Space Craft

CHICAGO—Work on a magnetohydrodynamic (MHD) power plant that may propel space vehicles for interplanetary exploration was reported to the Gas Dynamics Symposium held recently at Northwestern University.

The MHD generator, still in the theoretical stage, was described by General Electric scientists. The system would employ a closed cycle, recirculating the same working fluid.

Direct electrodeless conversion to a-c power would require a sinusoidal magnetic field traveling in the flow direction at less than flow velocity. Magnetic fields caused by currents induced in the fluid would cut magnetic coils and induce an emf in the coils.

Compact size and superior thrust per unit area of exhaust, offering advantages over ion devices were predicted for systems larger than a megawatt. Specific impulses could range from 2,000 to 40,000 seconds.

The speakers said that MHD generators have a theoretical efficiency of 56 percent. Chief problems are the development of materials able to withstand high temperatures, methods of creating stronger magnetic fields and attainment of higher electrical conductance.

Temperatures of 4,000 F are required to ionize cesium and potassium seed materials. If, as proposed for open-cycle systems, fossil fuels are also burned in the generator, combustion temperatures would rise to 5,000 F.

Mobile Radios Leave Messages in Trucks

EFFICIENT LINEMEN spend only about 20 percent of the time in their trucks, making it difficult to contact them by radio. Mobile radios used by Pacific Telephone and Telegraph trucks in the Los Angeles area are equipped to notify linemen when they are wanted by headquarters.

When the message is more than routine, an aural or visual signal is given. Otherwise, the dispatcher can leave one of five predetermined messages on a five-jewel cryptograph in the truck. The company reports the cryptograph has markedly reduced channel busy time by avoiding repeat calls.

The signaling system uses an eight function decoder. Each vehicle has a three-digit address, giving the system a theoretical capacity of 999 addresses. However, the use of one as a clearing pulse and other restrictions reduce the number of addresses to about 700.

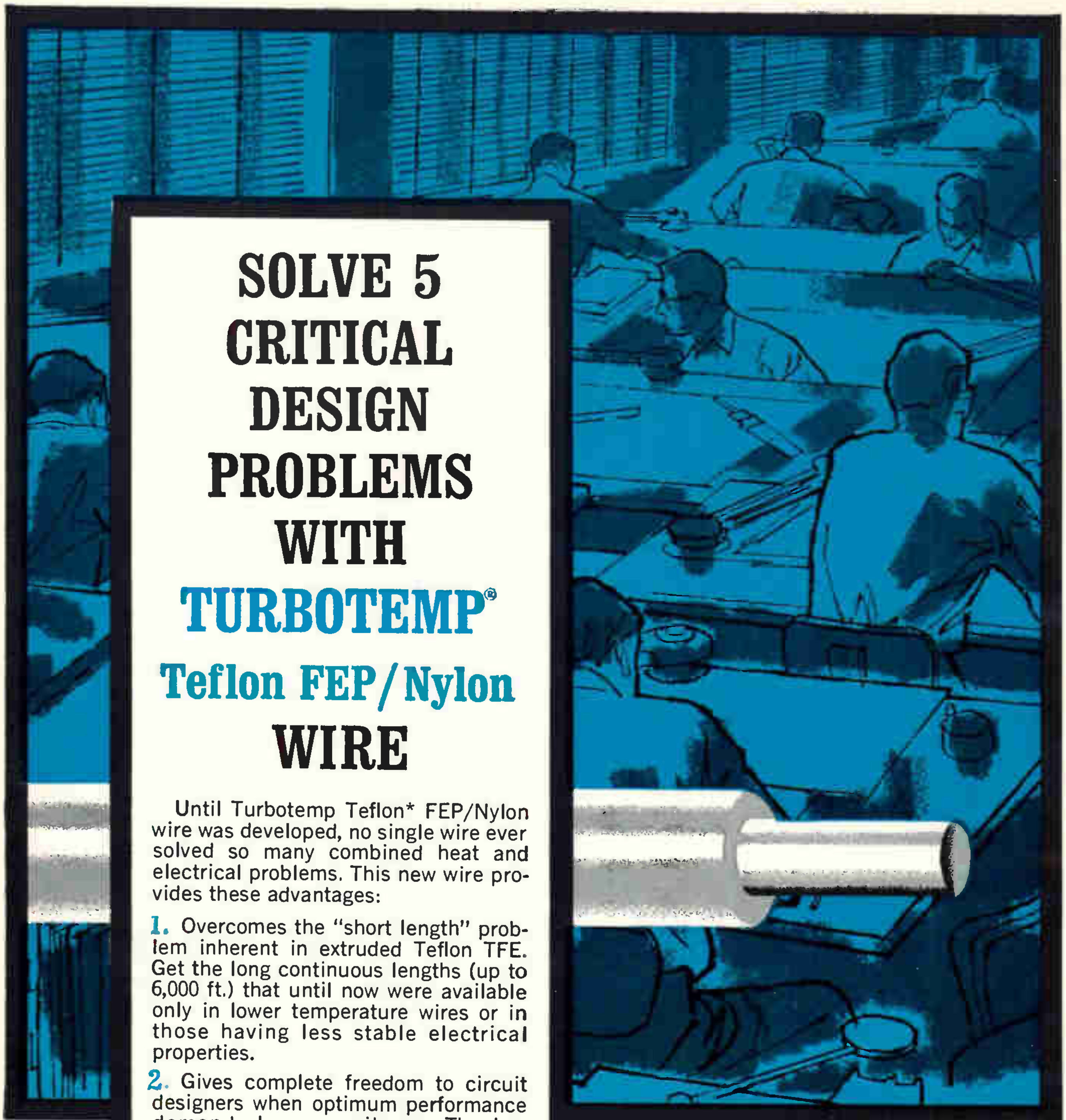
Dialing an address causes a buzzer in the truck to sound. If there is no answer, the dispatcher has two options. Dialing the number four will sound a bell or light the truck's spotlight at night. If the message is routine, the dispatcher dials eight, followed by either a two, four, six, eight or zero, depending on which cryptographic light message is to be displayed.

Under investigation is a method of making the unattended mobile give a receipt for the message.

The calling system was described at an AIEE conference held recently in Salt Lake City.

Radioactive Decay Powers Remote Weather Station

ATOMIC-POWERED weather station 225 miles northeast of Resolute Bay, Canada, has gone on the air. Built by Martin for AEC and the Weather Bureau, it is powered by a strontium-90 capsule. Heat of the capsule's radioactive decay is converted to electricity by 60 thermocouples. First maintenance call to the station will probably be made in mid-1962.



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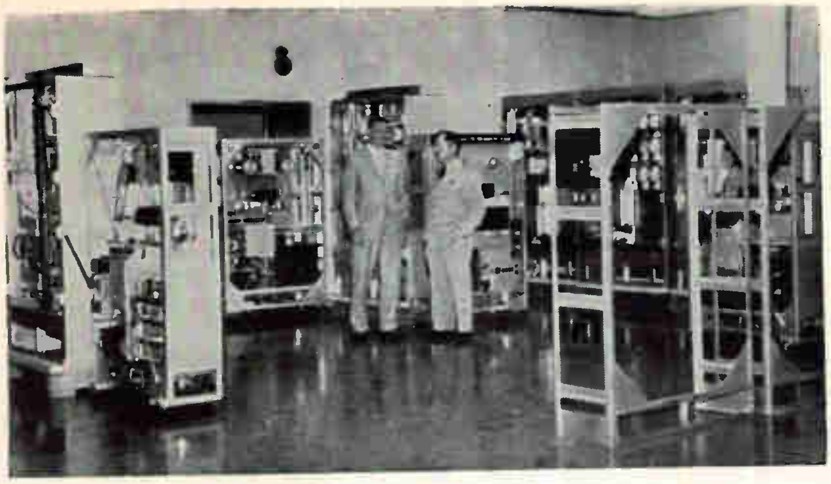

Equipment at Norton Air Force Base, first of five centers

Air Force Installs Logistics Network

INSTALLATION of the Air Force's Combat Logistics Network (COMLOGNET) is underway. Equipment has been shipped from contractors to Norton Air Force Base, San Bernardino, Calif. Norton is the first of five main centers being equipped by the Air Force Communications Service. The system will be completed in 1962.

Logistics data and message communications from more than 350 air bases, depots and stations in the United States will be interchanged through the centers. Completely automatic and compatible with other defense communications systems, COMLOGNET will be capable of sending and receiving more than 100 million words or seven million punched cards daily.

Western Union is prime contractor, with RCA supplying automatic electronic switching center equipment. The first shipment included tape storage units, computer and switching components, from RCA, and technical control components and terminal equipment racks, from Western Union.

Other centers will be installed at McClellan AFB, Sacramento, Calif.; Wright Patterson AFB, Dayton, Ohio; Tinker AFB, Oklahoma City, and Andrews AFB, Md.

The Air Force considers the network "a major step in development of space-age worldwide communications". Information can be fed into the system in punched-card, paper tape, magnetic tape or printed page form. All control information required for automatic switching, routing and other processing from origin to destination are contained in message headings. These include several levels of priority, with the two highest levels given a green light through the system.

Information transmittal rates range from 100 to 3,000 words per minute. The centers can employ speeds 20 times that, when needed. Construction is modular, so the centers can be added to or modified in the future.

English Flight Test Small Digital Computer

DEXAN, for digital experimental airborne computer, has been flight tested in England as a navigation instrument independent of ground stations. It was programmed to perform computations associated with doppler radar and gyro systems. Accuracy was checked against Decca fixes and found "adequate".

Computations are made by a digital differential analyzer, backed by a general-purpose whole number computer. Shaft encoders digitize analog inputs and convert output for analog display. Designed by General Electric, Ltd., and the Royal Aircraft Establishment, the computer would weigh less than 50 pounds and occupy one cubic foot in production models.

MEETINGS AHEAD

Sept. 8-10: High-Fidelity and Home Entertainment Show, Chicago, Crystal Ballroom, Palmer House, Chicago.

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

Sept. 14-15: Technical Scientific Communications, PGEWS of IRE, Bellevue-Stratford Hotel, Philadelphia.

Sept. 20-21: Industrial Electronics Symposium, PGIE of IRE, AIEE; Bradford Hotel, Boston, Mass.

Oct. 1-5: Electrochemical Society; Statler Hotel, Detroit, Mich.

Oct. 1-6: Suppression of Radio Interference, International Comm., CISPR, ASA, PGRFI of IRE; Univ. of Pa., Philadelphia.

Oct. 2-3: Engineering Education, Engineers Council for Prof. Devel., Sheraton Hotel, Louisville, Kentucky.

Oct. 2-4: Communications Symposium, PGCS of IRE; Utica, N. Y.

Oct. 2-4: IRE Canadian Convention, Region 8, Automative Bldg., Exhibition Park, Toronto, Canada.

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

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

Mar. 26-29; 1962: IRE International Convention, Coliseum & Waldorf Astoria Hotel, New York City.

ADVANCE REPORT

Feb. 7-9: National Winter Convention on Military Electronics. Confidential papers will cover: undersea warfare and sonar systems; radar and fire control systems; reconnaissance and electronic warfare; and military systems requirements and environments. Unclassified papers will cover: system and technical management; instrumentation; reliability; navigation and air traffic control systems; military equipment design and product engineering.

Prospective authors are requested to submit, prior to Nov. 15, an unclassified 100 word abstract, a 500 word summary, and a short biography to: Mathew E. Brady, Space Technology Labs., P.O. Box 95001, Los Angeles, California.

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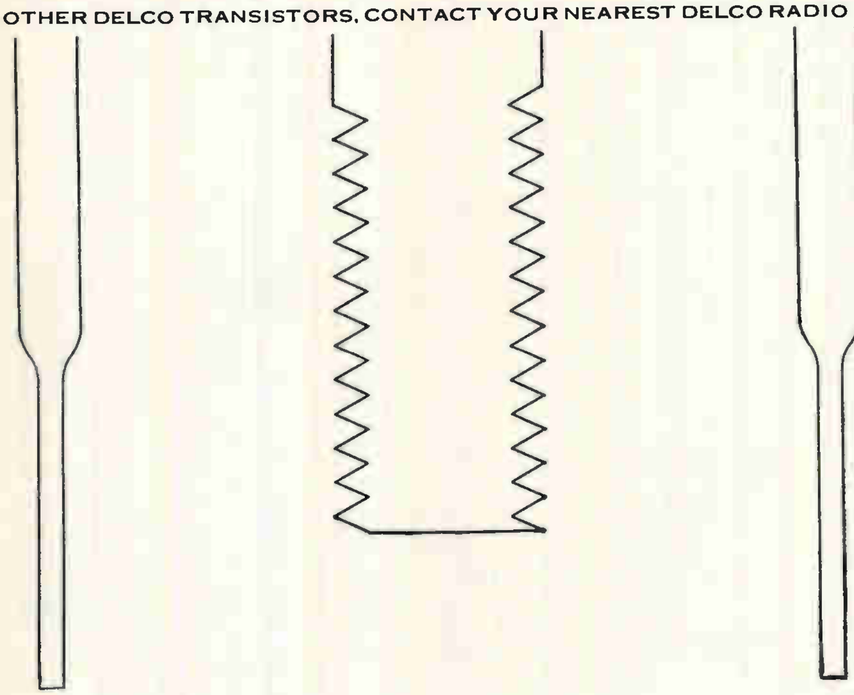

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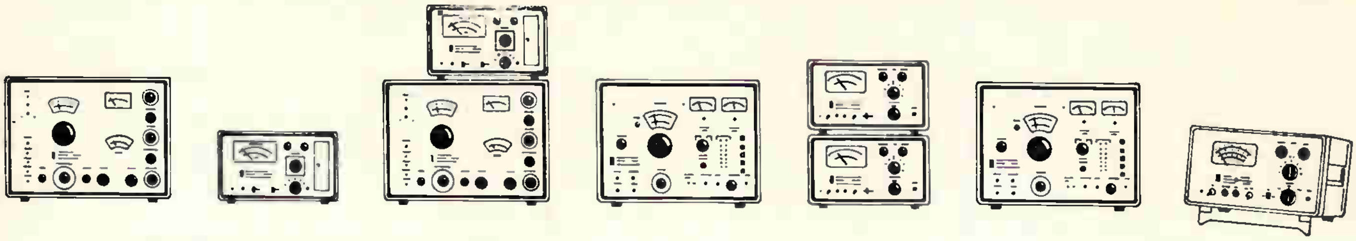

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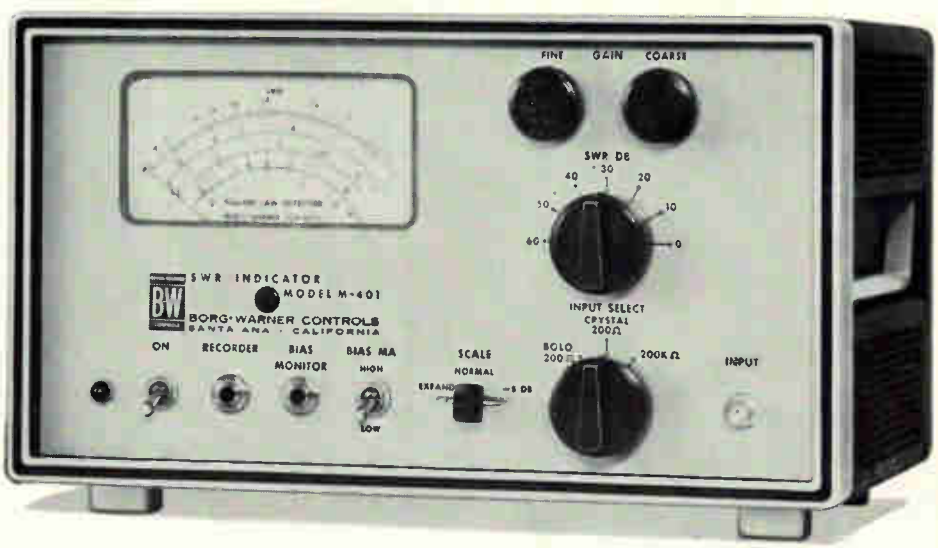

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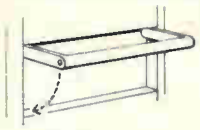

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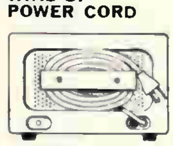

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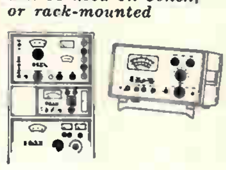

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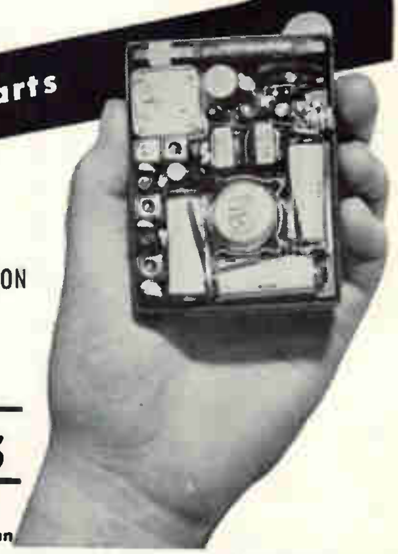

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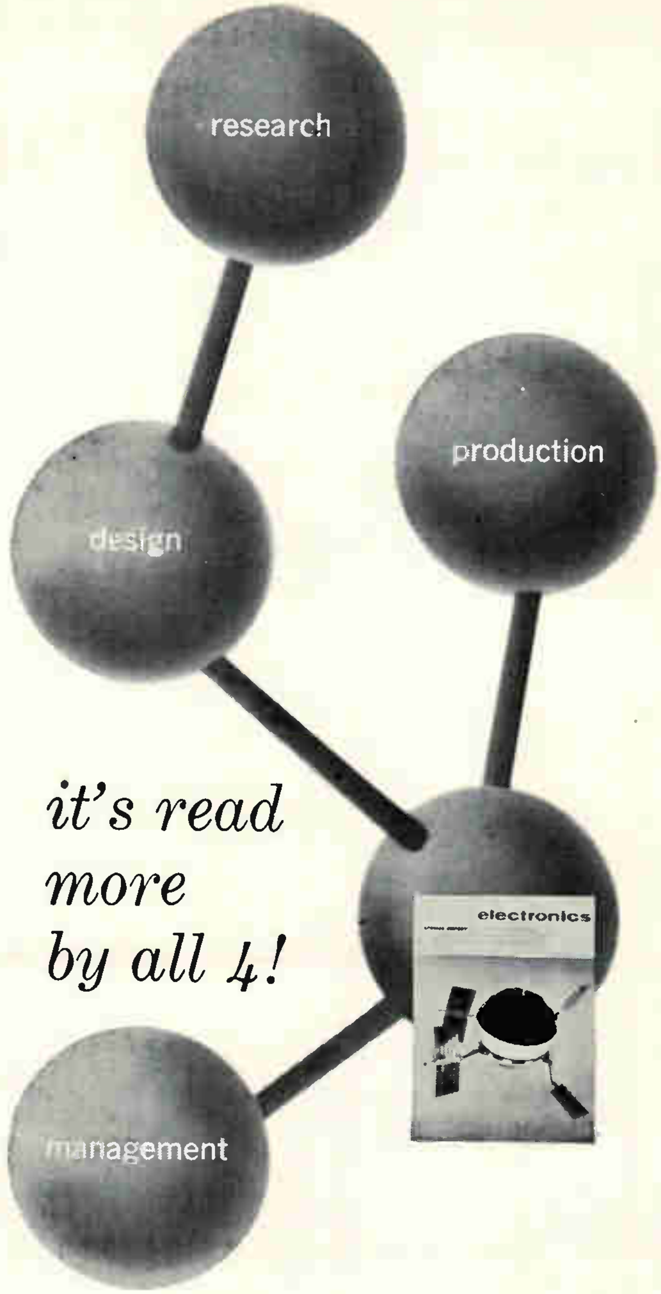

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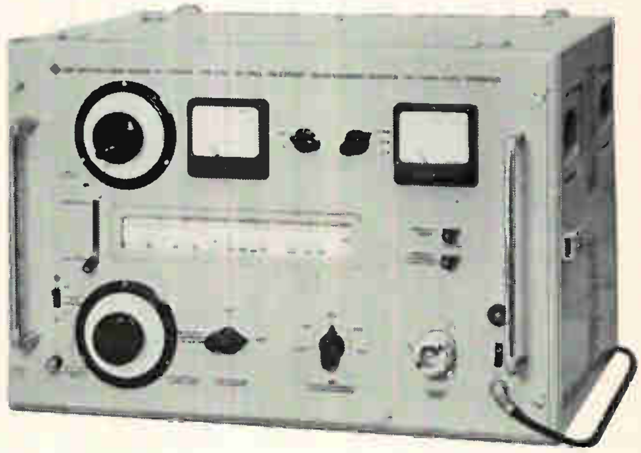

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30 to 300 MC	GENERATOR SMLM
30 to 300 MC	MULTIPLIER XVO
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1000 to 1900 MC	GENERATOR SCR
1700 to 2700 MC	GENERATOR SBR
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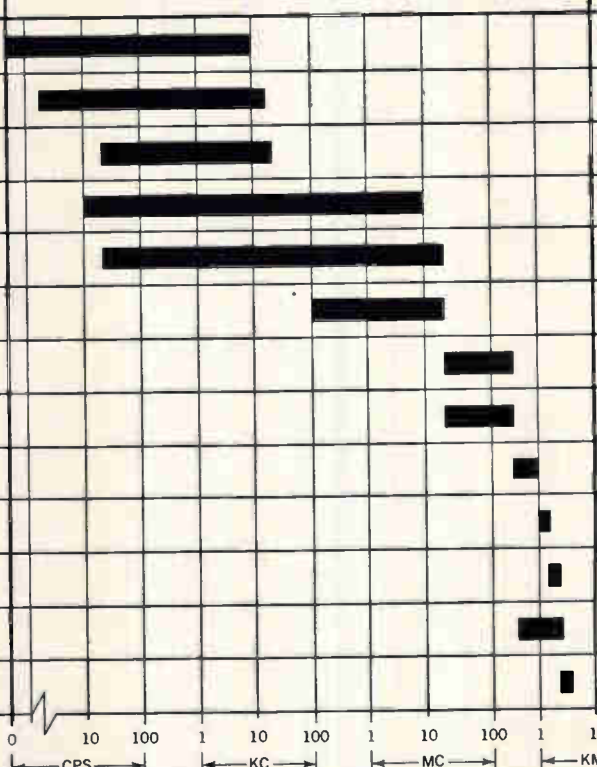
2700 to 4200 MC	GENERATOR SAR



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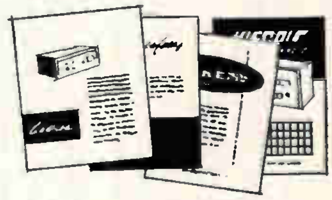

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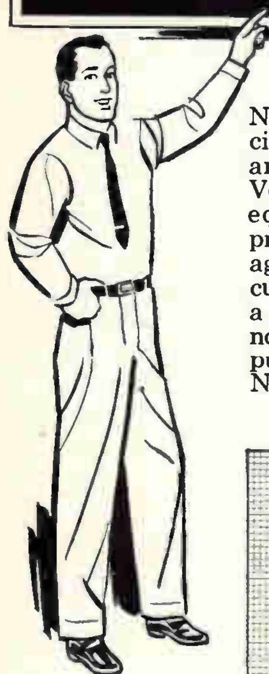

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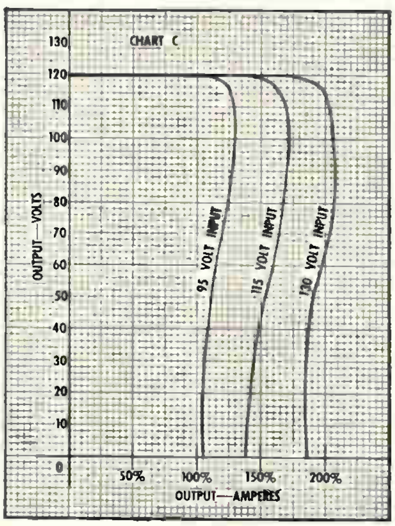

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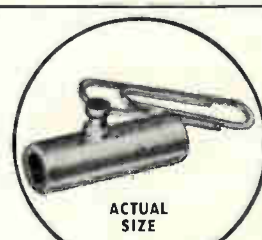

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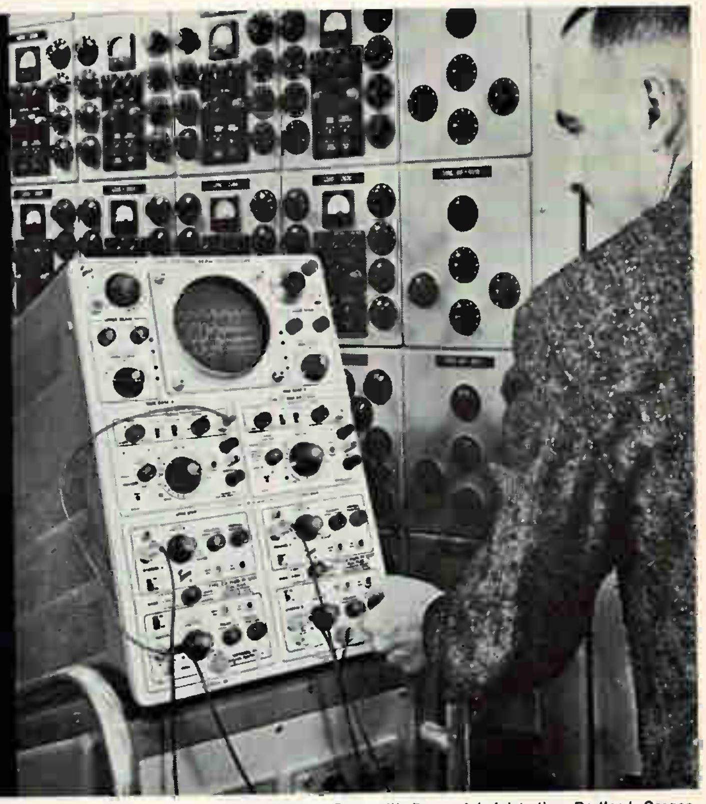

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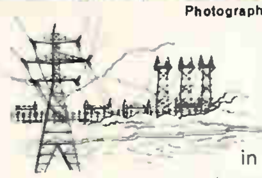

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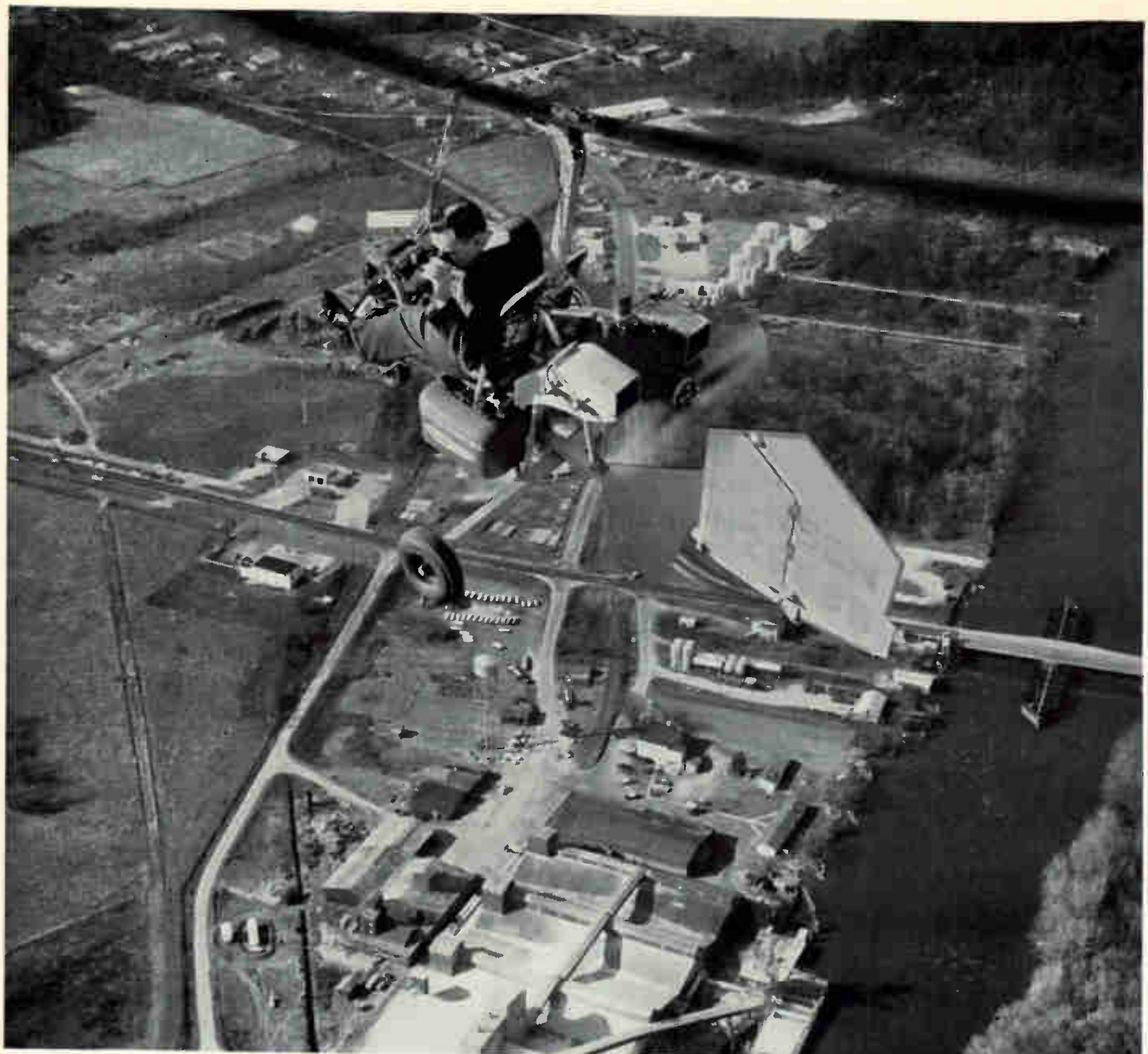

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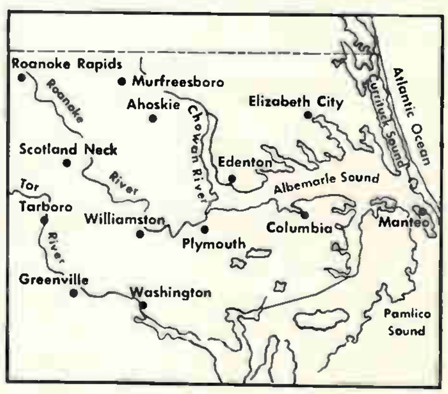

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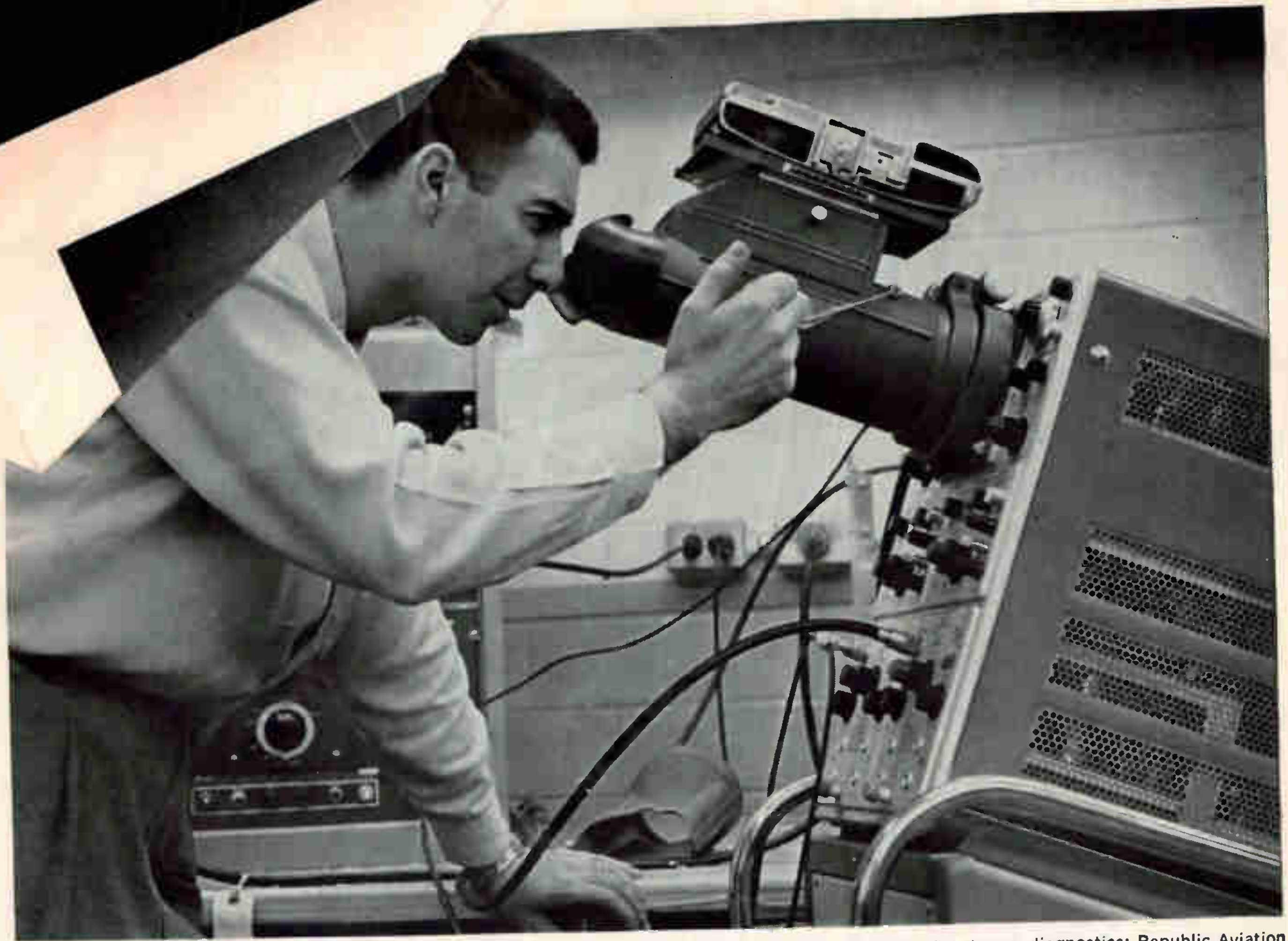

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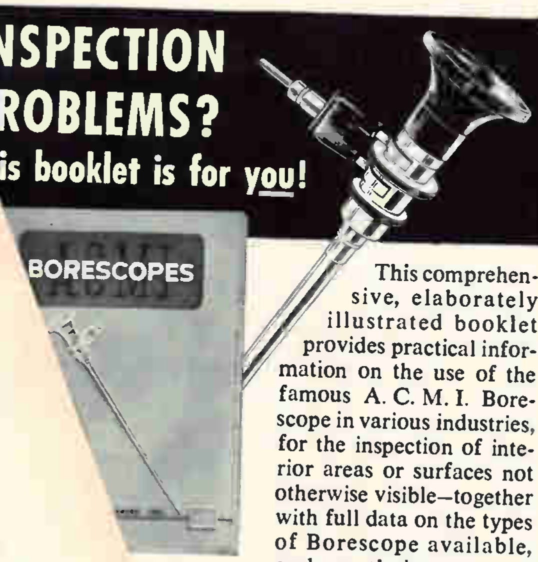

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3.6	1N747A	—	—	—
3.9	1N748A	—	—	—
4.3	1N749A	—	—	—
4.7	1N750A	—	—	—
5.1	1N751A	—	—	—
5.6	1N752A	—	—	—
6.2	1N753A	—	—	—
6.8	1N754A	1N3016B	1N2970B	1N2804B
7.5	1N755A	1N3017B	1N2971B	1N2805B
8.2	1N756A	1N3018B	1N2972B	1N2806B
9.1	1N757A	1N3019B	1N2973B	1N2807B
10	1N758A	1N3020B	1N2974B	1N2808B
11	1N962B	1N3021B	1N2975B	1N2809B
12	1N963B	1N3022B	1N2976B	1N2810B
13	1N964B	1N3023B	1N2977B	1N2811B
15	1N965B	1N3024B	1N2979B	1N2813B
16	1N966B	1N3025B	1N2980B	1N2814B
18	1N967B	1N3026B	1N2982B	1N2816B
20	1N968B	1N3027B	1N2984B	1N2818B
22	1N969B	1N3028B	1N2985B	1N2819B
24	1N970B	1N3029B	1N2986B	1N2820B
27	1N971B	1N3030B	1N2988B	1N2822B
30	1N972B	1N3031B	1N2989B	1N2823B
33	1N973B	1N3032B	1N2990B	1N2824B
36	1N974B	1N3033B	1N2991B	1N2825B
39	1N975B	1N3034B	1N2992B	1N2826B
43	1N976B	1N3035B	1N2993B	1N2827B
47	1N977B	1N3036B	1N2995B	1N2829B
51	1N978B	1N3037B	1N2997B	1N2831B
56	1N979B	1N3038B	1N2999B	1N2832B
62	1N980B	1N3039B	1N3000B	1N2833B
68	1N981B	1N3040B	1N3001B	1N2834B
75	1N982B	1N3041B	1N3002B	1N2835B
82	1N983B	1N3042B	1N3003B	1N2836B
91	1N984B	1N3043B	1N3004B	1N2837B
100	1N985B	1N3044B	1N3005B	1N2838B
110	1N986B	1N3045B	1N3007B	1N2840B
120	1N987B	1N3046B	1N3008B	1N2841B
130	1N988B	1N3047B	1N3009B	1N2842B
150	1N989B	1N3048B	1N3011B	1N2843B
160	1N990B	1N3049B	1N3012B	1N2844B
180	1N991B	1N3050B	1N3014B	1N2845B
200	1N992B	1N3051B	1N3015B	1N2846B

Now, as indicated in the Diode List reproduced here, a specific "Preferred" or "Guidance" MIL part number is shown for EVERY common voltage for the 400 mw thru 50 w types.

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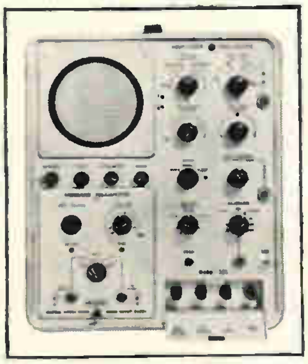

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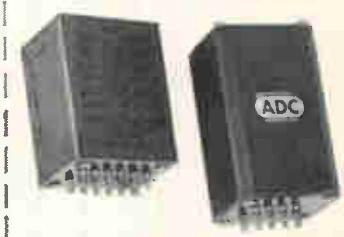

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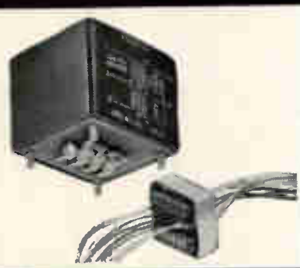

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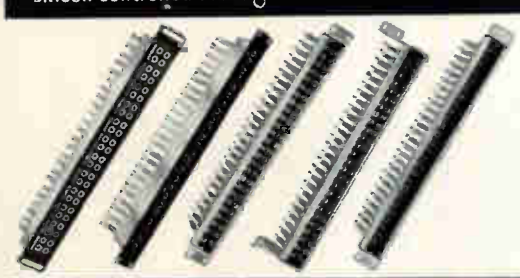

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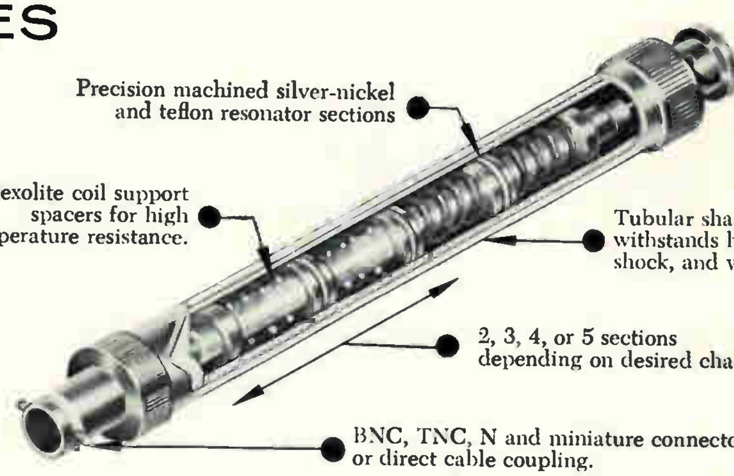

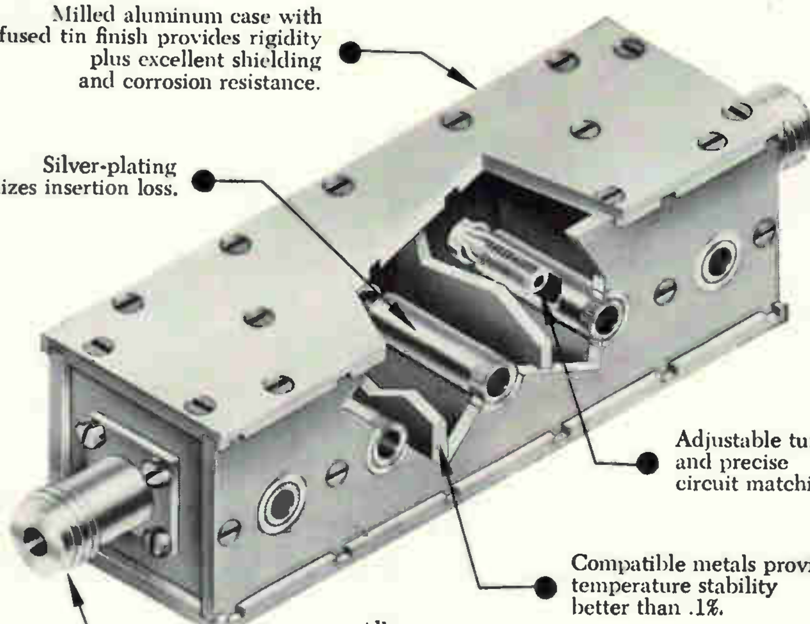

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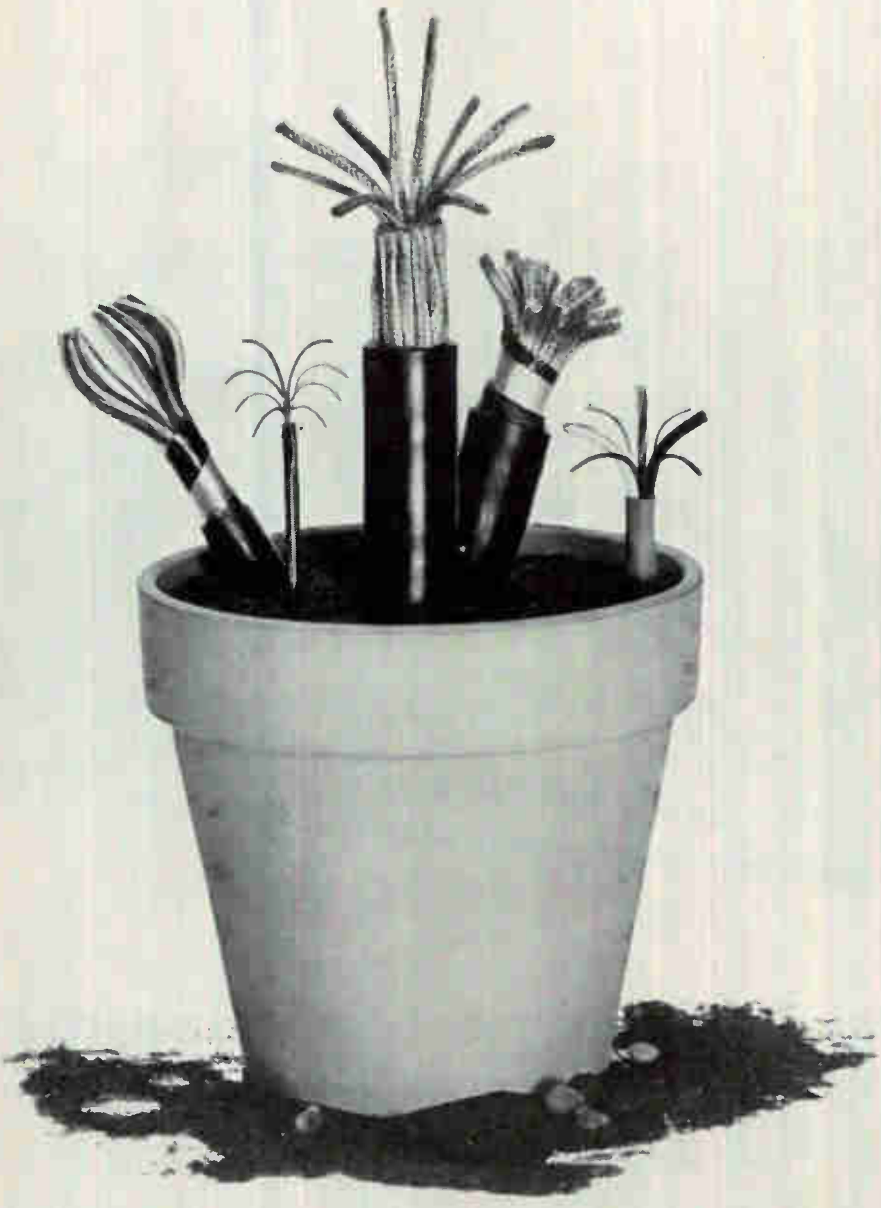

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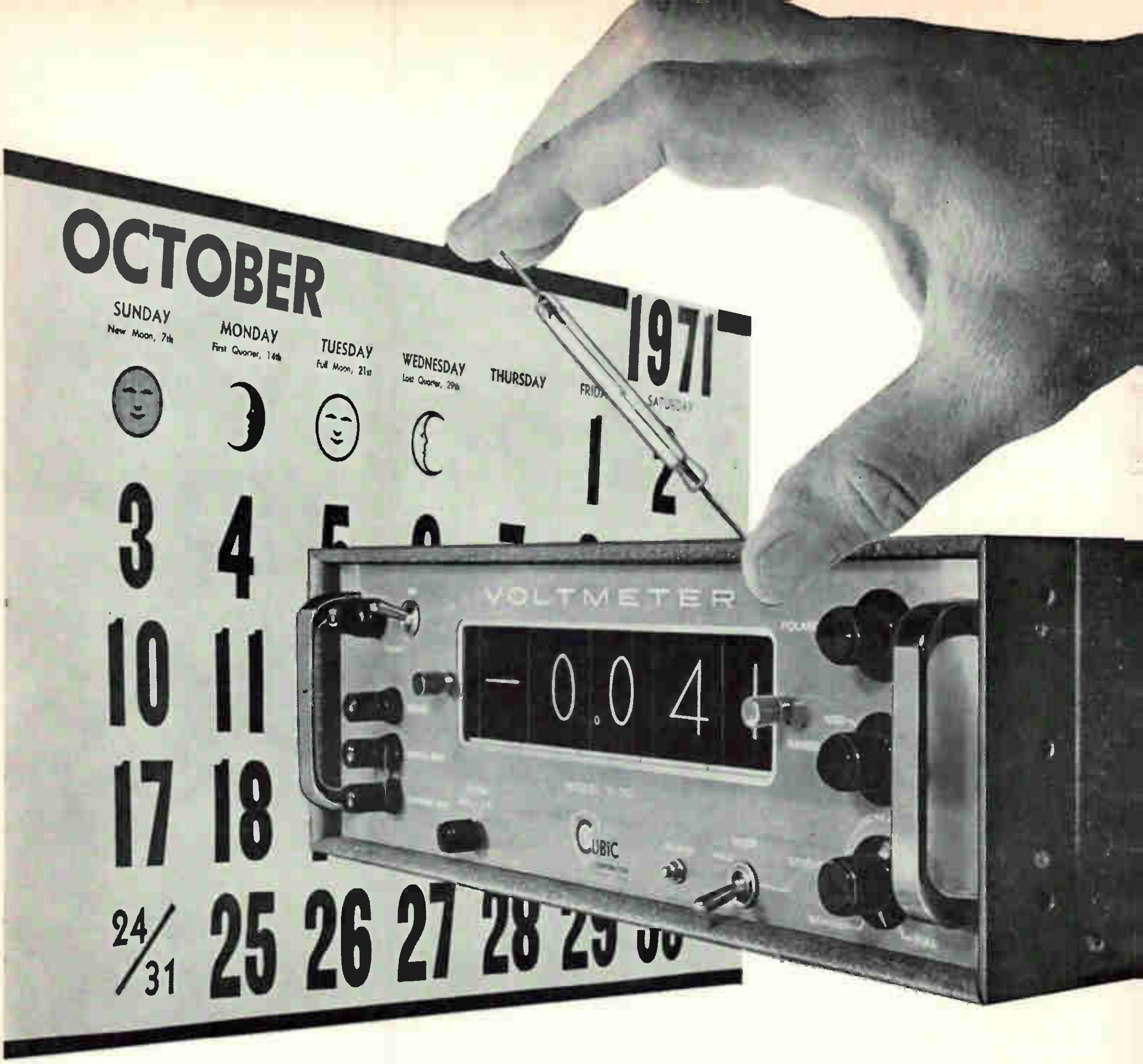

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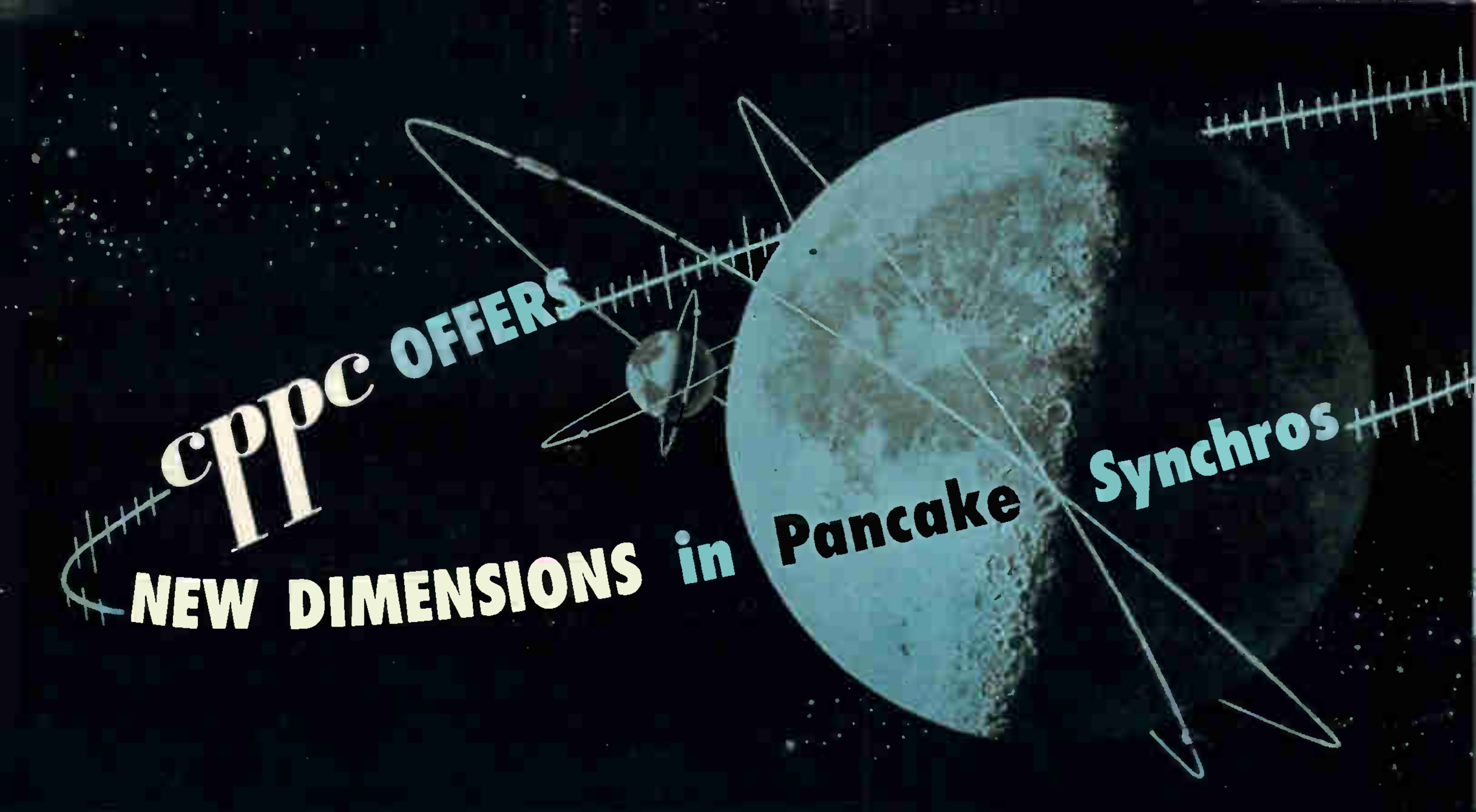

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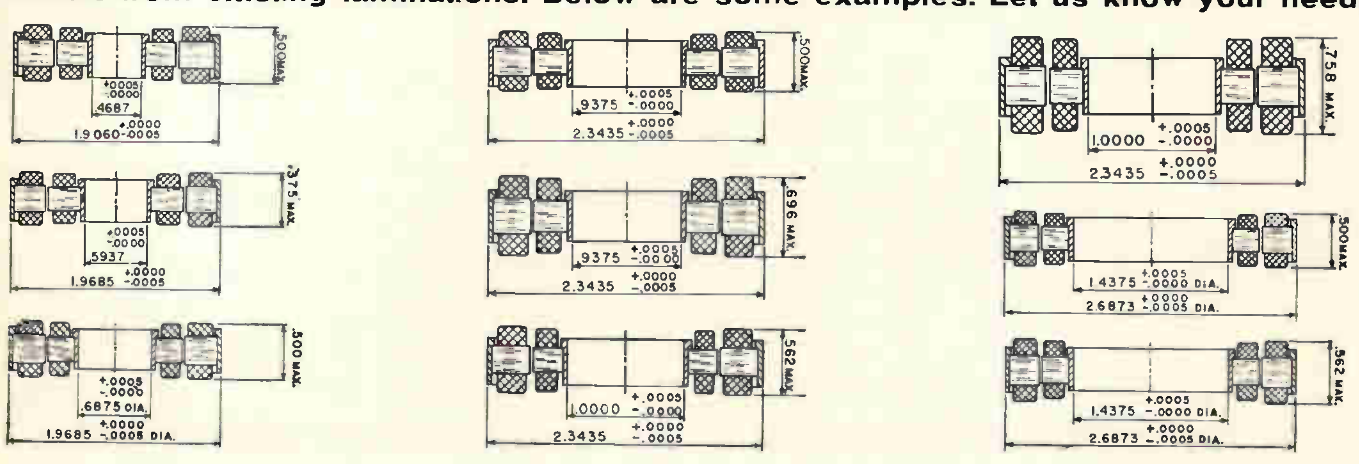


electronics
September 8, 1961

Wire-wound coils in rotating components, slip-rings, brushes, wipers and d-c motor commutators can be replaced by Hall generators

Checking the accuracy of a solid-state resolver on a two-second-accuracy index stand

Designing Solid-State Synchros With Hall-Effect Components

By Z. R. S. RATAJSKI,
Chief, Research & Advanced Dev. Dept., Kearfott Div., General Precision, Inc., Little Falls, N. J.

REQUIREMENTS FOR extreme reliability of new systems for supersonic air and spacecraft, as well as for ground support equipment, preclude the use of brushes and wire-wound coils embedded tightly in mechanical structures, for these items reduce the life and reliability of the systems operating on the ground or at high altitudes and in space environments.

Further miniaturization and simplification of presently available size 5 (0.5 in. outer diameter) rotating components appears to be impractical. Not only do production costs increase exponentially with miniaturization and the precision required, but there is also a lower physical limit to the size of magnet wire that can be used efficiently. With progress in microminiaturization of computer modules and networks, the comparatively large wire-wound servo components, even those of the smallest present size, appear to be out of place.

Considerable theoretical and experimental work has been carried out in recent years on the Hall effect observed in semiconductors. A number of new devices, based on the Hall effect, have been suggested and introduced.[3] The state-of-the-art in Hall materials and their shaping has progressed to a point where the Hall generator shows promise of replacing the wire-wound coils in a number of rotating components. Slip-rings, brushes, wipers and d-c motor commutators can be successfully replaced by Hall generators. The use of permanent magnets as field sources simplifies the design even further. For the majority of Hall-effect components, the range of power supplies, now limited to low-frequency a-c, can be extended from d-c to high-frequency a-c in the megacycle range. Direct-current operation is of great importance when solar batteries are the power sources.

This firm is engaged in the development of Hall-effect synchros and resolvers, sponsored by the Navy Department, Bureau of Naval

Weapons. Some time ago, a study and development of hardware for Hall-effect devices was initiated with the object of replacing windings and wear-prone contacts by semiconductors operating with permanent magnets.

To obtain the required stability and optimum performance of Hall generators in the suggested new devices, technical problems arising from magnetoresistance (Fig. 1A) and change in V_h with change in temperature (Fig. 1B) must be solved. These effects have been observed in Hall materials by many investigators.[2, 3, 5, 6] Furthermore, the type of Hall material, its doping level and physical configuration, the type of contacts and their size and location and the mobility and relaxation time of charge-carriers in the material, are important in the selection of Hall generators for a device. Presently available materials for Hall generators are indium arsenide, indium antimonide, indium phosphate, germanium, silicon, and indium arsenide phosphate.

In devices now under development, the Hall generators are used for signal generation and power transfer.

When used for signal generation, important parameters are the stability of signal, low noise (low Hall voltage at zero field), low magnetoresistance and temperature effects, high signal-to-noise ratio, and linearity and symmetry of the signal. Materials with high Hall voltage output display, however, high magnetoresistance and temperature effects. The higher the energy gap (that is, the degree of doping), the smaller is the temperature effect (and the magnetoresistance effect) but the smaller also is the mobility; hence the Hall voltage is lower. A compromise therefore must be reached in selecting Hall materials. The best materials for signal generation appear to be indium phosphide, germanium and silicon.[6]

To obtain a high signal-to-noise ratio, it is important to keep the noise level at a minimum. This is accomplished by the mechanical and electrical alignment of Hall voltage contacts for zero output at zero field for a given operating control current or input power.[7] Ratios already obtained have reached values over 1,000 to 1. Another important parameter is the linearity and symmetry of Hall voltages, when the control current or the direction of the magnetic field is reversed. This is assured by ohmic contacts for both the input (control current contacts) and output (Hall contacts). Rectification, thermoelectric effects and other phenomena, occurring at the points of contact between the Hall material and the conductors, should be avoided.[6]

When Hall generators are used for power transfer, other parameters are important: high Hall voltage output at low output impedance, high transfer efficiency (power out to power in), heat dissipation capacity and maximum operating temperature. On the other hand, magneto-resistance effect, temperature variations and noise level are of minor importance. The best materials for this application are indium antimonide and indium arsenide. Their inherent high mobility produces high Hall voltages at low output impedances and, therefore, these are most suitable where the Hall generator delivers power to the low impedance load.

Advantages to be gained by replacing windings, slip-rings and other wear-susceptible contacts by Hall generators and permanent magnets are: simple design and fewer parts, leading to substantial increase in reliability; reduced friction of the rotating member; further miniaturization capability with increased life; reduced production cost; and new areas of application with d-c and a-c power supplies.

The present range of wire-wound synchros includes torque synchros, receivers, control synchros, control transformers, synchro differentials, linear synchro transmitters (in-

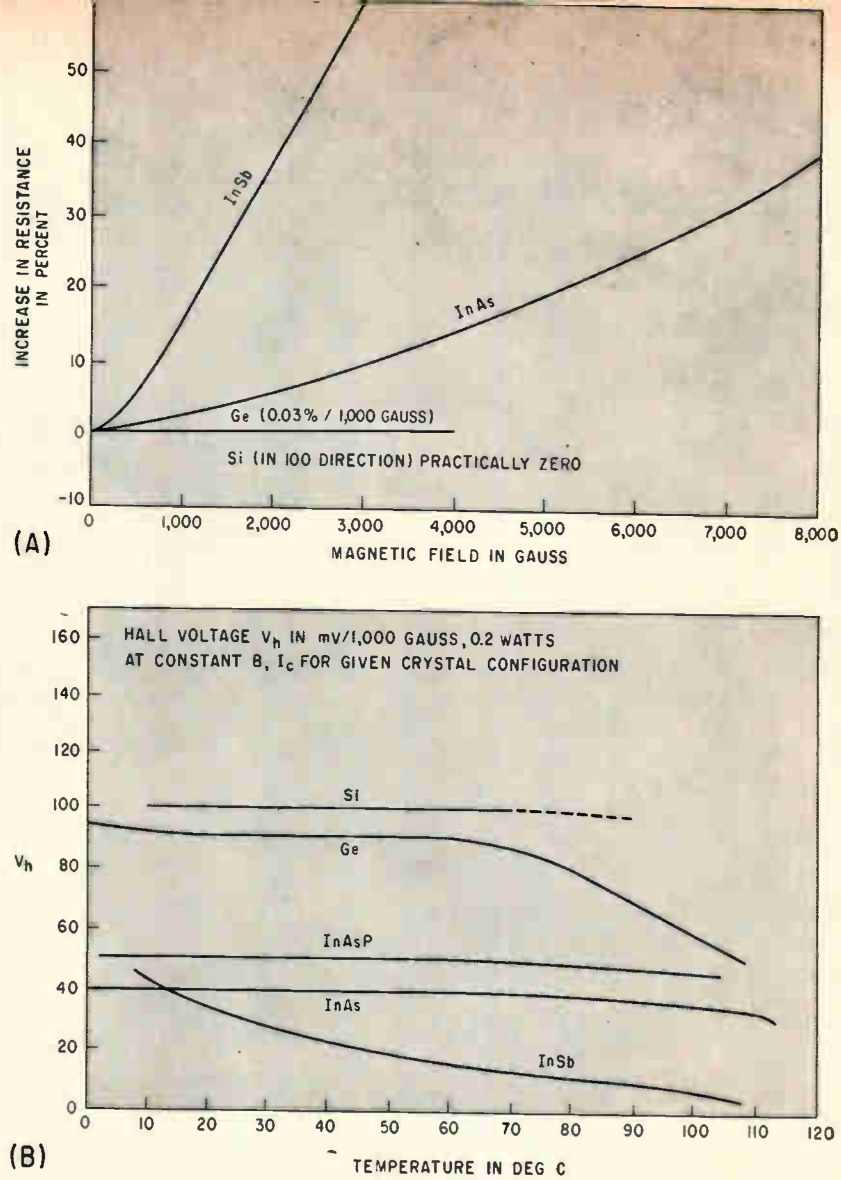


FIG. 1—Change in resistance of Hall generators under influence of magnetic field (magnetoresistance effect) (A); and change of Hall voltage with temperature (B)

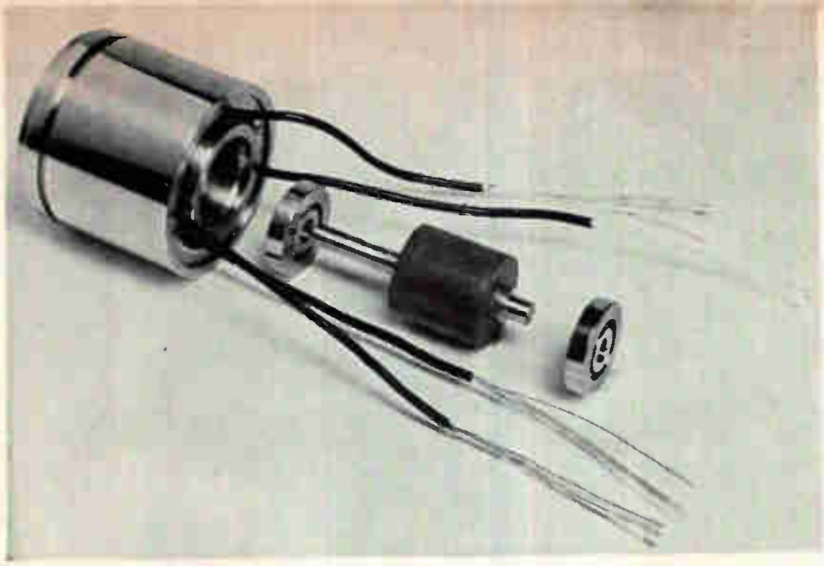


FIG. 2—In a Hall-effect resolver there are no moving parts other than the rotor assembly which consists of a magnet, a shaft and two bearings

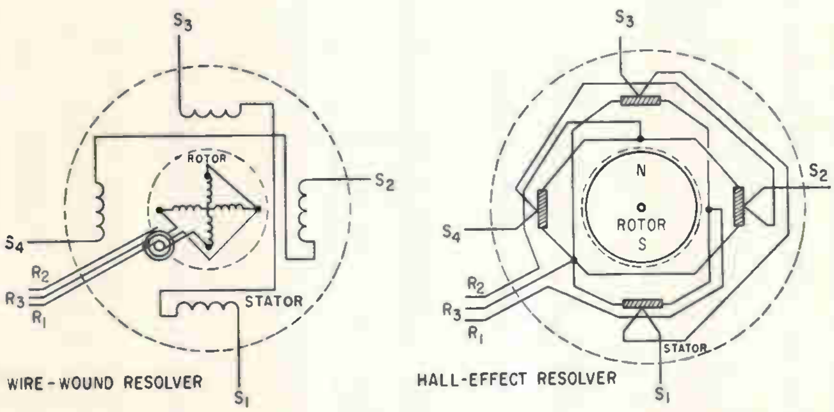


FIG. 3—Comparison of the circuits for a wire-wound resolver and a Hall-effect synchro-resolver

duction potentiometers), resolver transmitters, resolver control transformers and computing resolvers.

Torque synchros and receivers handle power and are used in open-loop systems to drive a light load or to indicate angular position. All other synchros are used in three or four-line chains for error signal transmission in closed-loop servo systems and for computations, or as single units for signal generation and signal modification.

The prime object of the development program is to replace the various types of present synchros by only two or three types that will perform all the required functions more reliably and over a wider range of applications. Torque synchros may be replaced by microminiaturized servo packages, in which the Hall-effect synchros will provide the error-sensing elements.

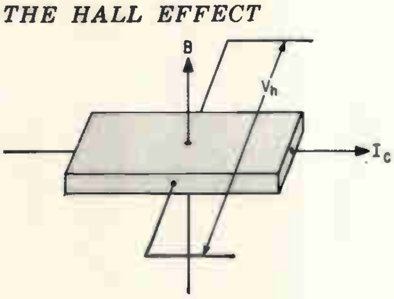
With successful completion of the development program, a few types of miniaturized Hall-effect synchros should replace all types of present synchros and resolvers, resulting in considerable reduction of production costs and system maintenance problems.

The Hall-effect synchros and resolvers have no slip-rings and brushes since the magnetic field is provided by a rotating permanent magnet. Hall generators, with the associated interconnections, replace the stator windings. There are no moving parts other than the rotor assembly, which consists of a magnet, a shaft, and two bearings (see Fig. 2). The circuits for a Hall-effect and wire-wound resolver are compared in Fig. 3.

In one of the experimental models, indium arsenide Hall generators were used, in the stator magnetic return path. At an input angle $\theta = 0$ degree (synchro electrical zero), the magnetic flux crosses the Hall generators associated with one of the outputs at its maximum, whereby no voltage appears at the terminals of the second output because the field across the other Hall generators is zero. With increasing angle θ, both outputs then follow a sine or cosine function. A voltage output pattern identical to that of a conventional wire-wound resolver, at a high signal-to-noise ratio, is thus obtained.

The output voltage of wire-wound synchros is a-c, but the Hall-

THE HALL EFFECT



When a conductor carrying a current I_c is placed in a transverse magnetic field B, as in figure, a voltage V_h will appear across the conductor perpendicular to both the current flow and the magnetic field.

The voltage V_h, called Hall voltage, is created by the redistribution of charge carriers which in turn is due to the combined effect of an electric and magnetic field on the carriers. The Hall voltage is proportional to the current I_c and the field B.

The discovery of the Hall effect was made in 1879 by E. H. Hall[1] while he was experimenting on a gold plate. Subsequent investigators carried out tests on various conductors available at the time. The Hall voltages obtained were extremely small. For example, copper produced 0.024 millivolt per kilogauss at 0.2 watt input. The Hall effect, therefore, remained a physical curiosity for nearly six decades.

With the development of the semiconductors used in diodes, transistors, and other solid-state devices, materials that produce Hall voltages several orders higher than voltages obtained with pure conductors became available. For example, germanium, properly doped, will produce at least 110 millivolts per kilogauss at 0.2 watt input. This is almost 5,000 times as much as copper produces. Further advances are expected in this field when new transistor manufacturing methods, recently introduced, are utilized.

The basic principles of the Hall effect have been explained and described in several different publications.[2, 3, 4, 5, 6] effect synchros can operate with d-c or a-c. Consequently, the output voltage may be d-c or a-c up to a high-frequency region, dependent upon the type of the input current to the Hall generators and the design of the unit.

There were many hindrances to obtaining a reasonable accuracy in the experimental models. The Hall generators must be positioned in the stator and in relation to the rotor so that the flux across each of the generators varies, within close limits, with the sine (or cosine) of the input angle. This is not easily achieved because of unavoidable air gap effects and other mechanical deficiencies.

Furthermore, the magnetic flux passes across several air gaps, which contribute to increased leakage and lower obtainable flux maximum. Therefore, the output voltage is low. Additional errors are introduced by unequal distribution of flux in the multi-return-path sectors and in the permanent magnet. New magnetizing fixtures were developed to achieve uniform flux in the magnet.

In later experimental models, germanium Hall generators of various configurations were used, developed by the solid state laboratory. The protecting ceramic plates were replaced in these generators by ferromagnetic materials, thus reducing the effective air gap in the return path. Properly doped germanium generators proved to be superior to any other generator, having at least three times higher output voltage, and low temperature and magnetoresistance coefficients.

Further difficulty was experienced when the synchro was operated with a d-c input. Considerable hysteresis effect in the return path was noticed, causing an operational error exceeding 2 percent. This effect was minimized by using proper ferromagnetic materials, by reshaping the return path, and by optimizing for best magnetic induction level in the magnetic circuit.

To obtain high output voltage, it is customary to connect voltage sources in series. This can be done with Hall generators, but several new problems arise, which have yet to be solved. In all Hall generators, the input (control side) is always resistively coupled with the output (Hall voltage contacts). The two circuits are not electrically isolated. Hall generators may therefore be represented by a four-terminal resistance bridge. When balanced, no output should appear at zero field.

For example, four generators may be used in a Hall-effect resolver (Fig. 3) to form two pairs, each pair associated with an output. The circuit of Fig. 3 is rearranged in Fig. 4. The generator inputs 1-4 and 5-8 are in parallel, the outputs 9-12 and 13-16 in series. The generators, like bridges, should be balanced for zero output, which, at zero field, may change or shift at different input currents. The generator resistances or their ratios should be identical within close limits at all magnetic field levels, a requirement difficult to meet in practice.

The circuit shown in Fig. 4 provides a low input resistance and a high output voltage. Other arrangements are possible with inputs connected in series or outputs connected in parallel. These arrangements, however, require adding isolating resistances in the circuits to minimize the unavoidable circulating currents.

The best solution to the problems encountered with two generators per output is to use only one generator per output, or better still, one generator for both outputs.

Experimental synchro models are under construction to use one or two Hall generators to achieve the performance equivalent to conventional wire-wound synchros and resolvers. A single Hall generator component should show extremely high reliability and long life.

Models of size 15, 11 and 5 (1.437 in., 1.062 in., and 0.5 in. outer diameter, respectively) were built and tested with various numbers of Hall generators.

Summarizing the results so far achieved, the following performance of a Hall-effect resolver in a housing with 0.4 in. outer diameter and 0.8 in. long represents the present state-of-the-art: input power, 0.4 watt maximum; output voltage, over 200 mv at maximum output; and overall operating error, 0.4 percent maximum.

Stator and permanent magnet rotor of Hall-effect resolver

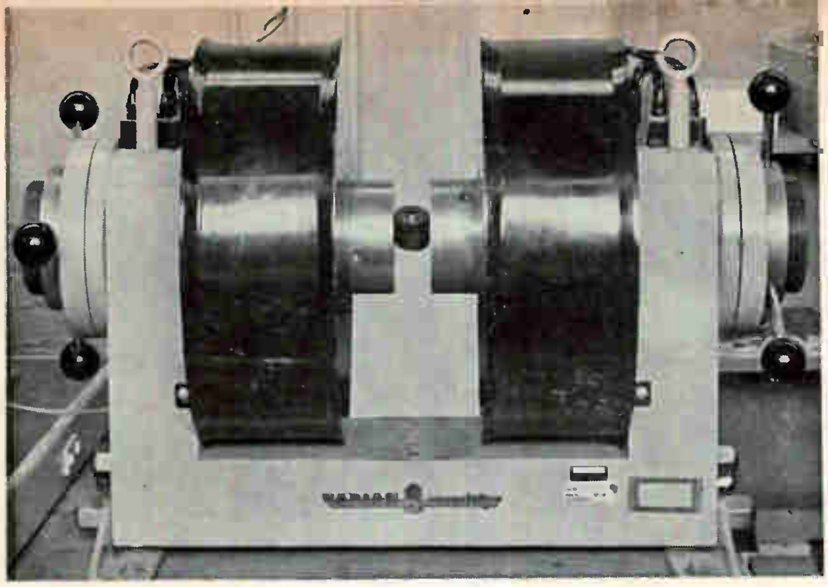
Development work on Hall materials is progressing rapidly. Improvements have been introduced in the configuration of generators and their protection against environmental extremes. New manufacturing techniques are being investigated that will solve the difficulties in producing thin-walled Hall generators. And recent improvements in permanent magnets will allow further miniaturization of all Hall-effect devices including synchros and resolvers.

Designs developed so far satisfy all applications for transmitters and resolvers but are not suitable for control transformers or differentials. Proposed schemes are now in an early development stage for these two applications. It is expected that a complete range, consisting, however, of only two or three types of Hall-effect synchros, will soon be available to cover all present applications of wire-wound synchros.

The development of reliable brushless d-c motors has been a goal of many motor manufacturers for several years. Operating models have been developed, but none of them, as far as is known, have the desired combination of characteristics of simplicity, reliability and compactness.

Various types of commutators were considered during an initial study. Although both electromagnetic and electrostatic sensors were considered, the Hall-effect commutator displayed superior flexibility and simplicity.

The Hall commutator consists of a rotating permanent magnet that provides the field to affect stationary Hall generators, which are arranged and positioned with respect to the magnet so that the latter replaces the conventional d-c motor commutator and brushes. There is an air gap between the magnet and the surface of the Hall commutator, so there are no surfaces or brushes to wear out. Circuit layouts that allow any arrangement of Hall generators are possible. The Hall gen-



Ferrite fixture between poles of electromagnet for magnetizing permanent magnet rotor of solid-state synchro

Brushless d-c motor incorporates Hall-effect commutator. Holes in this prototype permit checking of individual Hall crystals

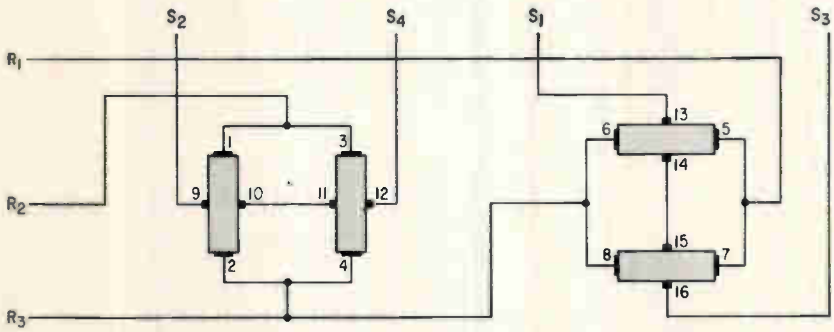


FIG. 4—Half-effect synchro-resolver, shown in Fig. 3, rearranged

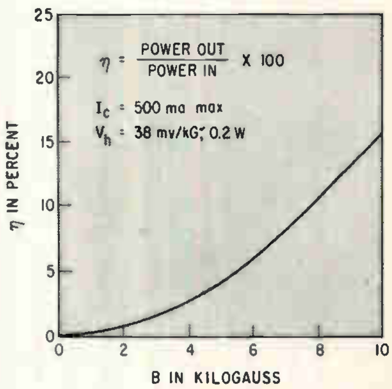


FIG. 5—Power transfer efficiency of Hall generator plotted against magnetic field level

erators may also be used for sensing, triggering, driving or biasing additional electronic networks for larger power-handling capacity or linearization.

The control current I_c to the stationary Hall commutator is also the input current to the d-c motor. The rotating stator field is instantly reversible because the polarity of the Hall commutator output will change with the reversal of I_c, the motor current. One or more permanent magnets can provide the fields for the d-c motor and the Hall commutator. Only two terminals are provided for the motor input; all other connections between the Hall commutator and the motor stator are made within the stator. With small modifications to the Hall commutator, many variants are possible to satisfy requirements.

During the initial study, two experimental models were built and tested. The commercially available indium-arsenide Hall generators for the first model were not suitable for this application because the Hall generators were intended for fluxmeters and other similar equipment. Consequently, they displayed a low power-transfer efficiency and low output voltage.

It has been found theoretically and confirmed in experiments that the power-transfer efficiency of a Hall generator is highly affected by the operating magnetic field level B. The efficiency increases exponentially with B (Fig. 5). It is therefore important to obtain an operating field that is as high as possible.

The efficiency of the Hall commutator is also dependent on the type of the Hall material and its mobility, on the physical proportions and design, and on the heat dissipation ability of the assembly.

Theoretical and experimental investigations are now in progress to develop efficient Hall commutators with internal resistances matched to the average level of the stator impedances for selected sizes of motors.

With the recent progress in Hall generators and in magnetic materials, various miniature components without brushes or windings will soon be in the hardware stage and available to system and equipment designers. It appears that this is the initial stage of development. The field of applications of the Hall effect shows much promise.

The designs described here are protected by patent applications filed or in preparation.

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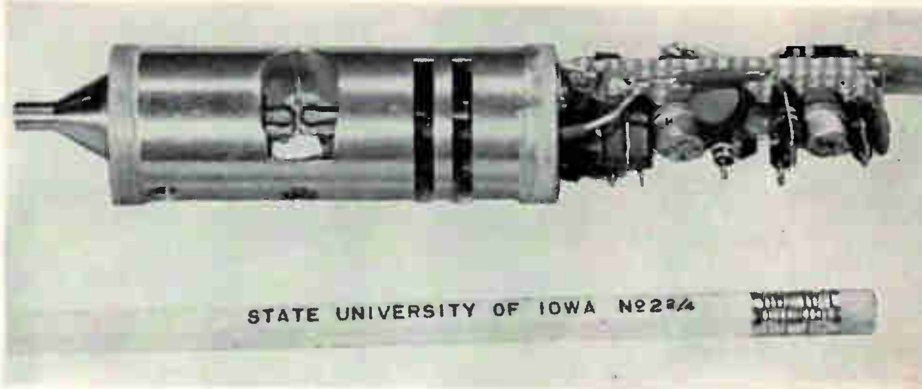
Measuring intraocular pressure is useful in diagnosing glaucoma. In this device, frequency shift is proportional to the applied pressure. The transducer is highly sensitive to small pressure changes with an infinitesimal mechanical displacement



Probe without cover shows crystal between ends of glass rods

Measuring Eyeball Pressure

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FOR SOME TIME it has been felt that an increase in pressure within the eye is directly related to glaucoma, a blinding disease. If diagnosed early enough, the pressure can be relieved by drugs or surgery. Consequently, several instruments have been devised or suggested for measuring this pressure. Mechanical devices usually involve an arrangement of known weights with levers for indicating the pressure on a graduated scale. Electronic instruments have been constructed that produce a signal when a predetermined area, usually a 3-mm circle, of the eye has been flattened, thus reflecting intraocular pressure[1,2]. Each of these methods has its relative advantages. Specifically, a good tonometer should be easy to use and produce reliable results. The experimental instrument described[3] shows possibilities of meeting these requirements.

When pressure is applied to an oscillating quartz crystal, the frequency of oscillation will change. If this change in frequency versus pressure is linear, this phenomena can be used to create pressure transducers. Figure 1A shows a typical curve of crystal pressure versus frequency change. The total curve is not linear. However, in this instrument the crystal is pressure biased into either the first or second region of linearity.

Although a change in the crystal temperature causes a shift in its frequency of oscillation, this effect has not been a problem.

The mechanical configuration for the eye probe is shown in Fig. 1B. The crystal is confined in the lateral direction by two glass rods. One rod is semipermanently fixed and the other receives pressure from the tip, which touches the eye, and transfers it to the crystal. This arrangement is being used so that various tip configurations can be tried. The semipermanently fixed rod can be located by two screws. A coarse adjustment is directly in line with the rod, and a vernier adjustment, offset from the center, presses against the flange containing the coarse adjustment. This arrangement works well and provides pressure biasing.

The photograph of the probe, with the outside cover removed, shows the crystal in the center with the two glass rods pressing against it; on the left end is the removable tip that presses against the eye and on the right end is the flange for vernier adjustment. Also attached to the probe is the oscillator circuit for the crystal.

The complete circuit (Fig. 2A) consists of an oscillator, multiplier, mixer, local oscillator, pulse former and integrator. This changes the frequency deviation into a measurable voltage.

The oscillator unit consists of a conventional transistor Colpitts oscillator followed by a grounded-collector isolation amplifier (Fig. 2B). Transistors are used in the probe because of small size, low heat output and mechanical rigidity. The emitter follower obtains impedance matching and isolation. Included in the oscillator circuit is a silicon diode capacitor (C_1) in series with the crystal to provide adjustment of the oscillation frequency after the probe tips have been changed. This is necessitated by the extreme sensitivity of the crystal to pressure variations. The oscillator is connected to the main unit by a cable consisting of three conductors, two for carrying d-c voltages and an RG-174/U coax for the oscillator signal. The oscillator signal is fed directly into the frequency multiplier.

The frequency multiplier is made up of three conventional multiplier stages. The stages multiply by three, two and two, respectively.

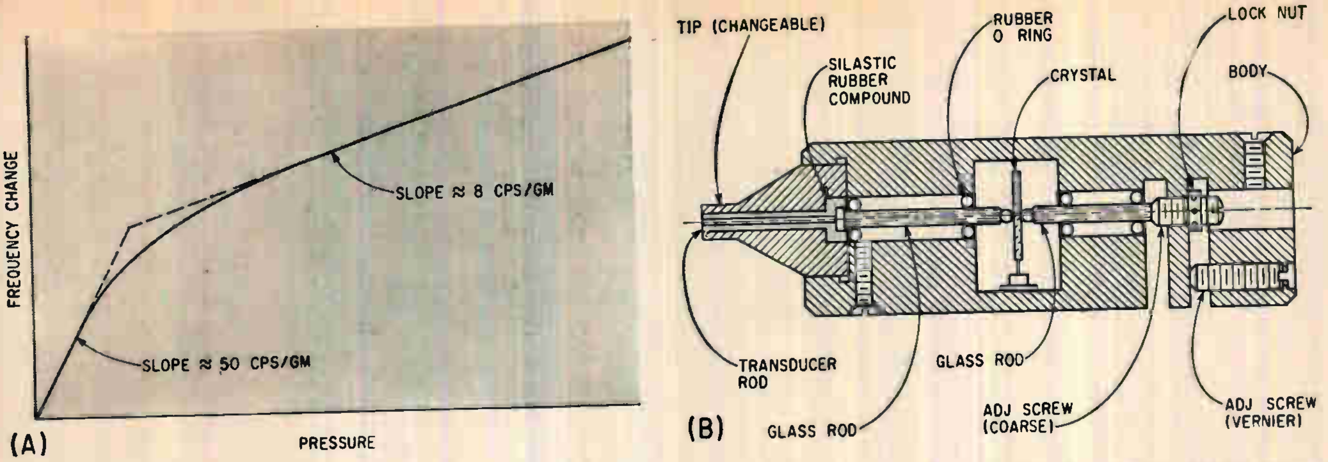

FIG. 1—Curve (A) of crystal pressure versus frequency change; cross-section view of probe (B) shows adjustment screws

With a Crystal Oscillator

This gives a total multiplication of 12 times the original oscillator signal containing the deviations due to pressure. This means that if a pressure on the probe produced a frequency change of 10 cps, the output signal from the multipliers would change 120 cps. This multiplication factor could be any number and permits the instrument sensitivity to be changed at will.

After leaving the multiplier, the approximate 36-Mc signal is mixed with a 36-Mc output from a local oscillator; the difference is detected and used to drive a monostable multivibrator.

The monostable unit converts the frequency shift with pressure into constant energy pulses that change in repetition rate due to pressure. These are then integrated and read on a meter or used to drive a recorder. In tests, both were done simultaneously, with the pen recording being the more easily read and providing a permanent record of the data.

One of the units constructed is capable of producing 0.5 cm per mm Hg recorder deflection. To date this degree of sensitivity has proved more than adequate.

Experiments indicate that the instrument has definite possibilities. Figure 2C shows a typical output curve.

Point P_o is suggested as the level of intraocular pressure as measured[4]. The application time is between one and two seconds. These data were obtained from an enucleated cat eye.

The authors acknowledge the support and encouragement of A. E. Braley, T. A. Hunter, E. Lundquist, M. F. Armaly and F. Anderson of the State University of Iowa.

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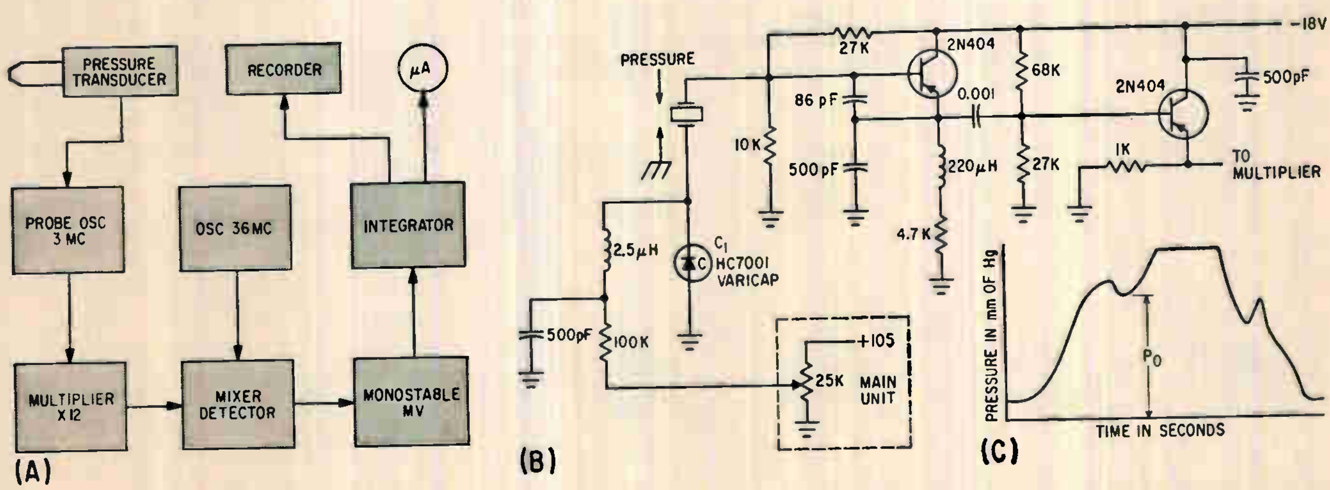

FIG. 2—Complete unit (A); probe circuit (B); and output curve (C) with a plateau caused by recorder clipping

GENERATING RANDOM NOISE

System provides both a random telegraph wave with a mean count rate of 80 Kc and Gaussian noise with a power spectrum flat between d-c and 20 Kc, for fast analog computation and especially for repetitive computer applications

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ANALOG-COMPUTER studies of random processes require generating randomly varying voltages with statistical properties to represent randomly varying variables, initial conditions and parameters.[1]

A noise generator for providing random input signals to a repetitive analog computer may require a flat power spectrum from d-c to several thousand cycles a second.

The output power spectral density may be altered to meet a given requirement by linear shaping filters; the output amplitude distribution can be shaped by diode function generators.

Gaussian-noise generation by noisy resistors,[2] diodes,[3] phototubes[8] and thyratrons in a magnetic field[4] requires elaborate regulation or monitoring of rms and d-c output levels, and also has the disadvantage of a nonuniform power spectrum at low frequencies.

Low-frequency spectral nonuniformities, including line-frequency components due to hum pickup, can be removed through sampling or demodulation and filtering of the noise generator output, which recenters a flat portion of the spectrum about d-c;[5] but the resulting noise output spectra are flat only to about 100-500 cps.

A flip-flop symmetrically triggered by a radiation detector actuated with a radioactive source yields a random telegraph signal with Poisson-distributed zero crossings (Fig. 1 inset).

If the levels $\pm E$ are accurately set by a precision limiter, the mean output is zero, whereas the mean-square, autocorrelation and power spectral density are given by

$$\phi(0) = E^2$$
$$\phi(\tau) = E^2 e^{-2\alpha|\tau|}$$
$$W(\omega) = \frac{E^2}{\alpha}\,\frac{1}{1+\omega^2/4\alpha^2}$$

where α is the mean count rate of the radiation-detector output pulses. Low-pass filtering of the random telegraph signal yields Gaussian noise of zero mean, with spectral density determined by the filter characteristics. The flat-spectrum random telegraph signal is useful in its own right. The binary nature permits its direct use for random switching (binary multiplication), for example, in correlators.[6] This nature permits its direct use for randomly timed events (Poisson process) in simulations of equipment failures and queing problems such as traffic control.[7]

An earlier noise generator of this type used a self-quenched Geiger-Mueller tube as the radiation detector,[8] but this device was limited to relatively low count rates (below 500 cps) by its deionization time. The noise generator replaces the Geiger-Mueller tube with a scintillation detector (type 931A multiplier phototube) and permits count rates well in excess of 75 Kc for wideband operation.

The block diagram of Fig. 1 shows the operation of the circuit. The noise generator consists of a source of radioactive material mixed in a light-emitting phosphor and a multiplier-phototube detector whose output produces current pulses corresponding to the emission of light impulses in the scintillating phosphor. After amplification in a five-stage pulse ampli-

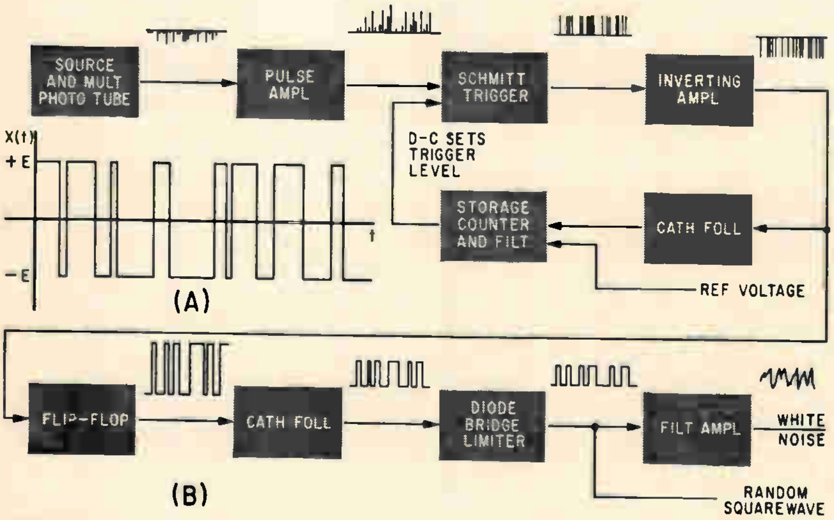

FIG. 1—Block diagram of noise generator with radioactive source; random telegraph wave (inset) with Poisson-distributed zero crossings

WITH RADIOACTIVE SOURCES

fier, pulses exceeding a threshold voltage operate a Schmitt trigger to produce short pulses of constant amplitude and random time occurrence. These pulses are inverted and applied to a flip-flop to produce a squarewave of constant amplitude with random zero crossings. The output squarewave has a d-c component, which is eliminated by a cathode follower followed by a symmetrical limiter. The cathode follower output is clipped at equal positive and negative voltage levels by a diode-bridge limiter. The result is a random telegraph signal having accurate levels of $+E$ and $-E$ volts. The random telegraph signal is amplified and filtered in a chopper-stabilized wide-band operational amplifier. The power spectral density will be flat from zero to near the filter cutoff frequency.

Since the mean count rate of the random telegraph signal affects the spectral density of the noise output, the threshold level of the Schmitt trigger is controlled by feedback through a storage counter using an operational-amplifier integrator.

The radioactive source consists of a radioactive isotope mixed with a light-emitting phosphor, such as is used on dials of luminous watches. This jewelers' paint is applied to a small region of the tube envelope covering the cathode of the multiplier phototube.

The 931A multiplier phototube was selected because of its relatively low cost, and because it is of the vacuum type, which, unlike a gas phototube, suffers little or no loss of sensitivity with use when operated continuously near full plate current.

A supply of 1,000 volts is applied to the phototube across a voltage divider providing 100 volts between successive dynode stages. A curve of count rate versus voltage across the phototube is shown in Fig. 2A for a Schmitt trigger threshold level set near maximum count rate.

The source and multiplier phototube are completely enclosed by a Mu-metal shield to prevent a-c fields from modulating the count rate; the earth's field might also cause a decrease in signal. The pulse output is of negative polarity and varies from near zero to ten or fifteen volts.

The count rate is determined by the number of multiplier phototube pulses that exceed a threshold value. The pulses occur at random times and can be close together. Hence, a fast amplifier is required, to amplify the small pulses above the threshold value, and not be overloaded by the larger pulses. The circuit is common to nuclear physics experimentation[9] (Fig. 2B). The feedback loops and design are similar to the Oak Ridge-Fairstein and Brookhaven-Chase circuits.[9] The negative signal from the multiplier phototube is amplified through V_{1A} and appears as a positive signal at the grid of V_{1B}. Tubes V_{1B} and V_{2A} are connected as a difference amplifier, with their grids coupled through a long time constant (220,000 ohms and 0.1 μf). Under normal conditions, that is, when the positive input signal at the grid of V_{1B} is small, the difference amplifier can operate with low effective cathode impedance (13,000 ohms in parallel with the r_p of the other tube) since both V_{1B} and V_{2A} are conducting. When the signal is large, V_{2A} cuts off and all current flows through V_{1B}, the cathode impedance of which is now 13,000 ohms. For large signals V_{1B} draws grid current; but since there is no coupling capacitor in the grid circuit, it will return to its quiescent operating point as soon as the large signal ceases. Tube V_3 is an inverting amplifier whose output is the triggering signal for the Schmitt trigger.

Two feedback loops help to stabilize the gain of the pulse amplifier. High-frequency negative feedback is applied from the cathode of V_{2B} to the cathode of V_{1A} through a capacitor and resistor in shunt. The capacitor in shunt with the feedback resistor overcomes the capacitance from the cathode of V_{1A} to ground. There is also a second, low-frequency feedback connection from the cathodes of V_{1B} and V_{2A} to the

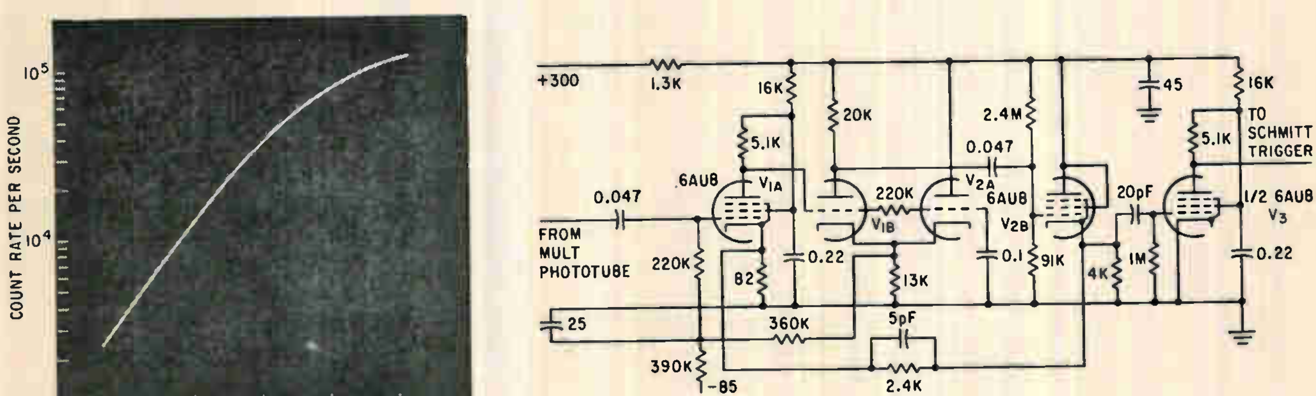

FIG. 2—Graph (A) of count rate versus voltage across the multiplier phototube; nonoverloading pulse amplifier (B)

grid of V_{14} to stabilize low-frequency fluctuations in voltage caused, for example, by changes in tube characteristics. The long time constant of the 390,000-ohm resistor and 25-μf capacitor confines the effectiveness of this feedback to the quiescent current conditions of V_{14} and the difference amplifier.

Tests were made on the amplifier with an astable multivibrator at 2 Mc. The rise time of the input pulse was 0.04 μsec, and the recovery time was 0.16 μsec. Amplifier rise time is no greater than 0.22 μsec; the recovery time 0.16 μsec. The pulse gain varies with input amplitude, due to the nonlinear difference amplification. The output voltage never exceeds 60 volts for an input of 4 volts. Reliable amplification is obtained in excess of 2.5 Mc.

The Schmitt trigger is of conventional design.[10] An output amplifier inverts the trigger and prevents loading of the trigger by the binary.

A resistance in the cathode circuit of the first tube reduces the loop gain to near unity and thus reduces hysteresis to about 1.8 volts. If the hysteresis were eliminated entirely, the loop gain would be equal to unity, which is a relatively unstable condition. Drift due to supply voltage changes or tube aging could cause negative hysteresis (loop gain less than unity) and the circuit would no longer change states.[10] The +1.8-volt hysteresis will ensure that the loop gain remains greater than unity even if the circuit drifts. The rise time depends on the speed of the triggering voltage, but is in no case less than 0.16 μsec. The output switches between +250 and +300 volts with a recovery time of 0.18 μsec. The maximum reliable count rate using the astable multivibrator connected to the input of the pulse amplifier is about 2.6 Mc. Drift of the switching point is eliminated by the feedback control circuit.

The flip-flop is also of conventional design.[10] An output cathode follower reduces the output voltage to near the desired level, lowers the output impedance and prevents loading the binary.

The output of the cathode follower is slightly greater than ±30 volts, as the diode bridge will limit to ±20 volts. This 20-volt margin ensures the elimination of any unwanted noise riding on the random squarewave, and also results in sharper pulses. Since the random squarewave is also attenuated in the resistance network preceding the cathode follower, the flip-flop output must be large. Furthermore d-c coupling is used from the flip-flop to the noise generator output to preserve the components of the random signal down to d-c. The cathode follower also acts as an isolation network; it prevents the diode bridge from loading the flip-flop, and at the same time feeds the bridge through a low input impedance.

The binary output swings from +300 to +180 volts or an output of 120 volts. The rise time is 0.6 microsecond and the recovery time is 0.3 μsec. The maximum number of reliable transitions is 0.7 million a second. The output of the cathode follower is from +30 to −30 volts.

To obtain an output voltage of adequate root mean square value with a stable zero mean, the output cathode follower is followed by the diode-bridge limiter[11] (Figs. 1A and 1B). To allow fast rise times, the impedance level should be as low as possible. Precision carbon deposited resistors provide accurate limiting levels. The bridge-bias voltages must be well regulated and preferably should be obtained directly from the reference supplies of the computer in which the device will be used. The circuit limits at ±20 volts within 0.3 volts for both short and long pulses.

The output element of the complete random noise generator must be a wide-band, d-c amplifier capable of supplying the required gain and low output impedance. A Philbrick USA-3 chopper-stabilized amplifier is used. The output low-pass filter is placed in the feedback loop of this amplifier; plug-in terminals permit use of different feedback networks.

The count rate can be set by the threshold level at the Schmitt trigger input. Figure 4A shows the feedback circuit. The count rate was measured at the output of the inverting amplifier.

Count-rate regulation could also be accomplished through feedback to the power supply of the phototube. This would have the advantage of having more elements within the control loop. This method is not used because other phototubes may use the same power supply.

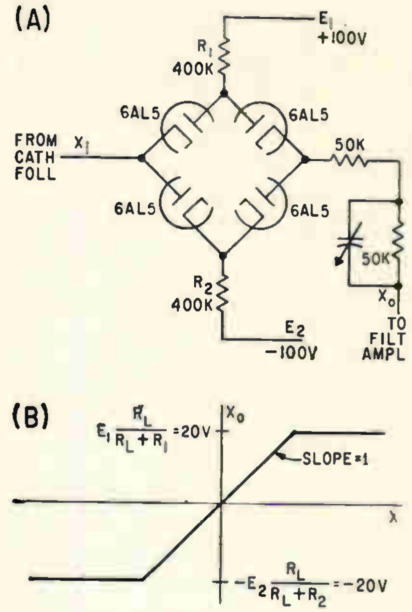

FIG. 3—Diode-bridge limiter (A) and its transfer characteristic (B)

Referring to Fig. 4B, cathode follower V_5 applies negative pulses through a low impedance to the storage counter. The negative pulses cause capacitor C_1 to charge through diode D_1. The time constant with which C_1 charges is the product of C_1 times the sum of the diode and cathode follower resistances. If this time constant is small compared with the duration of the pulse, then C_1 will charge fully to the value $e_1 = E$, with the polarity indicated. During the charging time of C_1, diode D_2 does not conduct and no current flows into the operational amplifier. At the termination of the input pulse, capacitor C_1 is left with the voltage $e_1 = E$, which now appears across D_1 and across the series combination of D_2 and the operational amplifier. The polarity of this voltage is such that D_1 will not conduct. Capacitor C_1 will, however, discharge through D_2 into the operational amplifier. The time constant with which this transfer of charge takes place must be small in comparison with the interval between pulses, to allow equilibrium to be established between the capacitor voltages (C_1 and C_2). Capacitor C_2 is large in comparison with C_1.[10] The average current flowing into the operational amplifier is EC_1a. The node equa-

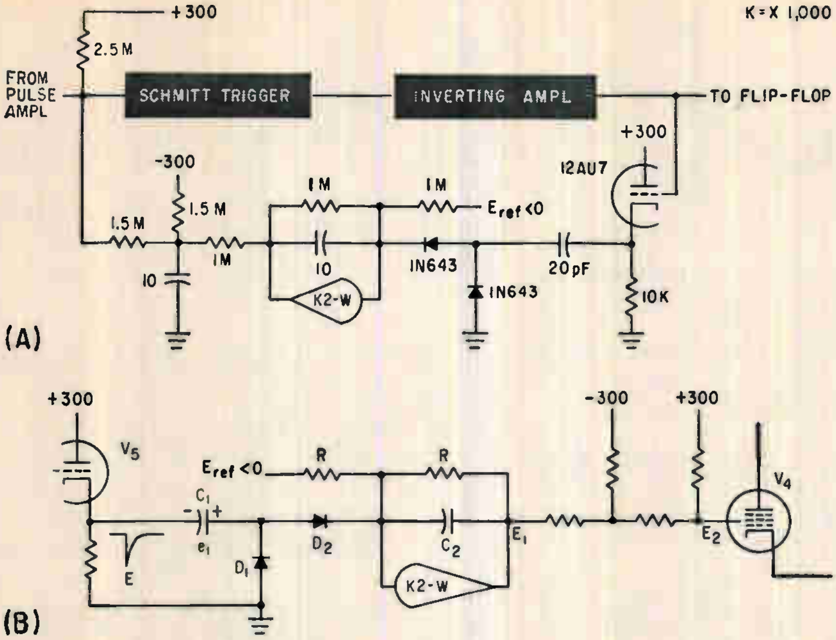

FIG. 4—Mean count rate control circuit (A), with a Philbrick K2-W operational amplifier; storage counter (B) with an operational amplifier circuit

tion at the input of the operational amplifier is $EC_1a = -E_1/R$ at d-c. Solving for E_1, $E_1 = -ERC_1a$.

This last equation indicates the direct dependence of the operational-amplifier output voltage on the mean count rate. If the mean count rate increases, the output voltage decreases and lowers the threshold voltage at the input of the Schmitt trigger, causing the count rate to decrease, and in doing so, regulating the noise generator.

Threshold level can be adjusted by varying the reference voltage at the operational-amplifier input.

The performance of the control circuit is

E_1 (volts)	E_2 (volts)	ΔV of Phototube (volts)
−10	+96	0
+5	+100	−50
+22	+103	−100

The count rate was varied by decreasing the voltage across the multiplier phototube. The large changes were for illustration and would never be expected to occur in practice. The reference voltage was 100 volts.

The noise generator has been built and will be incorporated in a repetitive computer now being built in the computer laboratory.[12, 13] It will be used in random-process studies.

The frequency capabilities of the generator circuits meet the design requirements and exceed the count rates obtainable from the source used. This permits use of a source of higher frequency should one become available, and provisions have been made for using two sources in parallel. If the sources are identical and independent, the mean count rate of the noise output should double.[14]

A primary consideration in random noise generator design is freedom from periodic components. The pulse circuit generating the random telegraph signal discriminates against line-frequency hum pickup, although stray 60-cps fields and currents can under some circumstances modulate the mean count rate both in the multiplier phototube and at the Schmitt input.

The effects on second-order statistics, such as the power spectrum, appear to be removed when the random telegraph signal is filtered for gaussian output.

It is believed that the main periodic interference in the random output is due to line-frequency components in the output amplifier.[15] This is due mainly to chopper ripple and spikes, which could be minimized by omission of the chopper stabilizer, and by d-c operation of the output amplifier filaments.

Small line-frequency components of this type are, unfortunately, rampant through most existing analog computers and measure about 3 to 5 mv rms. They are negligible in computations over the usual ±100-volt range, but might add up in statistical work.

In the application of the noise generator to the new repetitive analog computer, this has been taken into account; precision crystal-oscillator clock control[13] prevents computer repetition rates and sampling frequencies harmonically related to the line frequency, so that line-frequency components are averaged out in all presently projected random-voltage measurements.

This paper was written as an M.S. thesis in connection with a repetitive-computer project directed by G. A. Korn. The author is grateful to the Electrical Engineering Department of the University of Arizona and to P. E. Russell, department head, for their support of this project.

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Pulse Voltage Comparator Measures

Either positive or negative pulses equal to or greater than an

height of either polarity. The comparator responds to pulse widths

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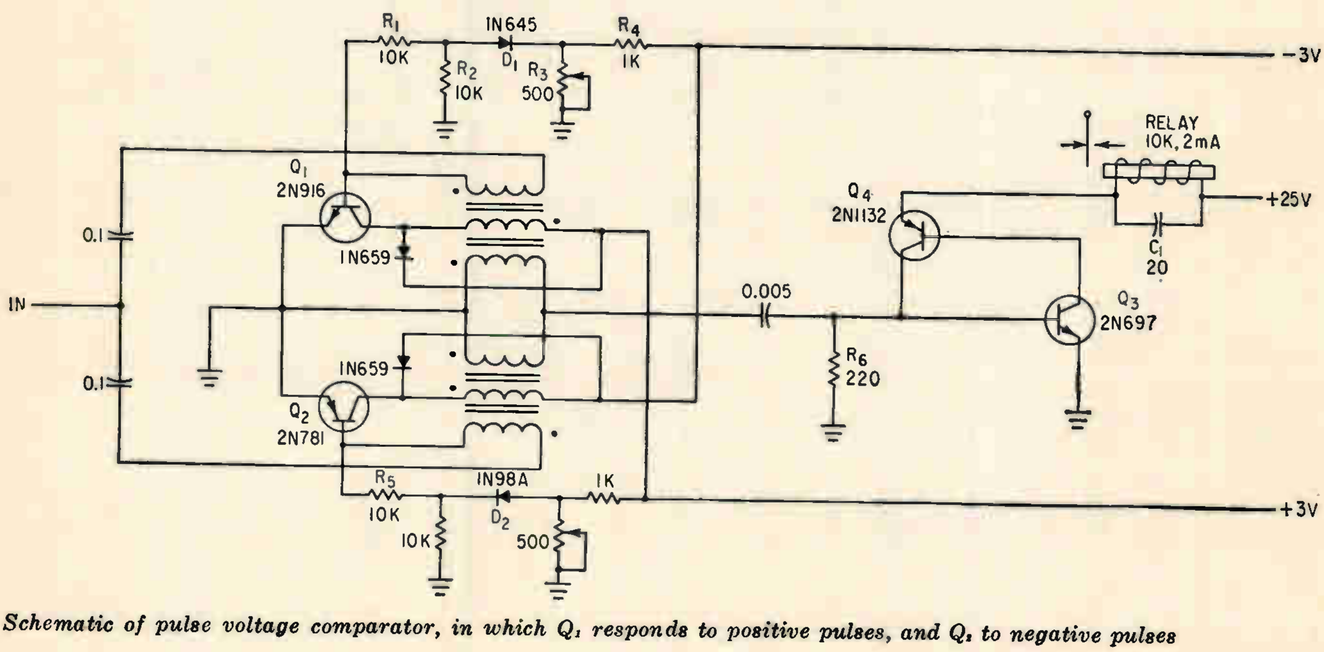
WHEN MEASURING pulse characteristics, a voltage comparator that responds to short-duration pulses of either polarity is often needed. The comparator described here responds to positive or negative pulses of short duration and low duty factor by closing a relay. It has a high input impedance before the threshold voltage is reached. The circuit responds accurately to pulse duty cycles as low as 10^{-7} and pulse widths as narrow as 50 nsec; threshold voltage is adjustable from 0.5 v to 1 v; and threshold voltage is within ±0.5 percent of nominal from 0 C to 50 C for positive pulses.

The circuit consists of two series-triggered blocking oscillators whose outputs are coupled to a monostable switching circuit that drives a relay. The *npn* transistor Q_1 responds to positive pulses and *pnp* transistor Q_2 to negative pulses. A positive pulse applied at the input, with an amplitude at or above the threshold voltage triggers blocking oscillator Q_1. The transformers are coupled such that Q_2 regenerates also, thus strengthening regeneration and increasing the speed. The positive output pulse from the blocking oscillators triggers the base of Q_3. The collector of Q_3 drives the base of Q_4, and the collector of Q_4 reinforces the starting pulse by driving the base of Q_3. The resulting positive regeneration drives each transistor into saturation and operates the relay. The discharge time constant of the relay circuit, determined primarily by C_1 and the relay resistance, is made long enough to keep the relay on for long intervals between pulses. Monostable operation is accomplished by making R_4 low enough to keep the loop gain less than one when the pulse is removed. Too high a value of R_4 will result in a latching operation of the relay and would have to be reset by turning off the 25-v supply.

The response of the circuit to narrow pulses is determined primarily by the transformers and transistors. The transformers have 1 μh leakage inductance and 10 pf of distributed capacitance. Accurate response to narrower pulses might be achieved by using transformers with lower leakage and primary inductance. However, the output pulse width of the blocking oscillators must be sufficient to trigger Q_3. The transformers have a 1:1:1 ratio. A 2N502A or 2N501A



Schematic of pulse voltage comparator, in which Q_1 responds to positive pulses, and Q_2 to negative pulses

Height of Positive or Negative Pulses

adjustable threshold voltage operate a relay, thus measuring pulse

as narrow as 50 nanoseconds and to pulse duty cycles as low as 10^{-7}

may be used for Q_2 but reliability may be reduced since BV_{EB} and $I_{C\,max}$ are slightly exceeded. Transistors Q_3 and Q_4 could be replaced with a *pnpn* semiconductor with bistable characteristics to simplify the circuit. However, the circuit would have to be adjusted to give monostable performance from a bistable device. Also the device must be capable of handling peak currents on the order of 100 to 200 milliampere.

The input at which regeneration takes place without biasing is approximately the forward voltage drop, V_{BE}, of the base emitter diode. However, V_{BE} decreases linearly as temperature increases at the approximate rate of 2 mv per deg C. The compensation to keep a constant cutoff voltage for Q_1 and Q_2 is provided by the networks of D_1 and D_2, respectively. Adjustable attenuator R_3-R_4 drops the -3 v supply to about -1 v. Since D_1 is a silicon diode with a forward drop of about -0.6 v, the voltage at the base of Q_1 is near -0.4 v. As the temperature increases, the voltage drop across D_1 decreases, resulting in an increased drop across R_2, thus compensating for a drop in V_{BE}. Compensation for Q_2 is provided in the same manner, using a germanium diode. As a result of this back biasing, the threshold voltage is kept reasonably constant at 1 v over wide temperature ranges and is adjustable. Resistors R_1 and R_5 isolate the low-impedance bias networks to give a higher input impedance.

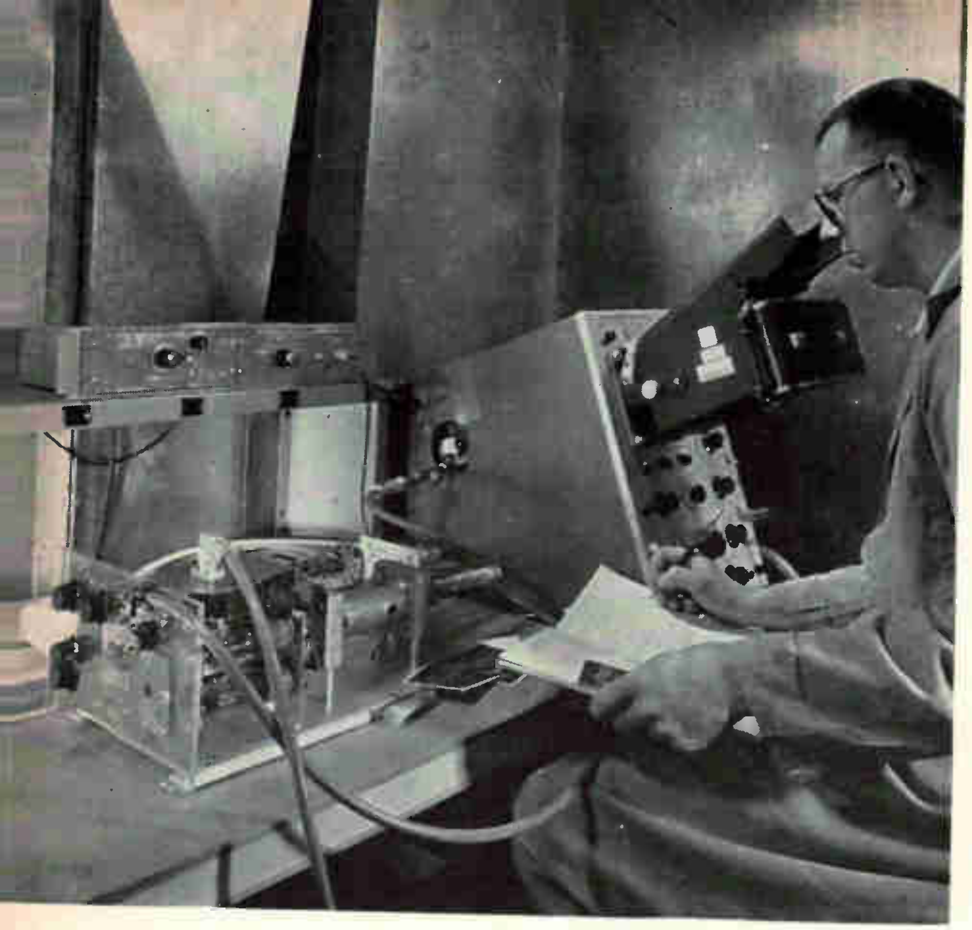
Transistor Q_1 is silicon with an extremely low I_{CBO}, thus the increase in I_{CBO} with temperature causes a negligible voltage drop across R_1 and little or no change in the bias voltage. However, because Q_2 is germanium, the increase in I_{CBO} with temperature is significant, especially if the transistor has a high initial leakage current. Because of I_{CBO}, tests using various germanium *pnp* transistors showed threshold deviations for negative pulses to be as high as 10 percent with a 30-deg C increase. Until a *pnp* silicon transistor with a speed equal to that of the present *pnp* germanium types is available, there exists the problem of changes in I_{CBO} due to temperature variations causing a change in the threshold voltage to negative pulses. There are a number of solutions to this problem, all of which require a compromise.

The first solution is to eliminate R_5 and decrease the impedance of the bias network. This makes the input impedance low. The ratio of input to source impedance should be as large as possible to eliminate errors caused by variations of source impedance. A second solution is to use nonlinear compensation employing another similar transistor, a black-biased diode or a thermistor to counteract the voltage drop caused by I_{CBO} of Q_2. This technique is undesirable because the compensation network must be tailored, and complete compensation may not be obtained over the temperature range. A third solution is to place the transistor in a small oven. This solution appears to be the most effective. The base-to-emitter voltage compensation network should still be employed when using an oven held constant within a few degrees, because a 1-deg C change can cause as much as a one-percent change in threshold voltage. For constant threshold voltage to negative pulses, one of the techniques should be used for large changes in ambient temperature. If, however, the comparator is used in an environment where the ambient temperature varies only a few degrees, then V_{BE} compensation is sufficient. The two 3-v supplies serve as references for the bias networks and should be regulated.

The circuit should find a wide range of applications in pulse-height measurement of either polarity. Since there are separate bias potentiometers, the positive and negative threshold voltages may be set to different levels. This permits pulse-height measurements of a differentiated pulse. Either the positive or the negative pulse output from a differentiator may be selected by adjusting the bias potentiometer.

By using filters, pulses having widths and rise times as short as 50 nsec and repetition rates to 10 cps may be indicated on a go/no-go basis. In tests, the voltage comparator was preceded by a gain-stabilized amplifier with a low output impedance and a high input impedance. This eliminated loading of the signal being tested and any reaction on the input waveform.

Another application may be in counting fast transients occurring at infrequent intervals and exceeding the threshold level. In this application the relay would be replaced by a mechanical magnetic counter with characteristics similar to those of the relay shown in the circuit. Capacitor C_1 would then have to be adjusted to enable the counter to operate at its fastest rate.



Set-up for testing magnetic materials with 30-nsec pulses

Tape-wound and ferrite cores are tested for operation at 30-nanosecond pulse width. Data can be extrapolated to large cores for 0.1-megawatt operation; ultimate objective is multimegawatt pulses at megacycles rates

How Magnetic Materials Behave

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WHEN OPERATED at narrow pulse widths, magnetic materials perform only marginally at best, and every technique that will improve performance must be used. Performance factors become especially important at high power levels.

Because information on core performance at pulse widths in the nanosecond range was lacking, a study was undertaken by the University of California Lawrence Radiation Laboratory. Various ferrite and fractional-mil tape-wound toroidal cores were tested at a pulse width of 30 nanoseconds.

Previous to this investigation, a pulse width of 0.3 microsecond was used to test toroidal cores 2 to 3 cm in diameter.[1, 2] On evaluation of the results for 0.3-microsecond pulses, several hundred tape-wound cores 2 feet in diameter were obtained for a high-peak-power induction electron accelerator. Preliminary tests confirm the design and show that data extrapolation from small test cores to large cores is valid.

Tests at 30 nanoseconds were instigated to obtain data for the design of large cores for an induction accelerator. The data, however, has many other uses, one being the design of pulse transformers for pulse widths in the range of the tests.

The data was obtained by exciting toroidal cores with a rectangular pulse 30 nanoseconds long, at a repetition rate of 60 pulses a second. The cores were not reset to

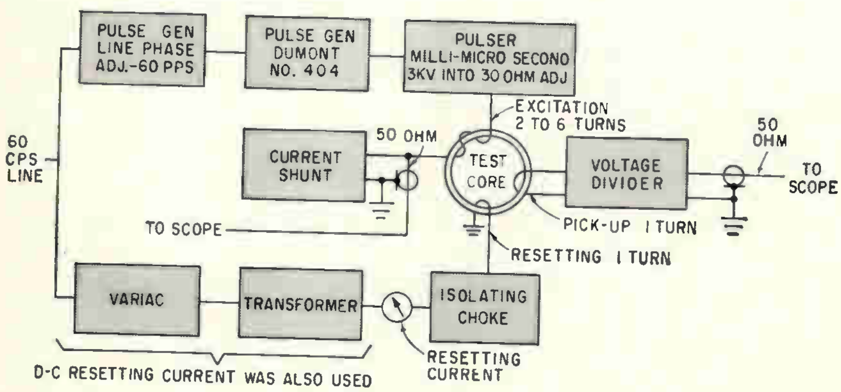
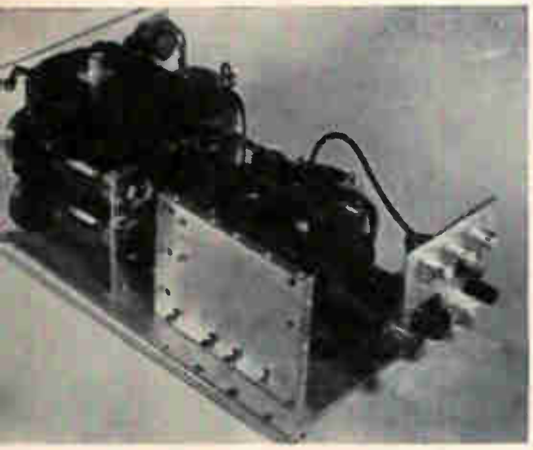


FIG. 1—Small test cores are pulsed with 30-nsec wide pulses at 60 pps. Cores are reset to give maximum output

High-frequency, high-power current shunt used in the tests



Pulse generator with coaxially mounted 3C45

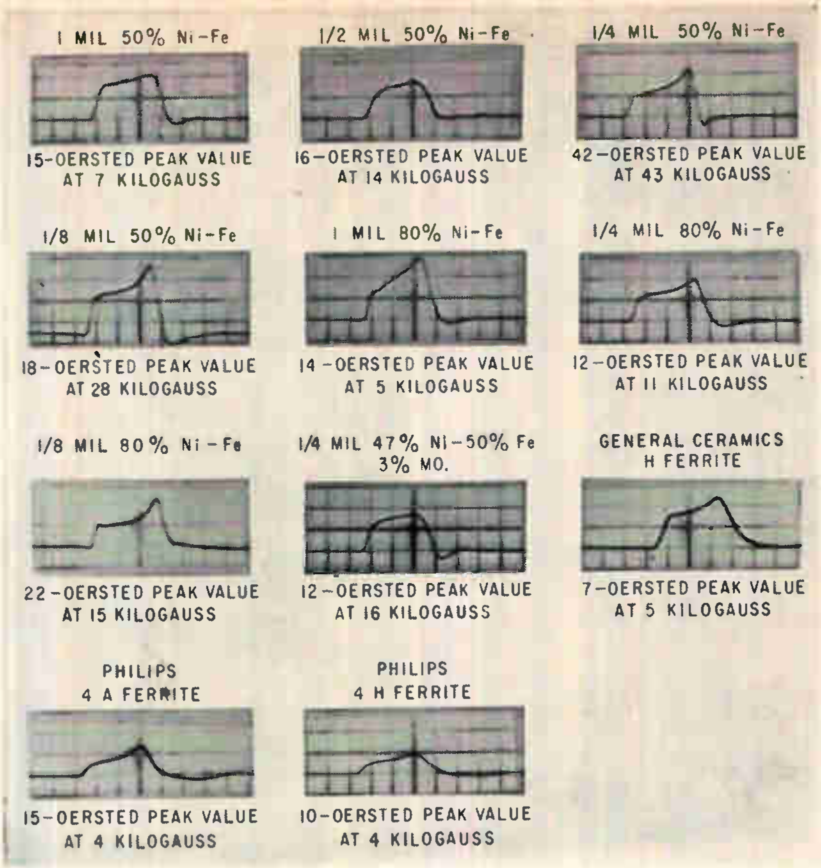


FIG. 2—Typical waveforms of drive current. Only shapes of the waveforms are comparable, not magnitudes

At Nanosecond Pulse Widths

zero flux and excitation, but were reset to give maximum μ at every point that was recorded. Negative resetting may be undesirable for simplicity and clarity of data, but the performance of magnetic materials is so marginal at this pulse width that any means of improving characteristics is welcomed.

The testing method is shown by the block diagram of Fig. 1. The rectangular excitation pulse is triggered by a 60-cps pulser. These pulses are adjustable in phase with respect to the 60-cps resetting current, which is introduced through a separate turn on the core through an isolating choke. The resetting current can also be d-c; d-c bias equal to the peak value of the a-c resetting current was used successfully. Resetting current is negligible for tape-wound cores and for ferrites is significant only at the highest excitation levels.

The block diagram also shows how data was obtained. A high-frequency shunt (shown in photograph) in the excitation winding provided pulse current information and a separate pickup turn provided pulse voltage. Pulse waveforms were applied directly to the deflection plates of calibrated Tektronix 517 oscilloscopes. Typical current waveforms, shown in Fig. 2, should be compared for shape only, not magnitude.

Whenever applicable, the standards and test methods described in AIEE Paper No. 58-71[3] were adhered to. A core to be tested was wrapped with an optimum number of turns (2 to 6) using an insulated copper ribbon as wide as possible. Care was taken to have short lead lengths and the closest possible coupling to the core. Stray coupling between windings was kept to a minimum, and all windings were kept fixed in relation to each other and the equipment.

At this high frequency, however, pulse waveforms are easily distorted, particularly in a system with pickup loops and voltage dividers. Although each test setup was compensated and checked by pulsing resistive loads, the errors, including those made by taking data from an oscilloscope, total approximately ±5 percent.

The data cannot be considered a true average or mean for any material since testing a large number of cores of the same material was not feasible. The tolerance of magnetic properties for the cores at this narrow pulse width is not known. Manufacturers have indicated that for lower frequencies materials may have variation as high as ±20 percent in saturation flux and μ for cores obtained from different batches. Closer tolerances at higher frequencies should not be expected, although such may be the case. No such variation was evi-

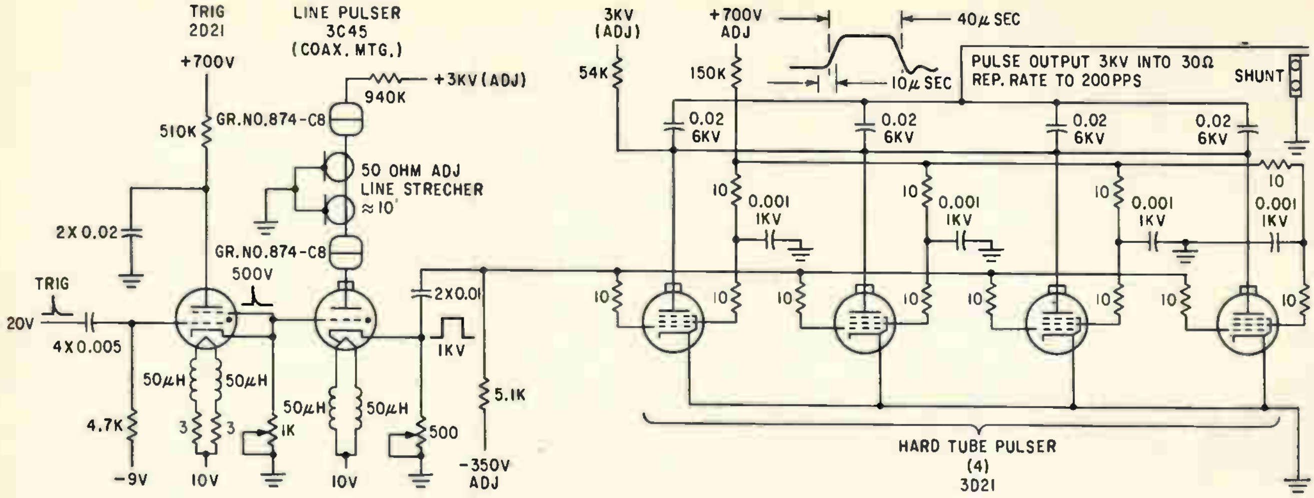


FIG. 3—Four tubes in parallel are used to drive the test cores, with drive power nearly equal to output power

dent when cores from the same batch were tested.

A pulser that could excite the cores at the desired levels had to be designed and constructed. What was needed was a rectangular pulse of 30 nanoseconds with about 0.1-megawatt peak power.

Required output current is about 20 to 30 amp at 3 kilovolts, with a risetime of the order of 5 nanoseconds. Furthermore, since the cores under test act as nonlinear loads, some degree of regulation during the pulse is needed. A saturated hard-tube output stage, Fig. 3, was used.

Another problem is risetime. Examination of the gain-bandwidth figure of the tubes, while certainly not valid for this mode of operation, nevertheless gives an indication of results. Substituting the parameters of the tubes in the equations for gain-bandwidth:

$$g_m/(C_i + C_o) = 220 \times 10^6$$

$$\frac{|A|}{t_r} = \frac{g_m}{2.2\,(C_i + C_o)}$$

$$|A| = \frac{220 \times 10^6\, t_r}{2.2}$$

$$|A| = 10^8\, t_r$$

where $|A|$ = voltage gain, t_r = rise time, C_i = input capacitance, C_o = output capacitance, and g_m = transconductance.

If $t_r < 10 \times 10^{-9}$

$$|A| < 10^8 \times 10 \times 10^{-9}$$

$$|A| < 1$$

This indicates that the gain of the output stage may be near unity when operated in the switching mode. The drive of the output tubes must therefore be large, and the impedance due to the grid current and stray capacitance will be about 50 ohms, since

$$C = (4) \times C_i + \text{Stray}$$
$$\approx 100 \times 10^{-12}$$
$$e = (1/c) \int i\,dt$$
$$i = c\,\Delta e/\Delta t \text{ (approximation)}$$
$$\approx 100 \times 10^{-12} \times \frac{3 \times 10^3}{5 \times 10^{-9}}$$
$$\approx 60 \text{ amp} + \text{grid} \approx 65 \text{ amp}$$
$$Z \approx \frac{3 \times 10^3}{65} = 46 \text{ ohms}$$

Drive power is thus almost as great as output power, but drive waveshape is unimportant as long as the output tube remains in saturation. The line pulser satisfies this need. A coaxially mounted thyratron is capable of a risetime of less than 10 nanoseconds and will deliver the peak power.

One of the photographs shows a 3C45 coaxial mounting[4] developed at the Lawrence Radiation Laboratory. The mounting encloses the tube in copper and allows it to appear as part of the 50-ohm pulse-forming network. This coaxial switch improves risetime and eliminates ringing and waveshape distortion due to external leads and mismatches. The cathode load for the 3C45 lends itself to coaxial mounting and a pulse transformer is not required, since a positive pulse is obtained. Special precautions must be taken to protect the filament when the tube is operated this way, and isolation chokes were used to confine the signal to the inside of the coaxial housing.

Pulse width is controlled by varying the length of line in the plate of the 3C45. This is accomplished by a 50-ohm adjustable line. Pulse width difference due to change in drive is then corrected by this continuously variable line.

Wherever possible, no leads at all were used, and connections were made directly or with short buses. Capacitors are mounted directly on the plate caps of the 3D21's. The line pulser is triggered by another thyratron to give fast risetime. This first-stage thyratron has a triggering level of about 20 volts; the output stage can deliver three kilovolts into 50 ohms at pulse widths of 10 to 100 nanoseconds, with a rise time of 6 nanoseconds.

Using the recorded data, flux density B and magnetic intensity H were calculated for each point by

$$B = (ET/AN_p) \times 10^8$$
$$H = 0.4\,\pi\, N_e I / l_m$$

where B = flux density in gauss, E = induced voltage in pickup turn in volts, T = pulse length in seconds, A = core cross-sectional area in cm², N_p = number of pickup turns, H = magnetic intensity in oersteds, I = excitation winding current, peak or end value, in amp, l_m = mean path of core in cm, and N_e = number of excitation turns.

Values calculated from the formulas were plotted for each core tested. The graphs shown in Fig. 4 and 5, cannot be called B-H curves in the strict sense because resetting current is neglected. For each point on the graph, however, the change in flux and magnetic intensity is the optimum obtainable for a 30-nanosecond pulse.

No stacking factor was used for the tape-wound cores. The cross-sectional area was computed from the number of turns and the tape thickness. The insulating thickness or stacking factor on tape-wound cores varies for different manufacturers and should be considered when comparing like materials.

With tape-wound cores, the pulse μ improves with thinner laminations. Nevertheless, by taking stacking factors into consideration, the effective magnetic characteristics are maximum for ½ to ¼-mil tapes. The effective pulse μ then deteriorates for thinner laminations because the stacking factor becomes prohibitive.

A comparison of the better ferrites with the ½-mil and ¼-mil tape-wound cores shows that the effective pulse μ (with stacking factor) is about the same for both (approximately 500 to 600). Consequently, the only advantage of tape-wound cores at 30-nanosecond pulse width is higher saturation.

The data is not limited to 30-nanosecond pulse widths. The waveforms of current. Fig 2, show how excitation currents proceed in time, and this information can be utilized down to times that approach the rise time of the pulse. Furthermore, when the data is presented graphically, it is easy to extrapolate to slightly longer pulse widths. These factors expand the usefulness of the data to about 15 to 45 nanoseconds.

The limitations of the data do not lie in the testing method or in measurement errors, but in the tolerances of magnetic properties for a material. The data is useful, nevertheless, for designing fast-pulse, high-power magnetic devices, because it reflects operating conditions. Large accelerator cores for an 0.3-micro-second pulse width were designed within reasonable limits; work on the accelerator cores for a 30-nanosecond pulse width is proceeding. The excitation losses, pulse μ and current waveforms are valuable tools in the design of the magnetic devices.

Future work involves testing to 100-megawatt peak power, at 10 to 20-megacycles.

The author is indebted to Vernon L. Smith and Kris Aaland; the work was performed for the U. S. Atomic Energy Commission.

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(2) Gilbert A. Reeser, "Magnetic Core Tests Using A 30-Nanosecond Pulse", UCID-4188, Aug. 1960.
(3) V. J. Louden, Proposed Standards For Core Test Methods For Toroidal Magnetic Amplifier Cores, *AIEE Trans Paper No.* 58-71, Feb. 1958.
(4) U. S. Patent No. 2,776,368.

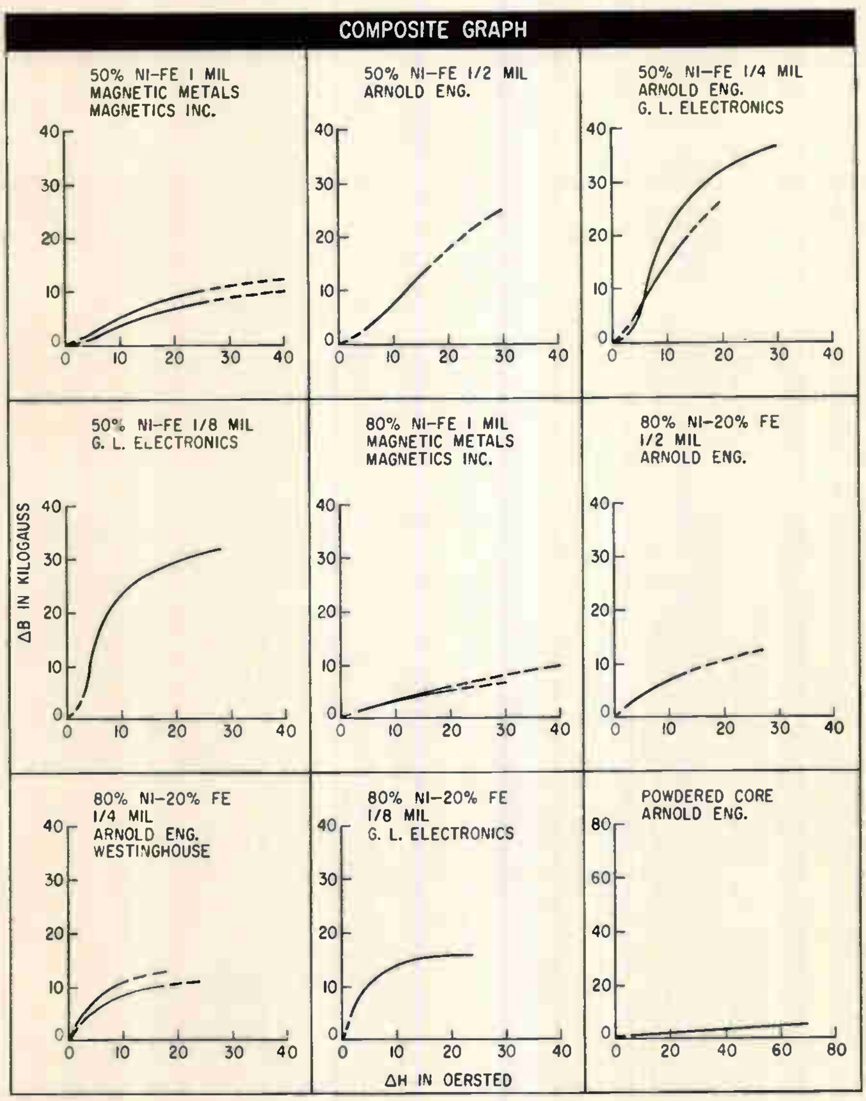

FIG. 4—Tape-wound core characteristics for 30-nsec pulses

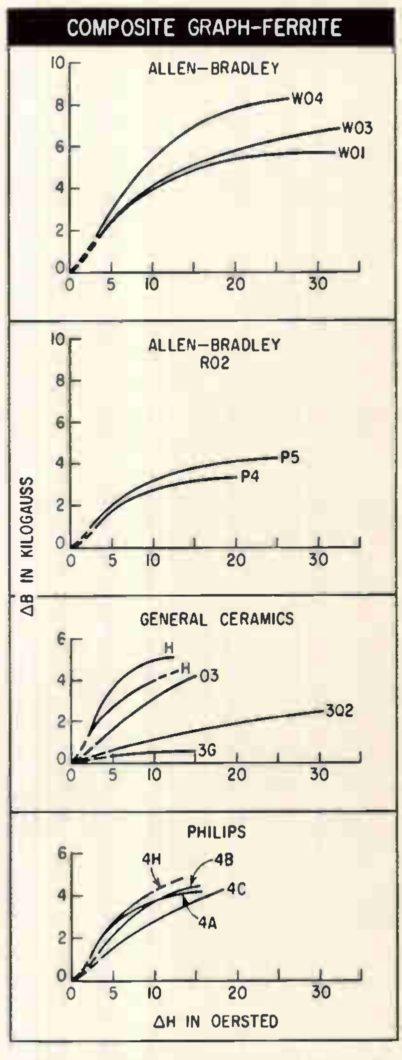

FIG. 5—Ferrite core characteristics for 30-nsec pulses. The better ferrites are generally as good as tape-wound cores

Detecting Transmission Errors

Test circuits at receiver compare a nine-bit block of transmitted data with an internally stored equivalent message. Polarity-detecting and correcting circuits compensate for phase ambiguity

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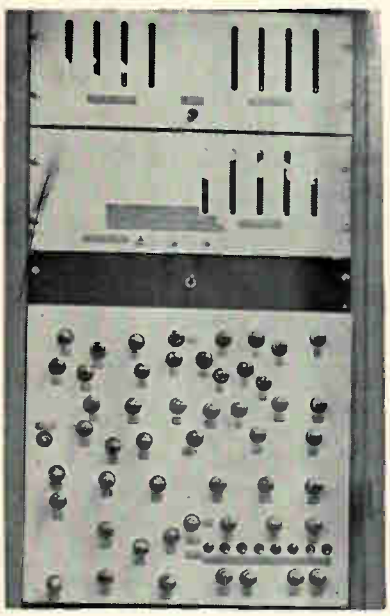
INCREASING USE of digital data transmission systems has led to new and better communications systems. To determine the quality of new equipment, field operating tests were developed. The procedure consists of transmitting a nine-bit test message, then comparing the received test message, bit by bit, with a replica of the message.

Inherent in the phase-locking of the reference oscillator of the synchronous detection receivers, used in the phase-shift keying systems tested, is an inability to distinguish between phase-lock at 0 deg and phase-lock at 180 deg. This results in a possibility of having the entire message inverted. The error detecting and polarity correcting unit detects a phase-lock at 180 deg and corrects the message inversion.

Figure 1 is a block diagram of the error detecting and polarity correcting equipment, showing how the major subunits are interconnected. The inputs to the equipment are: (1) the message to be checked; (2) bit-timing pulses in phase with the bits in the message to be checked; (3) bit-timing pulses halfway between consecutive in-phase bit-timing pulses; and (4) character-timing pulses.

The in-phase bit-timing pulses generate a local message identical to the test message. The character-timing pulse derived in the receiver from the received message makes certain that the local message is framed with the received signal so that the correct bits in the message are compared with each other. The in-phase bit-timing pulses sample the message from the receiver, and store it for one bit-period in a shift register. The out-of-phase bit-timing pulses then sample the bit in the shift register and the bit in the local message simultaneously, and compare them to determine if an error has been made. The first two bits of the message are compared in the MARK-SPACE decider and polarity corrector, while the remaining bits of the message are compared in the error detector. Only the first error in each character-framing period is counted by the message error counter, while all of the digit errors are counted by the digit error counter. The character-timing pulses are counted by the total message counter. The first counter to be filled interrupts the entire process, so that the counters may be read by the operator.

Into the pulse shaper (Fig. 2A) are fed the pulses shown in Figs. 2C, 2D and 2E. The character-timing pulses (Fig. 2C) occur every ninth bit pulse for synchronizing the start of the nine-bit message.



Main portion of error-detecting and polarity-correcting equipment

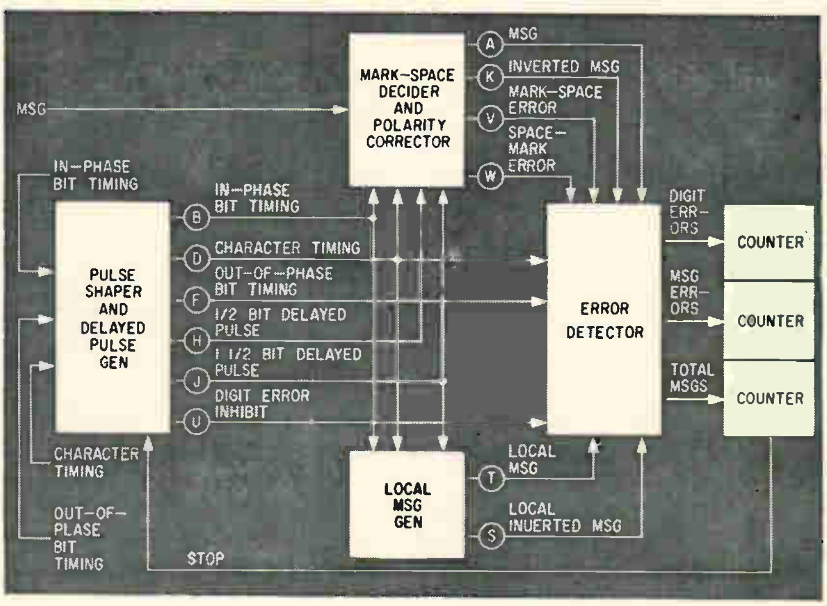


FIG. 1—Block diagram of error-detecting and polarity-correcting equipment shows interconnection of major subunits

In Phase-Shift-Keying Systems

All of these timing pulses are derived in the receiver from the message, so that they are bit-synchronous with the message. The in-phase bit-timing pulses (Fig. 2D) are so-named because they occur in phase with the peak of the raised cosine pulses in the message, as well as in phase with the character-timing pulses.

The start-stop flip-flop in Fig. 2A controls the gated blocking oscillators, so that tests may be manually started and automatically stopped. The automatic stop signal is furnished by one of the three counters: (1) the total message counter; (2) the total message error counter; or (3) the total digit error counter.

The first counter filled to capacity sends a stop pulse to the start-stop flip-flop, stopping the test run until it is manually restarted. In normal operation, the stop pulse is received from the total message counter. However, if the error rate is extremely high, it is possible that the message-error or bit-error counters will fill first, and this will also stop the test. Under normal conditions, the number of messages counted before the equipment is stopped can be varied.

The outputs of this portion of the equipment are: (1) reshaped timing pulses (Figs. 2I, 2J and 2K); (2) pulse delayed ½ bit-period after the character-timing pulse (Fig. 2F); (3) pulse delayed 1½ bit-periods after the character-timing pulse (Fig. 2G); and (4) pulse delayed 2 bit-periods after the character-timing pulse (Fig. 2H).

The pulse described in (2) is the command pulse for sampling bit 0 of the test message and storing its polarity in the first-bit storage bin (Fig. 4A). The pulse described in (3) is the command pulse for comparing the second bit of the test message with the sample of the first bit, and also is the command pulse that opens AND 1 to permit the in-phase bit-timing pulses to enter the local message generator.

The technique of generating the ½-bit, 1½-bit and 2-bit delayed pulses instead of generating pulses of fixed time corresponding to these

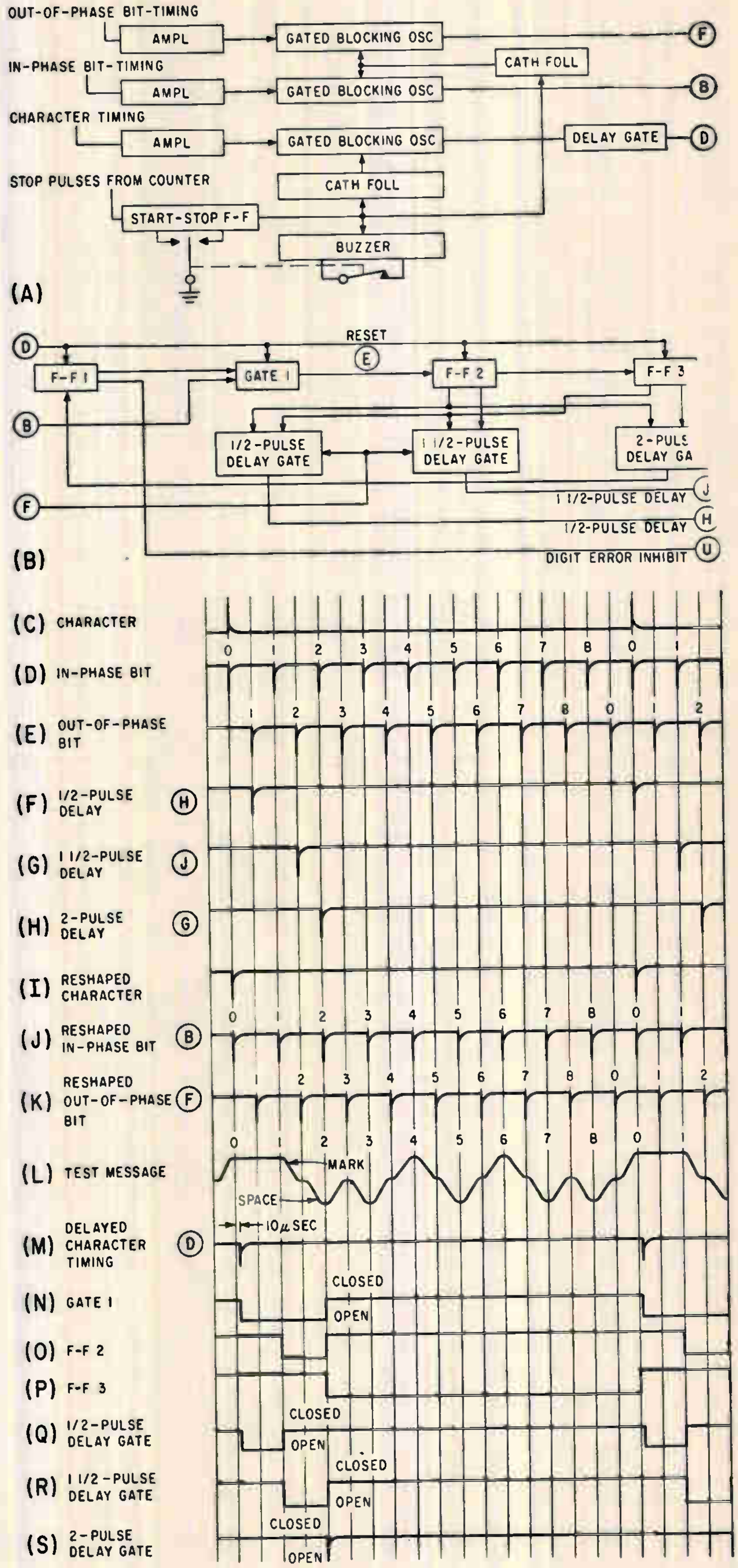


FIG. 2—Pulse shaper (A), delayed-pulse generator (B) and relevant waveforms (C through S)

delays at some fixed bit-rate, arose from a desire to operate at more than one bit-rate without making changes in the circuit. The method used in generating these pulses, was to gate out the specific pulses required from the out-of-phase bit train.

The following sequence of events takes place in the delayed-pulse generator (Fig. 2B). The delayed character-timing pulse (Fig. 2M) sets flip-flop 1 to ONE, opening gate 1 (Fig. 2N). It also resets flip-flops 2 (Fig. 2O) and 3 (Fig. 2P) to ZERO, opening the ½-pulse delay (AND) gate (Fig. 2Q). Since the ½-pulse delay gate is now open, pulse 1 of the out-of-phase bit-train will be gated out. Pulse 1 in the in-phase bit train (Fig. 2J) changes flip-flop 2 to ONE. This opens the 1½-pulse delay (AND) gate (Fig. 2R) and closes the ½-pulse delay gate. Since the 1½-pulse delay gate is now open, pulse 2 in the out-of-phase bit-train will be gated out. Pulse 2 in the in-phase bit-train (Fig. 2J) changes flip-flop 2 to ZERO, which in turn causes flip-flop 3 to change to ONE. This causes the 2-pulse delay gate (Fig. 2S) to send a pulse to flip-flop 1, changing it to ZERO, closing gate 1, preventing any further operation of flip-flops 2 and 3 and their AND gates.

Now the reason for delaying the character timing pulse can be seen. This delay was needed to make certain that pulse 0 of the in-phase bit train would never be the first pulse to operate flip-flop 2. The result of such a false operation would be to gate the ½-bit delayed pulse on to the 1½-bit delayed pulse on to the 1½-bit delayed-pulse line.

The local message generator (Fig. 3A) produces, at the receiver site, a message identical to that being sent by the transmitter. A typical test message is shown in Fig. 2L. A prior knowledge of which test message is to be sent is necessary so that the message-generator logic and set-up switches (Fig. 3A) S_1 through S_8 may be set for the message. Since the first two bits in the message are normally MARK, S_1 controls the first two bits of the test message. This unit generates both the test message and its inversion, and its inputs are reshaped in-phase bit-timing pulses (Fig. 3B), reshaped 1½-bit delayed pulse (Fig. 3D), and reshaped character-timing pulse (Fig. 3C).

The character-timing pulses operate counter-inhibit flip-flop 1 to close AND gate 1 (Figs. 3A and 3F). The 1½-bit delayed pulse turns on counter-inhibit flip-flop 1, closing AND gate 1. This stops the flow of in-phase bit-timing pulses (Fig. 3B) to the three-stage pulse counter. The pulse train (Fig. 3E) operates the counter to step it through its eight permutations. The counter, with the message-generating logic, will then select in sequence each of the eight message set-up switches, which are positioned to produce the same message as the transmitted message. When the switch is on, a MARK is generated in the pulse position associated with the switch. The MARK pulse is about −25 volts, while the SPACE pulse is about 0 volts.

The polarity-correcting circuits (Fig. 4A) sample the received signal at the peak of the received bit, and compare the first two bits of the message train to determine which of the four possible sequences of the first two pulses exist.

Based upon the results of the comparison: (1) If the two pulses are different (MARK-SPACE or SPACE-MARK) an error pulse is delivered to the output, and the reference phase is assumed to be the same as in the previous message; (2) If the two pulses are SPACE, the locked oscillator in the receiver is assumed to be locked 180 deg

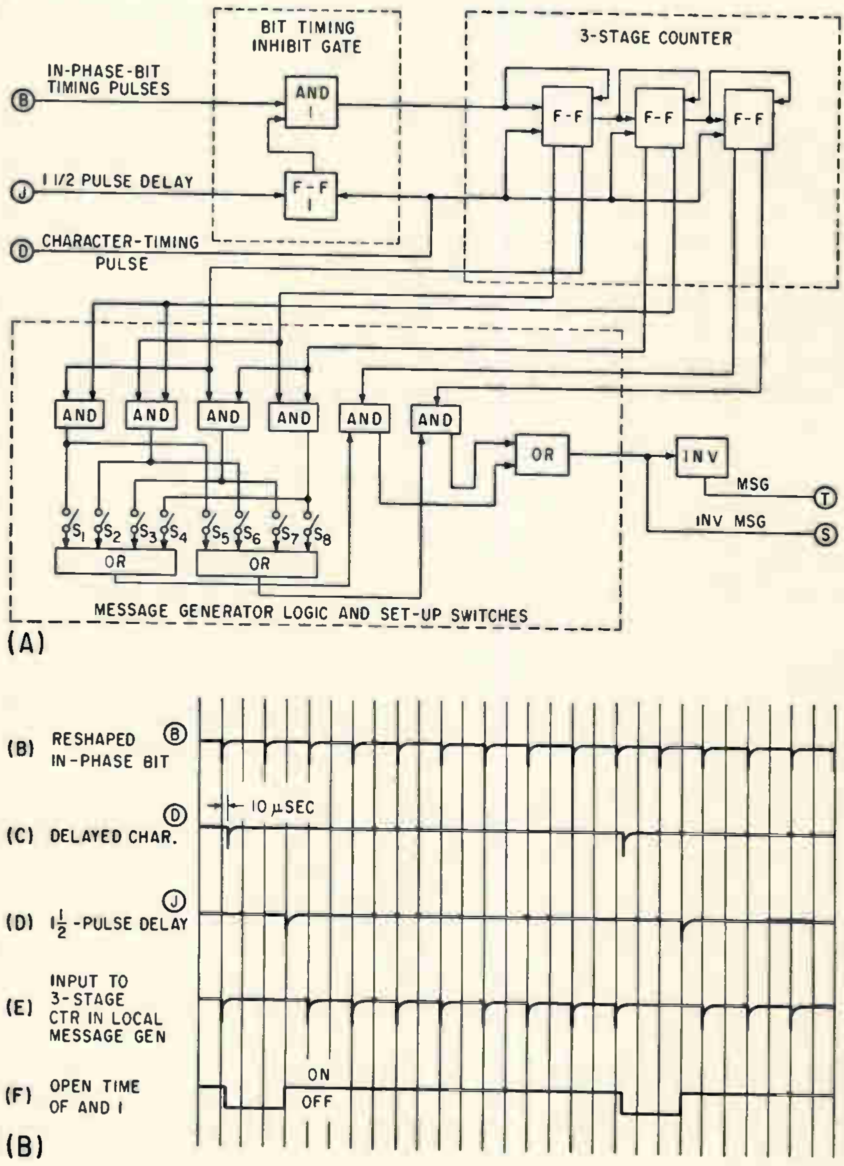


FIG. 3—Local message generator (A) and associated waveforms (B through F)

out-of-phase with respect to the transmitter carrier phase, so the message train is inverted.

The received signal is amplified by AMPL 1. The Schmitt trigger has a threshold of 0 volts so that any signal above 0 volts will be considered a MARK, and any below 0 volts, a SPACE. The in-phase bit pulses make the shift register sample the polarity of the signal in the Schmitt. This signal is then stored for one bit-period in the shift register, providing ample time for the sample to be compared with the stored replica of the transmitted signal. The ½-bit delayed pulse commands the first bit-comparer to determine the polarity of the first pulse coming from the shift register and to store this polarity in the first-bit storage bin. The 1½-bit delay pulse commands the second bit-comparer to compare the second bit from the shift register with the stored first bit. If these two pulses are SPACE, a pulse is sent to message-inverter flip-flop, changing its state to permit the opposite shift-pulse gate to operate during the incoming message sampling period, thus enabling message polarity to be inverted to the output. Since the first two pulses are transmitted to erase the phase ambiguity of the phase-locked oscillator, no decision as to correctness of the first pulse can be made until it is compared with the second pulse. Therefore, if the first two pulses are of different polarity, only one error is counted, and if the first two pulses are of the same polarity, no error is counted. This means that only eight errors per message are possible in the nine-bit message. Also, when the two samples are different, it is assumed that the local oscillator has not changed its phase, so the message output is not inverted.

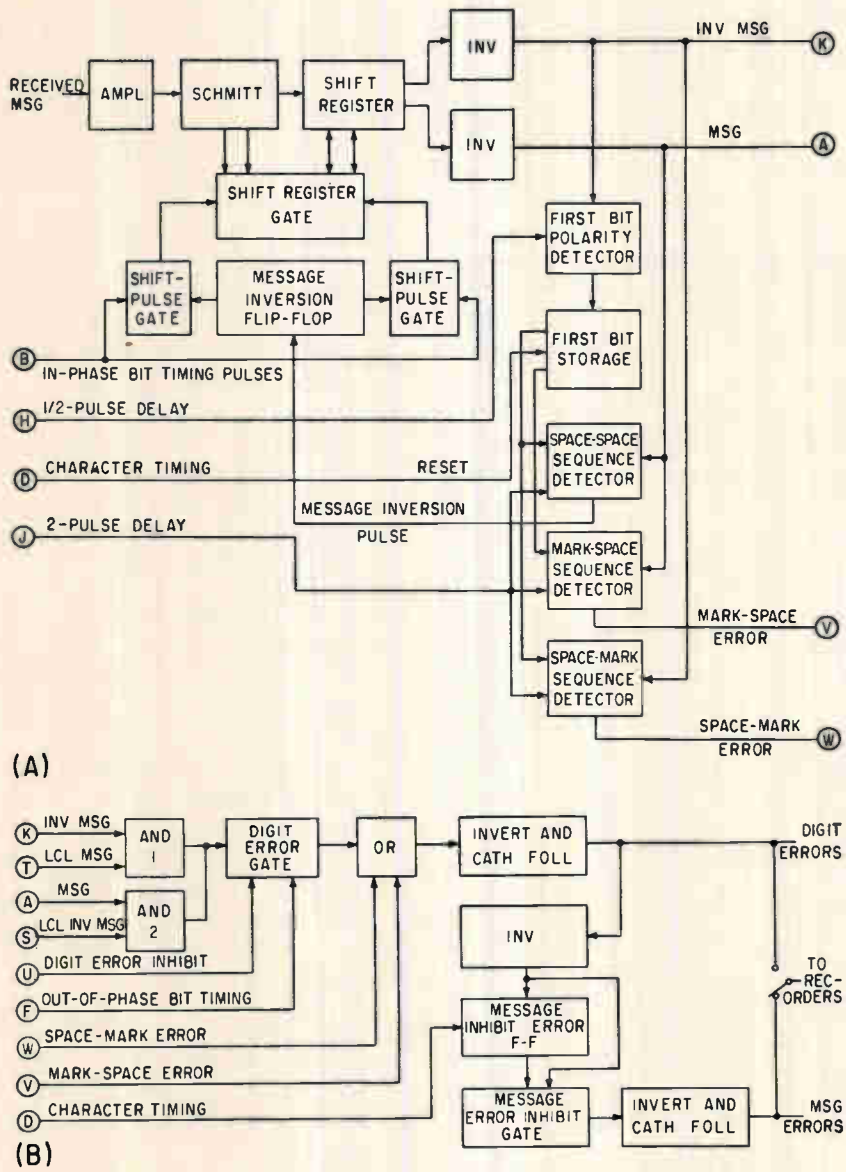


*FIG. 4—*MARK-SPACE *decider and polarity corrector (A); and error detector (B) where received signal is compared with locally generated message*

The error-detecting portion of the equipment (Fig. 4B) compares the processed received signal from the shift register of Fig. 4A with the message coming from the local message generator. Since the first two bits have already been processed, the control signal on *U* permits examining only the remaining seven bits. Because AND gates 1 and 2, which compare the received message with the local message, provide an output only when both halves of the tubes have negative grid voltages, it is necessary also to have available the inversion of both the local message and received massage. The local message is then compared with the inverted received message in AND 1, and the local inverted message is compared with the received message in AND 2. A MARK error is detected in AND 1, and a SPACE error is detected in AND 2. The digit-error AND gate samples the output of the MARK and SPACE error detectors. Digit errors are amplified and inverted so the positive polarity pulses required by the counters are delivered to the digit-error counter. The digit-error output is then inverted and fed to the message-error-inhibit flip-flop, which controls the message-error-inhibit AND gate. The first digit error in a message operates the message-error-inhibit gate, so that only one error per message will be counted by the message-error counter. This gate is reset by the character-timing pulse on *D*, at the start of the next message.

Berkeley decimal counting units count the number of messages received, the number of message errors, and the number of digit errors. Circuits added to these counters inhibit the pulse trains sent to them from the error-checking equipment when the total messages received reaches a predetermined level, or either the message-error or digit-error counter is filled.

The authors acknowledge the assistance of D. C. Bowman, F. Pfisterer and J. A. Harrington.

Simple Transistor Tester Uses Lamp For Indicator

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THIS transistor tester was designed to indicate, in one simple operation, whether a device had experienced a catastrophic failure, and if not, whether it could provide a minimum gain of $\beta = 20$ at 30 ma. Present equipment for performing such tests is expensive and not widely available. Multimeters, which are often used have internal voltages that exceed the specified safe reverse potentials. Furthermore, few of the available methods of analysis fulfill the requirements of a rapid single-operation test. Many have complex controls, while the multimeter method of testing often requires more than two hands to connect leads to the device under test.

The test circuit is an inverter with an emitter degeneration resistor, R_1. Degeneration provides control of collector current during the warm-up of the indicator lamp, during which time excess collector current would flow because the lamp has a low resistance.

When the switch is in its unoperated position, as shown, the transistor base is short-circuited to the emitter. A transistor operated under short-circuited base-emitter conditions conducts 2 I_{co}. At this low leakage current, the indicator lamp will not light for a properly operating transistor. If the collector-base junction is short-circuited, however, a direct path exists from the battery through the 20-ohm resistor and the short-circuited collector-base junction; the indicator glows brightly. Assuming the collector-base junction is good, moving the switch to its other position, resistor R_2 conducts 1.5 ma because it is clamped by D_1 to slightly above ground. As long as the base current does not exceed 1.5 ma, the base remains clamped slightly above ground. The emitter and upper end of R_1 will also be clamped, by base-emitter drop, near ground. Since the lower end of R_1 is returned to a fixed voltage (−3 v), the voltage across emitter resistor R_1 is therefore fixed at 3 v. Under these conditions, a fixed emitter and collector current of 30 ma will flow.

Since the collector current is regulated by the emitter circuit and is unaffected by voltage variations due to the low initial resistance of the indicator lamp, no damaging collector currents will occur.

The indicator lamp has an illumination threshold of 25 ma at 2 v. As the common-emitter gain of the device increases, the base current will increase, and eventually, when a low gain is encountered, its base current will cause D_1 to become reverse-biased through R_2. This in turn causes the base and the emitter voltage to become negative, decreasing the emitter and collector currents below the indicator threshold to indicate a low-gain device.

If the base-emitter junction is short-circuited, no collector current flows, and the indicator will therefore remain unlit.

Diodes can be tested, at 30 ma, by placing them between the collector and emitter terminals of the transistor socket. They should light the indicator for only one diode direction. This tester, when fitted with an adapter probe, permits testing transistors while in a circuit, because of the extremely low impedances in the test circuit.

This is not a dynamic test, and the tester will not indicate junction failures that might occur above 3 v. Also, since no reverse base-emitter bias is applied to turn off the device under test, no reverse base-emitter failures can be detected. Although these disadvantages may appear serious in theory, practical testing for three months has not allowed a catastrophic failure to pass unnoticed.

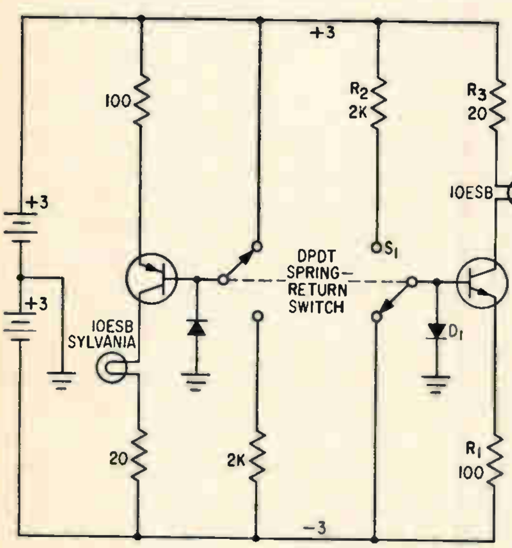


Diagram of complete tester for both pnp and npn transistors. The text discussion is based on the npn test circuit at right

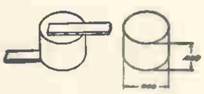
TABLE OF TEST CONDITIONS

Test Switch Activated	Light	Transistor
No	Unlit	Normal condition
No	Bright	Shorted C-B junction
No	Dim	Punch through C-E
Yes	Dim	Normal condition
Yes	Unlit	(a) Shorted B-E junction (b) Burned-out leads (c) h_{fe} (β) less than 20

WHEN THE HEAT'S ON DEPEND ON THESE CTS CERMET RESISTORS

with Space Age 500° C High Stability Metal-Ceramic Element

CTS cermet resistors have exceptionally high stability and reliability . . . tested extensively and proven under extreme environmental conditions . . . achieved by a unique, rugged, hard-surfaced metal-ceramic element processed at over 600°C. Specially adaptable to miniaturization because of high load and heat capabilities in small areas. Wide resistance range.



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Kit of 8 different resistance values available at nominal cost.

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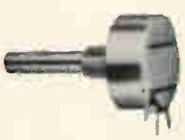


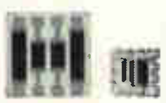
CeraTrolS®

Series 400

3 Watt 1¾" dia. Semi-Precision Military Variable Resistor

- Interchangeable with Style RV4 MIL-R-94 but far exceeds temperature and stability requirements.
- Available with 1%, 2% or 3% linearity.
- Power ratings: 3 watts at 85°C, 2 watts at 125°C, derated linearly to zero load at 175°C.

Request Data Sheet 179 for technical specs.



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- 5 to 300,000 ohms resistance per square. Resistance of 10 ohms to 1 megohm available in short straight paths without resorting to lattice or grid patterns.
- Unaffected by solvents, potting compounds or corrosive atmosphere.
- Resistant to nuclear radiation and high vacuum conditions.

Kit of 10 different resistance values—10 wafers with 2 identical resistors per wafer—available at nominal cost.

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1½ Watt ¾" dia. Semi-Precision Military Variable Resistor

- Interchangeable with Style RV5 MIL-R-94 but far exceeds temperature and stability requirements.
- Available with 1%, 2% or 3% linearity.
- Power ratings: 1½ watts at 85°C, 1 watt at 125°C, derated linearly to zero load at 175°C.

Request Data Sheet 180 for technical specs.

CERATRIM

Series 170

42-Turn 150°C Square Trimmer Resistor

- Available with wire leads or p.c. pins out bottom or side.
- Power Rating: 1 watt at 50°C derated linearly to zero load at 150°C.

Request Data Sheet 178 for technical specs.

CeraTrolS

Series 600

¾ Watt ½" dia. Military Variable Resistor

- Interchangeable with Style RV6 MIL-R-94B but far exceeds temperature and stability requirements.
- Power ratings: ¾ watt at 85°C, ½ watt at 125°C, derated linearly to zero load at 175°C.

Request Data Sheet 175 for technical specs.

CERATRIM

Series 180

25-Turn 200°C Rectangular Trimmer Resistor

- Available with p.c. pins or wire leads.
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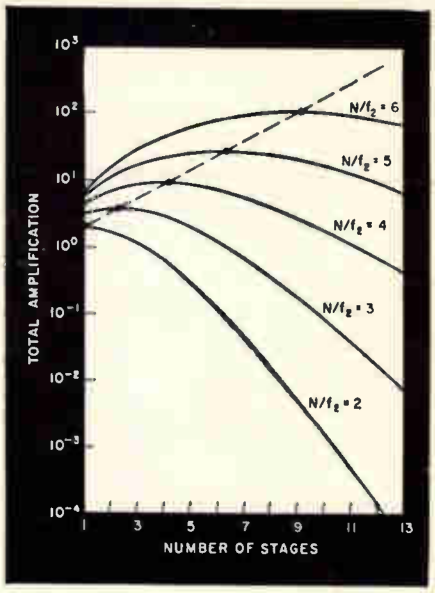
Calculating Pentode Stages for Given Bandwidth



By ANGEL M. R. FERRARI,*
Instruments and Control Div., Oak Ridge National Laboratory**, Oak Ridge, Tenn.

IN AN AMPLIFIER with a fixed bandwidth and cascaded pentode amplifier stages, a critical number of stages will give highest gain. This critical number, n_o, depends on the ratio of the gain-bandwidth product[1] of the individual stage to the desired bandwidth of the complete amplifier. For the desired bandwidth, there is also a maximum possible overall gain, A_{total}.

This analysis assumes that the amplifier consists of n identical stages, each with a plate load impedance consisting of a pure resistance shunted by a pure capacitance. The results are valid also for feedback amplifiers or for wide-band tuned amplifiers.

Mid-frequency amplification of a pentode with a load resistance small compared with the plate resistance is

$$A = -g_m R_b \qquad (1)$$

where A = amplification factor of one stage, g_m = transconductance in ma per volt, and R_b = load resistance in kilohms.

For an n-stage amplifier, Elmore and Sands[2] show that

$$R_b = \frac{1}{2\pi f_2 C} \sqrt{2^{1/n} - 1} \qquad (2)$$

where f_2 = upper cutoff frequency in cps of the complete amplifier, C = sum of the tube input and output capacitance in farads, and n = number of stages.

By combining Eq. 1 and 2

$$A = \frac{-g_m}{2\pi C} (1/f_2) \sqrt{2^{1/n} - 1} \qquad (3)$$

The factor $g_m/2\pi C$ is the figure of merit of the tube and is defined as N. (The figure of merit so defined is a constant of the tube. In a practical circuit, C includes parasitic capacitance; therefore, the circuit effective figure of merit will be lower.)

Equation 3 may be rewritten

$$A = (-N/f_2) \sqrt{2^{1/n} - 1} \qquad (4)$$

Amplification of n stages is

$$A_{total} = A^n = (-N/f_2)^n (2^{1/n} - 1)^{n/2} \qquad (5)$$

NUMBER OF STAGES FOR HIGHEST GAIN

N/f_2	Max Useful Number of Stages (n_o)	Max Possible Amplification
1	1	1
2	1	2
3	2	3.5
4	4	9.17
5	6	28.5
6	9	115
7	12	600
8	16	4.1×10^3
9	21	3.6×10^4
10	25	4.0×10^5

If N/f_2 is used as a parameter, A_{total} can be plotted as a function of n to yield the graph. For every value of N/f_2, there is a maximum value for n. These critical values (n_o) are listed in the table along with the maximum possible amplification. The curve corresponding to $N/f_2 = 1$ is omitted. It has no practical use since the maximum useful number of stages corresponds to n less than unity. Values of n_o in the table are the closest integers to calculated values. Maxima points on the curves were calculated with a digital computer.

As an example, consider a 6AK5 for which $N = 1.17 \times 10^8$ cps, and $f_2 = 2 \times 10^7$ cps. From the data, $N/f_2 = 5.85 \cong 6$. From the table, the critical number of stages is 9 and the maximum possible amplification is 100. If an amplification of more than 100 is required over a bandwidth of 20 Mc, a tube with a higher figure of merit than the 6AK5 must be used, or an inductively compensated interstage coupling network must be used[3], or the tubes must be connected as a distributed amplifier.[4]

*On leave from Instituto de Física de San Carlos de Bariloche, Argentina.
**Operated for the U. S. Atomic Energy Commission by Union Carbide Corp.

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(1) F. E. Terman, "Radio Engineering", 1947, pp. 266, 357.
(2) W. C. Elmore and M. Sands, "Electronics", 1949, p. 141.
(3) F. E. Terman, op. cit., p. 251. W. C. Elmore and M. Sands, op. cit., p. 140.
(4) E. L. Ginzton, W. R. Hewlett, J. H. Jasberg and J. D. Noe, Distributed Amplification, *Proc IRE*, 1948, 36, p. 956.

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NEW MOTOROLA FLANGELESS RECTIFIER WITH STUD-LIKE RATING

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Motorola's new 1N3189 flangeless series consists of three silicon rectifiers, each capable of carrying 1 AMP at 100°C. Available in voltages of 200, 400, and 600 PIV, these quality units offer superior stability, and can be employed in military designs where commercially available MIL-STD-701B "Guidance" types are acceptable.

Especially suited for printed circuit applications, these new flangeless rectifiers do not require heat-sinks and are easier and more economical to install than the bulkier studs. Yet, they operate in the stud-like 1 AMP region instead of the milliamp region usually associated with such subminiature axial-lead devices.

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MAXIMUM RATINGS	TYPE NO.	RATING	UNITS
Peak Inverse Voltage — PIV DC or Recurrent	1N3189 1N3190 1N3191	200 400 600	volts volts volts
Average Half-Wave Rectified Forward Current @ 100°C Ambient Temp.	All Types	1.0	Amps
ELECTRICAL CHARACTERISTICS ALL TYPES	**AMBIENT TEMPERATURE 25°C**	**150°C**	**UNITS**
Maximum forward voltage drop at 750 mA continuous DC.	1.0	—	volts
Maximum forward voltage drop, full cycle average at maximum rated current & voltage	—	0.5	volts
Maximum reverse current at maximum rated DC voltage	0.005	0.500	mA
Maximum full cycle average reverse current at maximum rated voltage & current as half-wave rectifier with resistive load	—	0.3	mA
Operating & Storage Temperature Range	−65°C to +175°C		

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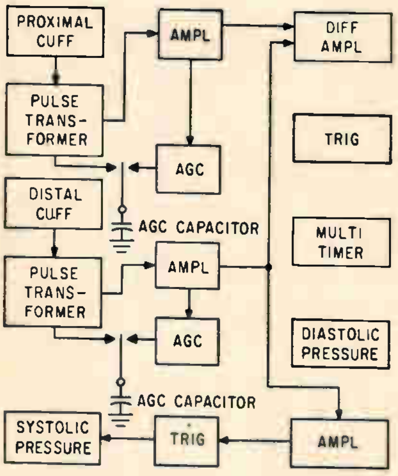
Circuits Improve Blood Pressure Tests



Simplified block diagram shows method for measuring diastolic end-point

DIFFERENCE amplifier and sampling-type agc circuit enable an automatic instrument for measuring blood pressure to sense diastolic end-point. The instrument, presently undergoing evaluation in a hospital, was described at the 1961 International Conference on Medical Electronics in a paper by T. I. Marx and B. R. Baldwin, Midwest Research Institute. The project was supported by the Holland and Davis partnership.

The instrument is a modified sphygmomanometer, which measures diastolic and systolic pressures. The method for sensing systolic pressure is conventional; the innovation is for sensing diastolic end-point.

Each cuff of a double cuff assembly applied to the arm of the subject provides a pulse waveform to the difference amplifier in the figure. The two arm cuffs are slowly inflated at the same rate. At cuff pressures below diastolic, output from the difference amplifier is low because the waveform from the distal or downstream cuff is nearly identical to the waveform from the proximal or upstream cuff.

Above diastolic pressure, a slight lag in phase appears in the ascending wave from the distal cuff. The phase lag causes a spike in the difference amplifier output concurrently with the ascending wave of the cardiac cycle. The spike indicates diastolic pressure.

To compare the two waveforms, amplitude must be approximately equal. If the distal cuff is slightly smaller than the proximal cuff, the two amplitudes are nearly equal for most subjects. To ensure that results are reliable for all subjects, but at the same time not require manual adjustments of gain, an agc system was required. Conventional feedback circuits proved unsatisfactory so a sampling arrangement was used.

As the cuff assembly is being inflated to 30 mm Hg, pulse amplitude from each cuff is being measured and the two agc capacitors in the figure are being charged. When pressure reaches 30 mm Hg, measurement is stopped and the voltage on each capacitor is applied to the associated amplifier through a long time constant circuit to control gain. Thus when pressure exceeds 30 mm Hg, the pulse amplitudes are equalized.

Movement of the cuff tube or the arm of the subject might introduce artifacts causing false trigger signals to be produced during the period of diastolic sensing. A multivibrator timer circuit was incorporated after the diastolic trigger circuit to overcome this problem. Diastolic pressure cannot be registered unless two triggers are produced not more than 1¼ seconds apart.

A conventional systolic sensing system is also incorporated in the automatic sphygmomanometer. As the cuff assembly is inflated, the onset of repeated spikes from the difference amplifier results in a diastolic manometer being locked at the pressure being indicated. The cuffs are then inflated rapidly above systolic pressure, after which they are slowly deflated until pulses appear from the distal cuff. The systolic dial is locked and pressure in the cuffs is rapidly reduced. To make this test, no adjustments are required for different subjects.

Initial evaluation of the sphygmomanometer was made using twenty-five subjects at Midwest Research Institute. Conventional auscultatory determinations were used for comparison. The average error in diastolic pressure measurements was 4.5 mm Hg, maximum error was 11 mm Hg and repeatability was 3 mm Hg. Although these results indicate high accuracy and repeatability, the ranges of age, body builds and pressures were small. The instrument is undergoing further evaluation at a hospital where both diastolic and systolic measurements are being made over wide ranges of pressure, pulse magnitudes and pulse shapes.

Recorder Aids Analysis of High-Speed Transients

TRANSIENT analysis recording equipment called TARE facilitates detailed studies of high-speed transient phenomena. A special dual-beam oscilloscope and a high-speed shutterless camera enable the system to record complex video signals on photographic film.

The equipment was originally developed as a pulse recorder by General Dynamics/Electronics for Rome Air Development Center. It is now being made available for other military and commercial applications.

Bandwidth of the eqipment is from 3 cps to 22 Mc. Because of the rapid phosphor rise and decay times, as well as trace intensity of the crt, sweep speeds up to 0.5 μsec/cm can be used at repetition rates to 200 Kc. These sweep speeds permit recording of pulses only 0.1 μsec wide with rise times up to 19 nanosec. Dual interlaced horizontal sweeps with time overlap between successive sweeps ensures a continuous time base so that no video signal information is lost.

Coded information is automatically added on data tracks along the edges of the film that signifies real time of day, sweep rate, vertical

sensitivity and video input selector position. By providing this information, the need for supplementary log sheets is eliminated. Accurately placed Z-axis time markers and standard amplitude marker pulses are also provided for presentation on the horizontal sweeps.

The 16-mm film used in the recording camera is commercially available in lengths of 50 to 400 ft. Camera running time and film speed are controlled from an operator position, from which the camera can also be loaded and unloaded. Any one of four input signals can be selected for recording.

Oscillator Frequency Is Changed by Plug-In Units

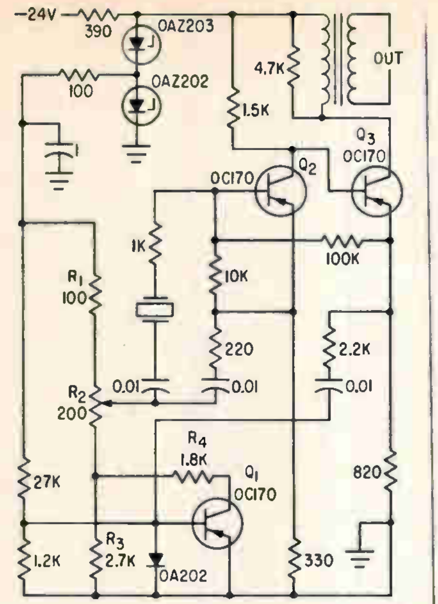
By R. COUVELA,
Telephone &
Electrical Industries Pty. Ltd.,
Australia

CRYSTAL oscillator operates at frequencies throughout a range from 8 to 170 Kc by changing plug-in units containing only two components. The oscillator can be produced in quantity with the plug-in unit comprised of the crystal and one capacitor inserted later for the particular operating frequency required.

Applications of the stable oscillator include use in multiple-channel telephone systems in which a crystal oscillator is required for each channel. They can also be used where the stability of a crystal-controlled oscillator is required for operation at more than one frequency. In this case, a switch can select the crystal and capacitor for each operating frequency.

The oscillator in Fig. 1 derives its stability from squaring transistor Q_1, which feeds the crystal. Transistor Q_1 switches the d-c voltage at the junction of R_2 and R_3 between two levels. When Q_1 is off, voltage at the junction is determined by the voltage divider comprised of R_1, R_2 and R_3. The effect of transistor leakage current is negligible.

When transistor Q_1 is saturated, R_3 is shunted by R_4 and the low resistance of the conducting transistor. Because of this low resistance, the square wave at the junction of R_3 and R_4 is not significantly affected by characteristics of the



Oscillator frequency can be changed by replacing crystal and one capacitor in feedback loop

switching transistor. To prevent supply voltage from affecting the square wave, zener diode regulation is used.

Voltage at the base of amplifying transistor Q_2 is the square wave with the sine wave from the crystal superimposed on it. However the square wave is also fed to the emitter of Q_2 so that it is effectively canceled and only the sine wave appears at the collector. The two different impedances for the two inputs to Q_2 are provided by the series input resistors.

In the two-stage d-c coupled amplifier, temperature-compensating d-c negative feedback biases the first stage. In addition to useable amplifier output, a second output of low impedance provides feedback to the switching transistor. A silicon diode is included in the feedback path in addition to an attenuating resistor and a phase-advancing capacitor. The diode prevents a charge from building up at the base of Q_1 and limits base potential during positive half cycles.

To limit relative phase shift over the wide range of operating frequencies, drift transistors are used with a very high cut-off frequency relative to operating frequency. Also some advance in phase is provided by the capacitor in the feedback loop to compensate phase lag in the amplifier. For this reason, the capacitor must be changed when operating frequency.

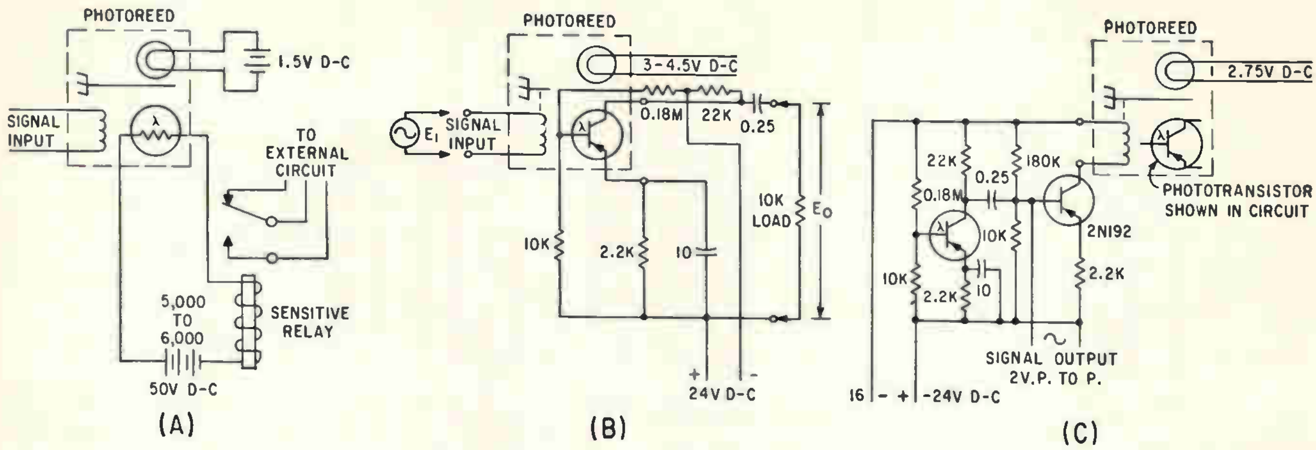


FIG. 1—Basic circuit of contactless switching combines resonant reed relay and photosensor (A). Photoreed concept can be used in a filter function circuit (B), or in a transistorized oscillator (C) for remote control, telemetry, and logic functions

Frequency-Sensitive Control Uses Light

FROM THE WESCON forum last month, F. H. Inderwiesen of Midwest Research Institute introduced a design for a resonant reed relay that requires no contacts on the reed. This is a frequency-sensitive control in which the switching function of the contacts is accomplished by electro-optical techniques[1].

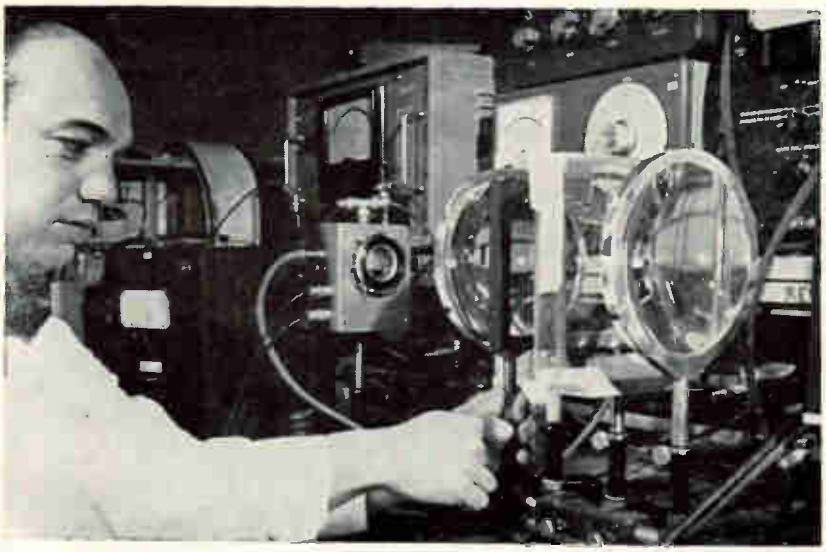
The principle of operation evolves from combining resonant reed and photo-electric principles. The action of light on a suitable photosensor is used to regulate the current through the photosensor and its load circuit. The photosensor is exposed to the light when the reed, acting as a shutter, vibrates. This principle can be used for switching, filtering, and frequency generation.

Conventional resonant reed and tuning fork resonators have excellent selectivity and are rugged and reliable, are inexpensive, and will find more and more applications in the audio frequency range. In the conventional resonant reed relay, the reed vibrates and a current flows between the contacts when they touch.

Now, engineers seek to better the contact dwell time to attain higher power through the contacts, improve tuning error, obtain closer spacing of operating frequencies, extend the useful frequency range, improve sensitivity, avoid r-f interference problems for nearby devices, and eliminate arcing, pitting and sticking of contacts.

Midwest Research Institute engineers answer to these problems is to use a photoactuator consisting of a light source, a photosensitive element, and let the reed act as a shutter. Experimental models using this principle demonstrate that all the functions of the resonant reed can be obtained without use of contacts. Substitution of different

Organic Crystals and Their Mobilities



In apparatus above, David Kahn of Martin in Baltimore, focuses a beam of light on an organic crystal and plots mobility figures of the charge carriers. Significance: to determine what promise is held by inexpensive organics for components.

The light beam produces a marked increase in electrical conductivity providing the crystal contains a defect known as a color center. Kahn will calculate the mobility of the polaron: an electron with its associated polarized ions. Thus the Martin Company hopes to establish basic electronic concepts involved in the behavior of organic semiconductors

length reeds shows a frequency range from 100 to 1,200 cps.

The final choice of lamp and photosensor combinations depends upon several factors. The photosensor is selected first, on the basis of the function to be performed. For example, relay switching requires a photosensor with a large sensitive area and a long time constant. By contrast, an oscillator or a filter requires a small sensing area and a fast response. Therefore, two electro-optical systems were designed for use with a basic reed driving unit.

No lens is required for the optical system. Two types of operation are possible depending upon the position of the reed as a shutter in the light path. An optical system can be designed for direct control of the relay, or for filter and oscillator.

The basic circuit used for power switching using a sensitive relay controlled directly by the JBT-Photoreed is shown in Fig. 1A. The lamp chosen is supplied with a source of d-c voltage. The photoconductive cell is connected in series with a 10 mw d-c relay and d-c voltage source. The signal input power to drive the reed coil is about 0.5 milliwatts. This represents a signal power gain of 20. The relay in turn can handle currents up to several amperes through an external load. For completely contactless switching, a hydrogen thyratron such as the 2D21 or a power transistor can be used in place of the d-c relay.

The unit with a phototransistor has an electrical output that varies linearly with the input signal at the resonant frequency of the reed, and can function as a bandpass filter. The complete circuit with a 10 K resistive load is given in Fig. 1B.

The filter unit was placed in the regenerative feedback path of a vacuum tube amplifier to obtain an oscillator. The circuit was self starting and gave a good sine-wave output at the frequency of the reed. The sharp phase change about the resonant reed frequency indicated that the tight frequency of the oscillator frequency was insured. A transistor oscillator circuit was developed, Fig. 1C, that requires only one transistor external to the unit.

The transistor oscillator and a Photoreed switching unit can be operated to give a tone-operated remote control. Several of these remote control combinations can share a single pair of wires or a radio link to transmit the tones.

There are several performance advantages of these circuits. Since the shutter is open nearly 90 percent of each cycle, this long dwell time combines with the smooth action of the photoconductor and permits operation of the auxiliary relay without a capacitor and eliminates induced noise.

Reeds within the range of 100 to 1,200 cps can be tuned with an error of approximately 0.05 percent. Tuning of the reed is facilitated by using the electrical output of the photosensor. Bandwidths of 0.1 to 0.2 percent of the resonant frequency are possible for filters, because full Q of the reed can be used.

The effective bandwidth of a Photoreed used for control functions can be electrically varied. This can be done by controlling the sensitivity of the photoconductor by changing the applied voltage.

The threshold of sensitivity of the Photoreed is under 200 microwatts when used for direct relay control operations. The filter circuit functions with an input signal of only 18 microwatts.

The single, nearly symmetrical frequency response of the Photoreed permits closer spacing of operating frequencies and more channels per spectrum, and there is no noise due to contacts.

Special Photoreeds could be developed to perform AND, OR and NOR functions. The Photoreed concept has been applied for the improvement of other frequency sensitive devices such as tuning forks and torsion resonators. A miniature torsion resonator using solid bearings has operated as high as 280 cps.

The fields of remote control, telemetry, computers and many others should benefit from control with the speed of light.

This project was sponsored by the JBT Instruments. Inc., of New Haven, who are now starting production on these units, and they are ready to supply prototypes.

REFERENCE

(1) F. H. Inderwiesen, The Photoreed—A New Versatile Frequency-Sensitive Control Element, Midwest Research Institute, Kansas City, Missouri, paper given at WESCON, San Francisco, Aug. 22, 1961.

School for Solderers, Old and New

By STEPHEN W. MAHON
Westinghouse Electric Corp.
Pittsburgh, Pa.

FORMAL TRAINING in wiring and soldering techniques—for experienced as well as inexperienced employees—more than pays for itself. A training program established here has substantially reduced defective work, has helped standardize techniques and has heightened employee awareness of the need for high-quality, high-reliability work (this division is primarily a military contractor). Inspection and rework expenses are correspondingly decreased.

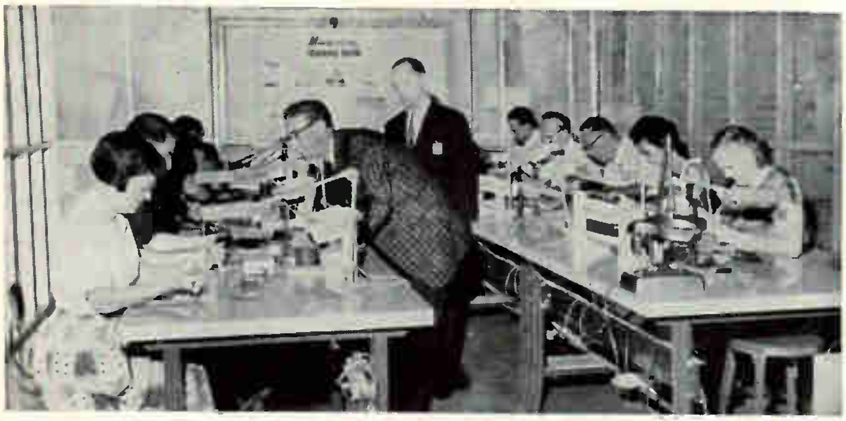
Studies show that on-the-job soldering training at work stations is a poor substitute for formal training. Bad habits are passed on to new employees, supervisors cannot spare time for training, and foremen have varying preferences for tools and techniques. Furthermore, on-the-job training—especially if novices are working on production assemblies—can result in poor quality, doubtful reliability, excessive rework, and maltreatment of tools and equipment. Three major objectives of the school were established early: to certify experienced assemblers in accordance with prescribed and uniform specifications; to certify employees of a lower labor grade for promotion; to train supervisors, inspectors and manufacturing engineers in the same specifications.

The classroom is located in the plant, and closely duplicates the working environment. A senior production operator with a record of high-quality work, capable of teaching and commanding respect is the instructor. Trainees attend classes in groups of twelve, and the training cycle is not interrupted. Emphasis is placed on terminal-style soldering since there is little hand soldering of printed wiring boards in this plant.

The training schedule, outlined in the table, includes two introductory sessions. These explain the program, emphasize need for product reliability, stress the value of individual contributions and foster a sense of craftsmanship. Instruction becomes meaningful and trainees understand the value of correct techniques and specifications.

The final test is designed to encourage employees to strive for perfection first, then speed. Tests are graded by one demerit for each faulty connection (voids in solder flow, cold solder, excessive solder or globules of solder, excessive rosin or dirty connections), and demerits for loose or broken strands, damaged insulation and lack of component stress relief. Seven demerits out of a possible 29 means failure of the test. Trainees who have passed average less than four demerits, with men performing slightly better than women.

In the first eight months, 292 operators and 35 inspectors, supervisors and engineers took the course. Of the 292 operators, 241 were experienced in wiring and



Twelve employees learn correct wiring and soldering techniques. Inexperienced operators receive 40 hours of instruction, experienced operators receive 19 hours

SOLDERING COURSE PROGRAM

I. Introduction to Program (by Training Department Representative) (0.5 hr.).

II. Film Presentation—Lecture, film "The Art of Soft Soldering", review of film noting highlights, Instructions on acquiring tools. (0.5 hr.)

III. Orientation and Indoctrination (by Instructor)—Training school rules, good housekeeping and safety, new tools, soldering irons, techniques of holding tools and performing various operations. (Experienced operators: 2 hr.; others: 4 hr.)

IV. Shop Practice

A) Resistor and Jumper Boards—Wire and component preparation, wire and component wrap, soldering of resistor, jumper wire boards, sequence sheets. (Exp.: 4 hr.; inexp.: 10 hr.)

B) Plugs—wire and plug preparation, wire wrap, soldering plugs. (Exp.: 3 hr.; inexp.: 7 hr.)

C) Tube Sockets—wire preparation, cabling and tying, wire wrap, soldering. (Exp.: 2.5 hr.; inexp.: 5 hr.)

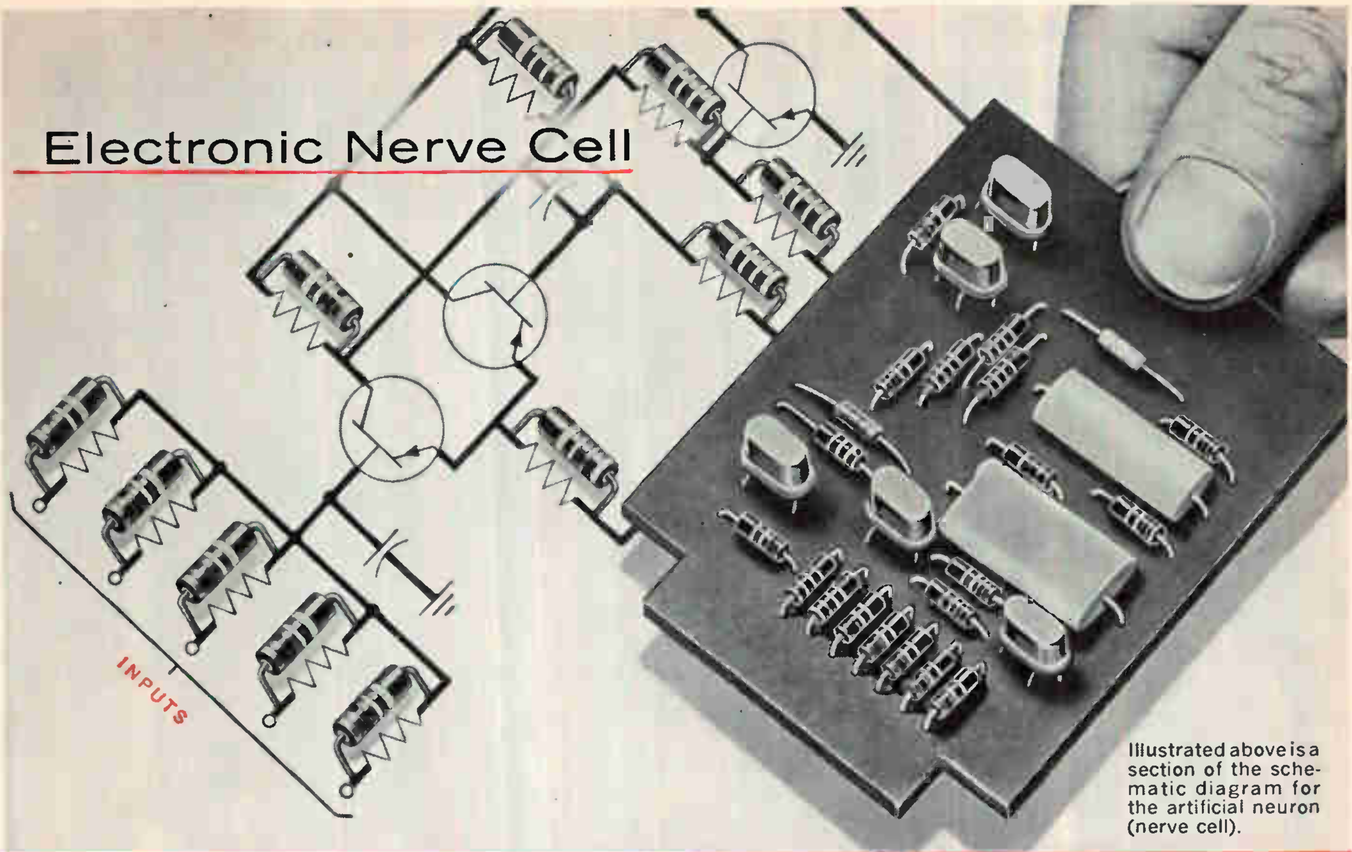
D) Repair Methods—solder removal, prevention of wicking, wire replacement, treatment of difficult-to-solder finishes. (Exp.: 3.5 hr.; inexp.: 7 hr.)

V. Pre-Test Review—review all specifications, visual appearance of good and bad connections, defects and causes. (Exp.: 2 hr.; inexp.: 4 hr.)

VI. Test—Test board consisting of 24 wiring connections and 24 soldering connections, including stranded wires and ½ watt resistors, completed with no guidance other than sequence sheet. (1 hr.)

VII. Inspection of Work—Review and grading by Product Reliability Department.

VIII. Final Review—Oral test on specifications, review tests, supplementary discussion, questions, clean up. (1 hr.)



Illustrated above is a section of the schematic diagram for the artificial neuron (nerve cell).

Goal of New Research Project:
MORE EFFICIENT COMMUNICATION SYSTEMS

Research to explore the information processing in nervous systems is now underway at Bell Telephone Laboratories. Here, scientists are experimenting with newly developed electronic elements which are designed to imitate the actions of a living nerve cell. Too little is yet known about living cells to permit exact electronic duplication. However, experiments with groups of artificial neurons have roughly duplicated some of the eye's basic reaction to light. This new approach to studying basic nerve network functions can provide clues for stimulating further exploration into the fundamentals of the transmission of intelligence.

Allen-Bradley is very happy that the quality of their hot molded resistors caused them to be selected for these exacting experiments. With their uniform properties and conservative ratings—A-B resistors will provide the same superior performance in your electronic circuits. Be certain you specify A-B hot molded resistors—especially for your critical jobs. Send for Publication 6024.

A-B Hot Molded Composition Resistors

SHOWN ACTUAL SIZE

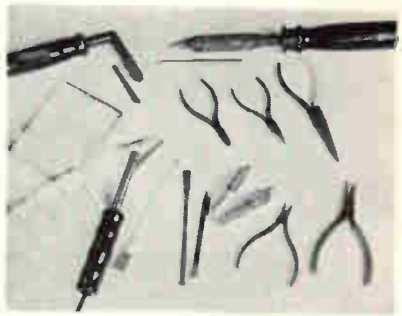
Hot molded composition resistors are available in all standard EIA and MIL-R-11 resistance values and tolerances.

*Pending MIL Spec Assignment

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

ALLEN-BRADLEY Quality Electronic Components soldering and 51 were inexperienced. A passing score was achieved by 202 experienced operators and 44 inexperienced operators. Of the 39 experienced operators who failed, 33 passed upon repeating the course and four more passed on a third try after obtaining new eyeglasses.

Almost the same percentage of experienced and inexperienced operators passed on the first try, demonstrating that "unlearning"



Standard soldering kit

Iron is held upright over the terminal, with thumb over the top to prevent hand from slipping down onto heated section

experienced operators is not difficult. Those who pass are given certificates, comparable to a diploma, and will be required to take recertification examinations yearly. In addition to the 292 operators and 35 other personnel, another 205 operators were trained more recently with similar results. Total training costs for all 532 was $48,-641, including direct labor charges, materials and the instructor's pay.

A controlled study indicates that wiring and soldering defects have been reduced approximately 75 percent since the program began. Before the program started, soldering defects averaged nine per unit; after nine months the average was two per unit. An estimated 25 percent reduction in inspection costs has resulted.

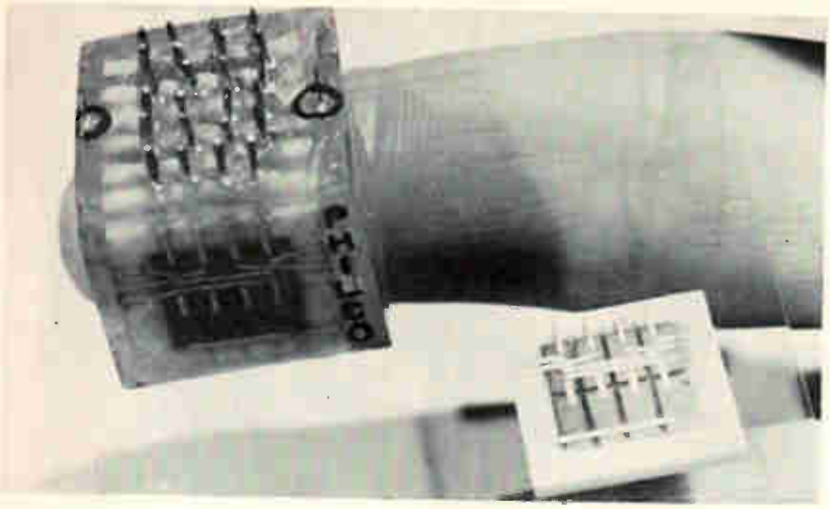
It is estimated that 60 percent of all training costs will be offset this year (1961) and that the entire cost will be recaptured early in 1962. Employe reaction has also been gratifying. Those who first took the course expressed overwhelming approval and those who had not yet taken it asked to be next in line.

The contour soldering technique followed in the training sessions has significantly helped standardization. It gives assemblers, inspectors, supervisors and engineers the same objective, visual specification for a properly-soldered joint. The alloying attachment between wire and terminal is the solder film, about 0.004 inch thick. Once this thickness is reached a sound joint has been formed and there is no advantage to adding further solder. Approximately 30 percent of the wire contour should be visible in the solder; the minimum acceptable amount of solder will expose 50 percent of the wire contour.

A new, standard tool kit was issued. It has a 60-watt soldering iron with two iron-plated tips. Tips are not filed by the operator and are wiped on a wet cellulose sponge instead of dry rags. The iron is held upright on the terminal being soldered and is rocked to heat the terminal evenly. The operator holds his thumb over the end of the handle to facilitate rocking and to ensure safety.

The kit (photograph) contains, besides soldering irons, small diagonal cutting pliers, long nose pliers with serrated ends and cutters, a pair of erasers mounted on a bent strip of beryllium copper for cleaning leads and other cylindrical surfaces, a secretarial stick eraser for cleaning non-cylindrical surfaces, a bristle brush for cleaning soldered joints, a phenolic pick for manipulating leads and parts during repair and rework, and pipe cleaners. The pipe cleaners, dry, are used to remove solder and to prevent solder splash; when moistened they serve as an antiwicking heat sink on stranded wires.

New On The Market



Microelectronic Circuits
THIN FILM AND SOLID STATE

FIRST GENERATION of its microelectronic components is announced by Lansdale Div., Philco Corp., Lansdale, Pa. Transistors, diodes, capacitors and resistors for a circuit are formed in a single wafer of silicon. Circuit elements are formed by diffusing into only one side of the silicon wafer. Resistors and transistors are interconnected by evaporation techniques. Representative thin-film circuits include RTL NOR packs and multivibrator circuits. Representative solid-state circuits include silicon flip-flops and commutators consisting of six solid-state circuit wafers each containing 16 diodes and four resistors.

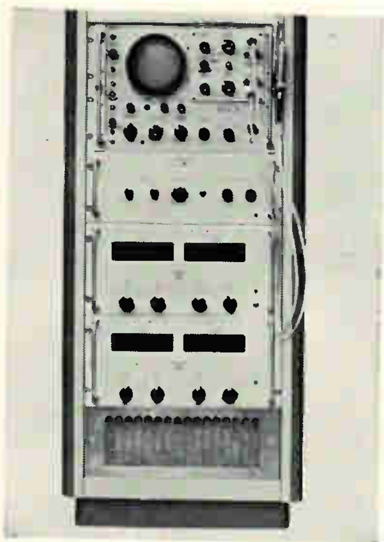
CIRCLE 301 ON READER SERVICE CARD

Core Driver Transistors
ELECTROCHEM DIFFUSED

FOUR electrochemical diffused collector transistors, suitable as high-current core drivers, have excellent beta linearity from less than 1 ma to over 400 ma, high frequency response with a gain bandwidth product of 300 Mc and low saturation resistance. Rated power dissipation is 400 mw.

High specification types 2N2100 in TO-9 case and 2N2097 in threaded-stud mounting TO-31 case are priced at $20.25 and $21.60 each in quantities of 1-99, and $14.85 each and $15.85 each, respectively, in quantities of 100-999. The corresponding standard specification types, 2N2099 and 2N2096, are priced at $8.85 and $10.15 each in 1-99, and $6.45 and $7.45 each in 100-999 lots. Manufacturer is Sprague Electric Co., North Adams, Mass.

CIRCLE 302 ON READER SERVICE CARD



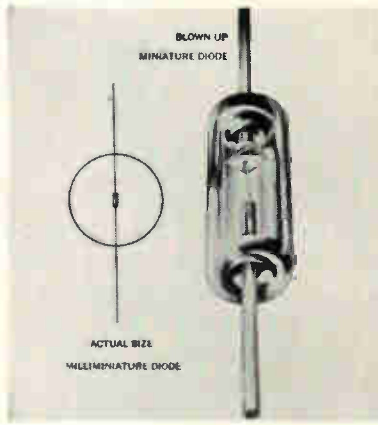
Waveform Timing
DIGITAL READOUT

SYSTEM THAT digitally measures the elapsed time between any two points on a high-speed waveform is available from Dymec, a div. of Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif. Accuracy is better than ± 4 percent of full scale, ± 0.4 nsec. In addition to measuring transistor delay, rise, storage, and fall time, the DY-5844 will make similar measurements on diodes, magnetic cores, and high-speed components and circuits. This system can also be used to measure pulse amplitude, area, and stored charge. Price is $8,000 to $12,000; delivery in 10 to 16 weeks.

CIRCLE 303 ON READER SERVICE CARD

Miniature Diodes
GOLD BONDED

CLEVITE TRANSISTOR, Waltham, Mass., announces a line of gold-bonded germanium glass diodes that are one-eighth the size of the



subminiature type. Glass encapsulated package is effective against moisture and contamination, and withstands high mechanical stress. Any electrical specification that could be met by the subminiature glass germanium diode can now be supplied in the milliminiature package. Types CID-205 through CID-209 have various inverse voltage ratings.

CIRCLE 304 ON READER SERVICE CARD

Adaptable Transistor
DOES MANY JOBS

SILICON TRANSISTOR that can perform the jobs of up to 40 percent of more than 2,000 transistor types is announced by RCA Semiconductor and Materials Div., Somerville, N. J. The 2N2102 is produced by triple diffusion and planar manufacturing techniques. Fifty-five electrical and mechanical tests must be conducted during production to

Shallcross precision circuit news

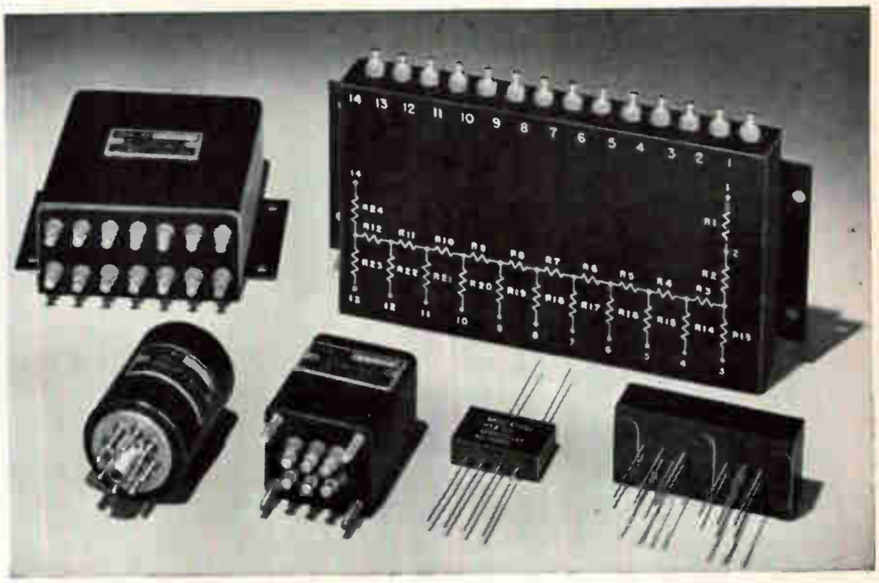
RESISTANCE NETWORKS

. . . the inside story on quality

In reading ads for wirewound resistance networks, you sometimes find the superiority of one technical characteristic emphasized to a misleading degree. Desired accuracy, temperature coefficient, stability, and voltage division obtained in one type of network may be impossible to achieve in another.

Essentially, network quality is determined by the quality of its individual resistors. Beyond this, network performance improves or deteriorates depending on packaging and mounting techniques, AC layout and trimming methods, accuracy of measuring instruments, the manufacturer's production standards and his knowledge of the latest developments in network theory.

Shallcross offers a unique background of experience, reliability data, manufacturing and testing skills to minimize what few error factors remain in Shallcross precision wirewound resistors when the networks are sealed. For a sample of this ability, submit your next network requirement for evaluation by Shallcross engineers. Meanwhile, send for Bulletin A-2 for a practical discussion of proper network design.



Temperature Stabilized COMPUTER NETWORKS

High reliability Shallcross P-Type precision wirewound resistors help these computer networks maintain close AC ratios over wide temperature ranges. To maintain these tolerances, Shallcross has refined resistor manufacturing techniques to provide TC tracking within ± 1 ppm in many cases. Individual resistor reliability is enhanced by stability "exercises" and by new tension relieving devices within each resistor. Beyond this, extremely accurate AC and DC measuring instruments help in final network design, trimming, packaging, and proof-of-performance testing.

From an extensive background of network engineering Shallcross offers analog to digital and digital to analog converters, voltage dividers, summing and integrator networks, and others to virtually any configuration.

WHY PACKAGE RESISTANCE NETWORKS?

Packaging does far more for resistor networks than provide convenient mounting and environmental protection. Some can also increase power dissipation, provide electrical shielding and increase network stability over extended temperature ranges. Principally however, enclosed networks maintain electrical performance by preventing "field introduced" errors brought about by improper mounting or damage to critical AC layouts through improper resistor replacement during maintenance. Where unusually critical voltage division tolerances must be maintained, the design engineer should make provision for a packaged network in his application.

Shallcross regularly supplies networks in many hermetically sealed, encapsulated, and plug-in designs. For a discussion of when to use which style, write for Bulletin A-2.

Shallcross Manufacturing Co. Selma, North Carolina

Precision wirewound resistors, Switches, Instruments, Delay lines, Resistance networks, Audio attenuators.

insure high performance in the many applications in which the transistor can serve. Scheduled for early introduction into the military and industrial markets, the transistor is tentatively priced at $12 in production quantities.

CIRCLE 305 ON READER SERVICE CARD

Static Charge Detector
CHECKS BONDING, GROUNDING

ELECTRONIC instrument that detects the static charge differential between improperly grounded or bonded objects is announced by B. K. Sweeney Mfg. Co., 6300 E. 44th Ave., Denver 16, Colo. Model SWE-1125 Static Meter features a green-red, go/no-go dial that shows whether the grounding or bonding connections are good. Battery-powered instrument is voltage-operated and reads electrostatic charge—not resistance. Energy as low as one millimicrojoule from the measured source will actuate the indicator; meter indicates charge polarity.

CIRCLE 306 ON READER SERVICE CARD

D-C/A-C Inverter
TRANSISTORIZED

POWER INSTRUMENT CORP., 235 Oregon St., El Segundo, Calif. Model PI 1341 converts 12 v d-c to 115 a-c, 60 cps and will handle peak loads up to 1,300 w and continuous loads to 500 w. The inverter is designed to power a-c motors with high peak starting current surges

and low starting power factors. Efficiency is 80 percent at full load. Price is $300.

CIRCLE 309 ON READER SERVICE CARD

True RMS Voltmeter
HIGH ACCURACY

VOLTMETER DISPLAYS true rms value of applied a-c voltage. Autograf Model 21 is multirange, servo-operated, designed for general laboratory use. Full scale voltage ranges are from 10 millivolts to 200 volts rms in 14 steps; frequency is from 5 cps to 100 Kc. A segment of the signal drives a thermocouple heater, which then provides an arms equivalent signal for a servo loop. Price of the voltmeter is $985, from F. L. Moseley Co., 409 North Fair Oaks Ave., Pasadena, Calif.

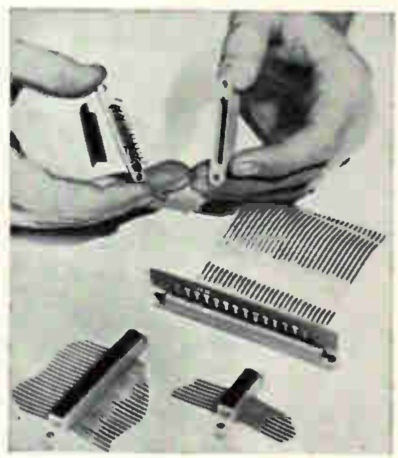
CIRCLE 307 ON READER SERVICE CARD

1,000-G Tape Recorder
14 DATA CHANNELS

MULTI-CHANNEL miniature magnetic tape recorder, capable of operating in extreme environmental conditions—including up to 1,000 g shock—is announced by Borg-Warner Controls, a div. of Borg-Warner Corp., P. O. Box 1679, Santa Ana, Calif. Designed for advanced missiles and space vehicles, model MR-21 records up to 14 chan-

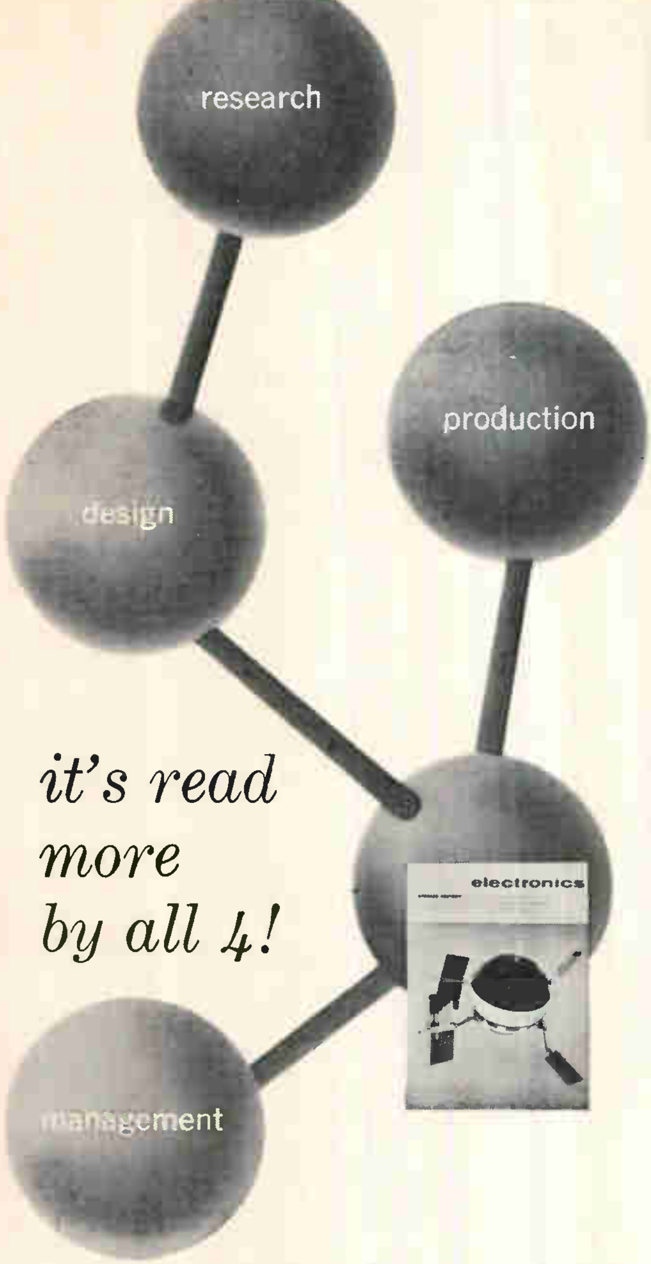
nels on one inch tape; total tape capacity is 69 feet. Recorder is four inches in diameter by three inches long, weighs less than 2 pounds. Environmental conditions include temperatures from −65 to 165 F; it will record through a 1,000-g, 3-millisecond shock.

CIRCLE 308 ON READER SERVICE CARD



Connector
HIGH RELIABILITY

THE THOMAS & BETTS CO., Elizabeth, N. J., announces the Pos-E-Kon, a device for connecting flat conductor cable to p-c boards or to flexible etched circuitry. It produces a direct conductor-to-conductor contact without solder. A continuous one-piece spring locks the cable into the



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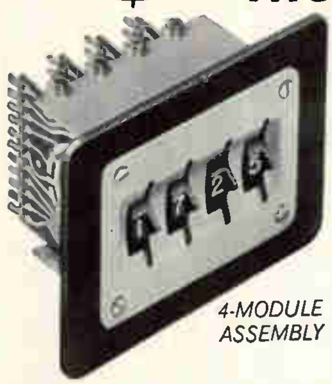
CIRCLE 215 ON READER SERVICE CARD

FASTER... EASIER SWITCHING

New Convenient Tabs on...

C·D·I THUMBWHEEL SWITCH Modules



4-MODULE ASSEMBLY

Equally accurate for gloved or barehand operation. Especially useful when manual settings are changed often. Large, clear numbers. High legibility because only selected number is visible. Can be furnished in 8, 10, 12 or 16 positions with single or multi-wafer construction in lug or time-saving removable type printed circuit wafers. Digital, binary, multiples of each, or multiples of both available with or without internal lighting. Ask for technical details today.

CHICAGO DYNAMIC INDUSTRIES, INC.
C·D·I PRECISION PRODUCTS DIVISION
1725 Diversey Blvd., Chicago 14, Illinois

CIRCLE 99 ON READER SERVICE CARD

connector. It provides a pressure point at each conductor contact.

CIRCLE 310 ON READER SERVICE CARD

Potentiometers
ULTRARELIABLE

CLAROSTAT MFG. CO., INC., Dover, N. H. New materials and techniques employed in the PotPot process makes possible ultrareliability of components under the most extreme environmental conditions. Process includes a pre-sealing of the component and a pre-test of the seal before complete encapsulation. Shafts and bushings are sealed with Neoprene O-rings.

CIRCLE 311 ON READER SERVICE CARD

Tape Reader
BIDIRECTIONAL

TELECOMPUTING CORP., 9229 Sunset Blvd., Los Angeles 46, Calif. Medium speed bidirectional tape reader will read either paper or Mylar tape with minimum tape wear. It reads up to an 8-bit character plus feed hole, at asynchronous speeds up to 150 lines per sec; synchronous up to 600 lines per sec.

CIRCLE 312 ON READER SERVICE CARD

Magnetic Amplifier
DIFFERENTIAL TYPE

AIRPAX ELECTRONICS INC., Fort Lauderdale, Fla. The M-5301-D differential type data logging amplifier delivers an output of ±5 v at a linearity better than 0.1 percent. Voltage gains from 100 to

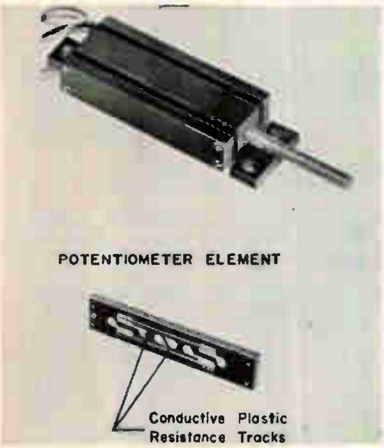
10,000 are obtained. A three-stage amplifier, it combines a harmonic type of preamplifier having a very stable null with a double-ended, full wave magnetic amplifier to obtain high open-loop gain.

CIRCLE 316 ON READER SERVICE CARD

Memory Module

CBS LABORATORIES, High Ridge Rd., Stamford, Conn. Sixteen bit linear select device is 0.625 sq in., and withstands shock, vibration.

CIRCLE 317 ON READER SERVICE CARD



Linear Motion Pots
DUAL-ELEMENT

MARKITE CORP., 155 Waverly Place, New York 14, N. Y., offers rectangular rectilinear pots for servo control systems and instrumentation transducers in aircraft and missile applications. Resistance element embodies two electrically isolated solid raised tracks of conductive plastic integrally co-molded, together with taps and terminals, to an insulator base of high temperature phenolic resin of matched thermal expansion coefficient.

CIRCLE 318 ON READER SERVICE CARD

Variable Transformer
20-AMPERE UNIT

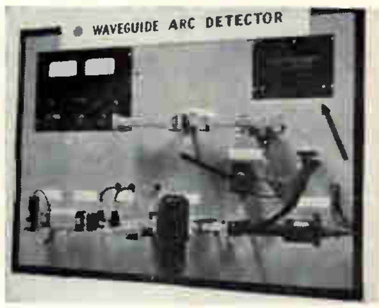
OHMITE MFG. CO., 3665 Howard St., Skokie, Ill. The VT20 series offers sturdiness of construction, plus versatile mounting facilities. Heavy radiator and base plates facilitate heat dissipation, and the radiator plate is counterbalanced to compensate for the weight of a "beefed-up" brush assembly. The shaft can be extended from either side of the transformer as required for panel or horizontal surface mounting.

CIRCLE 319 ON READER SERVICE CARD

Silicon Diodes

PACIFIC SEMICONDUCTORS, INC., 12955 Chadron Ave., Hawthorne, Calif. Failure rate for general purpose alloy diodes is 0.008 percent for 1,000 hours and 0.004 percent in 1,000 hours for a silicon diffused computer fast logic switch.

CIRCLE 320 ON READER SERVICE CARD



Arc Detector System
FOR WAVEGUIDES

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif. The U-9000 arc detector system covers the frequency range between 7.0 and 7.5 Gc in RG-51/U waveguide. Sensing unit is mounted on a bend near the power amplifier output window. Included in the sensing unit are two channels of solar cells and amplifiers, and a test lamp.

CIRCLE 321 ON READER SERVICE CARD

Miniaturized Relay
RUGGED UNIT

WHEELOCK SIGNALS, INC., 273 Branchport Ave., Long Branch,

N. J. A 10-ampere miniaturized relay, series 200, is designed to operate under stresses of space environment. It is hermetically sealed and highly resistant to moisture and temperature extremes. Relay can withstand shock and sustained acceleration of 50 g, and vibration of 30 g up to 2,000 cps. It measures 1 by 0.6 by 1.25 in. and weighs 2.5 oz.

CIRCLE 322 ON READER SERVICE CARD

Isolation Transformer
VARIABLE TYPE

STANDARD ELECTRICAL PRODUCTS CO., 2240 E. Third St., Dayton, O. The Adjust-A-Volt IV series isolated variable transformers provide a means for smooth control of an electrically isolated a-c voltage output. Available in 3 sizes of portable, cased, metered units for electrical under and over voltage testing, they are built for 120 v, 50/50 cycle input with 0 to 140 v isolated output. Kva ratings range from 0.28 to 4.8 Kva.

CIRCLE 323 ON READER SERVICE CARD

Ratio Transformer

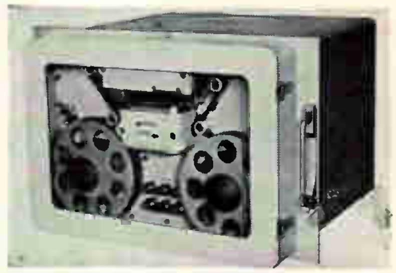
GERTSCH PRODUCTS, INC., 3211 S. La Cienega Blvd., Los Angeles 16, Calif. Ratio transformer measures 3½ in. high, accuracy is 0.001 percent. Price: $275.00.

CIRCLE 324 ON READER SERVICE CARD

Resin Prepolymer
CURES RAPIDLY

ISOCHEM RESINS CO., 221 Oak St., Providence 9, R. I., announces Isochemrez Poly U, a high dielectric rigid polyurethane flexible foam for potting in under extreme or normal thermal shock. It has excellent h-v characteristics plus stability to high temperatures and top ageing characteristics.

CIRCLE 325 ON READER SERVICE CARD



Tape Recorder
MILITARIZED

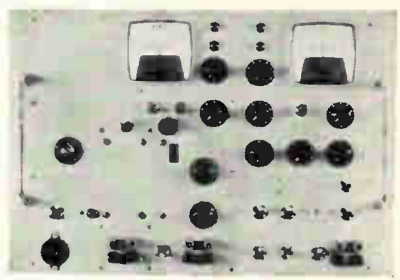
FERRANTI ELECTRIC INC., Industrial Park No. 1, Plainview, L. I., N.Y. Type 271 is a militarized tape reader to MIL-E-4970 and MIL-I-26600. Reading speed is up to 300 characters/sec with fully synchronous operation possible up to 220 characters/sec. Fast advance/rewind is provided at 1,000 characters/sec. With the exception of the clock pulses, all data logic is NRZ in nature.

CIRCLE 326 ON READER SERVICE CARD

Particle Counter

CAIN & CO., 2615 W. Magnolia Blvd., Burbank, Calif. Counter is sensitive to particles larger than 0.5 micron and counts to 1,500,000 particles a minute.

CIRCLE 327 ON READER SERVICE CARD



Servo Analyzers
SOLID-STATE

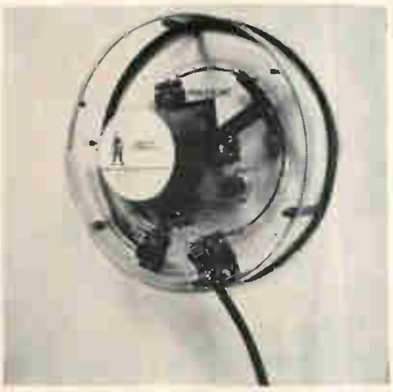
GIANNINI CONTROLS CORP., 1600 S. Mountain Ave., Duarte, Calif. Series DSA dynamic servo analyzers are designed for checkout of missile and aircraft servo controls systems in factory or field. They combine the functions of signal generation, dynamic servo-response analysis, and data presentation—minimize measurement errors caused by harmonic distortion, noise, and d-c offset in the output signal of the servo under test.

CIRCLE 328 ON READER SERVICE CARD

Frequency Standard

CLAUSER TECHNOLOGY CORP., 3510 Torrance Blvd., Torrance, Calif. Rubidium frequency standard is accurate to 5 parts in 10^{10} and offers a long term stability of 2 parts in 10^{10}.

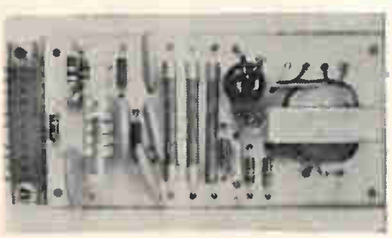
CIRCLE 329 ON READER SERVICE CARD



Digital Converter
FOR POINTER UNITS

MACLEOD INSTRUMENT CORP., 4250 N. W. 10th Ave., Fort Lauderdale, Fla., announces a digital converter for converting the indication of conventional pointer type instruments for operation of standard digital readout equipment. It is comprised of a scanner unit (illustrated) which attaches by means of adapters to the instrument to be read, and the electronic unit which houses the electronic circuitry and digital display.

CIRCLE 330 ON READER SERVICE CARD

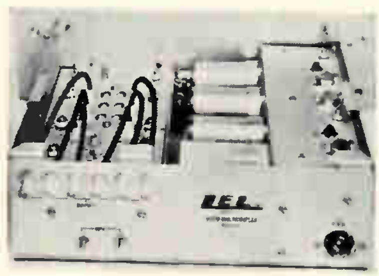


H-V Power Supply
D-C TO D-C REGULATED

FRANKLIN SYSTEMS, INC., P.O. Box 3250, West Palm Beach, Fla. Model

15-W-004 miniature transistorized plug-in converter is useful in small, portable battery operated equipment. It has use as a multiplier phototube bleeder supply, Geiger tube supply, low noise h-v bias supply, scintillation counting supply as well as proportional and neutron counters. Using 18 to 30 v d-c input voltage, the units are available in seven output voltages ranging from 800 v (– 10 v) to 2,000 v (– 50 v).

CIRCLE 331 ON READER SERVICE CARD



Video Multicoupler
SOLID-STATE

LEL, INC., 75 Akron St., Copiague, N. Y. The VF1327 multicoupler uses all solid-state circuitry and provides, in a self-contained rack and panel assembly, six emitter follower outputs driven from a single input. A bandwidth of 40 Mc and a gain of 12 db is provided. Isolation between channels is greater than 50 db at 10 Mc.

CIRCLE 332 ON READER SERVICE CARD

Rejection Filter
SEALED UNIT

KEARFOTT DIVISION, General Precision, Inc., 14844 Oxnard St., Van Nuys, Calif. Tunable notch band rejection filter is tunable from 9,000 to 9,300 Mc; rejection bandwidth, 45 db, 20 ± 5 Mc; bandwidth, 3 db, of approximately 60 Mc; insertion loss, less than 0.5 db; vswr, less than 1.2 at $f_o \pm 90$ Mc; operating range, from – 55 to + 100 C; length, approximately 4 in.; weight, approximately 11 oz.

CIRCLE 333 ON READER SERVICE CARD

PRODUCT BRIEFS

SILICON BRIDGE RECTIFIER compact, low-cost. Syntron Co., Homer City, Pa. (334)

PULSE HEIGHT ANALYZER multichannel. Radiation Counter Laboratories, Inc., 5121 West Grove St., Skokie, Ill. (335)

SLIP RING & BRUSH BLOCK ASSEMBLY 24-circuit capsule-type. Airflyte Electronics Co., 535 Avenue A, Bayonne, N. J. (336)

HIGH TEMPERATURE DIODES 0.15, 2 and 10 amp. General Electric Co., Schenectady 5, N. Y. (337)

GLASS ZENER DIODES feature low voltages. International Rectifier Corp., 233 Kansas St., El Segundo, Calif. (338)

AXIAL LEAD CAPACITORS for subminiature assemblies. Mucon Corp., 9 St. Francis St., Newark 5, N. J. (339)

BASIC SUBMINIATURE SWITCH with either turret or solder type terminals. Milli-Switch Corp., Gladwynne, Pa. (340)

VARIABLE SPEED DRIVES electronic control regulator. Tenney Engineering, Inc., 1090 Springfield Road, Union, N. J. (341)

VLF RECEIVER modular construction. Textran Corp., Box 9207, Austin 17, Texas. (342)

TRIMMER TYPE POTS with stepless resolution. Intellux, Inc., 30 South Salsipuedes St., Santa Barbara, Calif. (343)

COAX R-F CONNECTORS subminiature. Micon, Inc., Roosevelt Field, Garden City, L. I., N. Y. (344)

MICROMINIATURE TRANSFORMERS reliable, low-cost. James Electronics, Inc., 4050 No. Rockwell St., Chicago 18, Ill. (345)

SOLID STATE A-C RELAY features 2 μsec actuation. Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif. (346)

PORCELAIN DIELECTRIC MATERIAL for capacitors. Vitramon, Inc., Box 544, Bridgeport 1, Conn. (347)

Literature of

ONE-SHOT MULTIVIBRATOR Rese Engineering, Inc., A and Courtland Streets, Philadelphia 20, Pa. Technical bulletin 60-F describes the type 2011 UV Logix Block one-shot multivibrator, a 5-Mc transistorized plug-in module. (348)

WIDEBAND CONVERTER & LOOP ANTENNA Aerospace Research, Inc., 94 Massachusetts Ave., Cambridge 39, Mass. Data sheets contain specifications on the VLF-1 Caliverter and L-1 loop antenna. (349)

SOLID STATE POWER PACKS Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J. A 4-page bulletin covers high current, miniaturized, regulated, solid state power packs. (350)

TUBE RETAINERS Westrex Communication Systems, 540 W. 58th St., New York 19, N. Y. Descriptions and specifications of all Top Hat retainers for tubes and other plug-in components are contained in three data sheets. (351)

H-V POWER SUPPLIES Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill. Bulletin 5-70.1 describes a line of h-v d-c power supplies with outputs of 250 Kv at full load ratings of 50 ma. (352)

GENERAL PURPOSE RELAYS Elgin Advance Relays, division Elgin National Watch Co., 2435 N. Naomi St., Burbank, Calif. An 8-page booklet covers the GH series general purpose relay line. (353)

TELEMETRY RECEIVER Defense Electronics, Inc., 5451-B Randolph Rd., Rockville, Md., announces a data sheet illustrating and describing the model TMR-2A telemetry receiver. (354)

RMS VOLTMETER John Fluke Mfg. Co., Inc., P. O. Box 7428, Seattle 33, Wash. A technical data bulletin describes a true rms voltmeter featuring broad bandwidth. (355)

TRANSISTORIZED SCANNER Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin DPS/A22 covers a high speed transistorized electronic scanner. (356)

MULTITURN POTS Duncan Electronics, 2865 Fairview Rd., Costa Mesa, Calif. A two-page technical

the Week

bulletin describes the 3700 series of high reliability, multiturn potentiometers. (357)

PICTORIAL PROFILE Litton Industries, Inc., 336 N. Foothill Rd., Beverly Hills, Calif. A portfolio depicts the company's typical R&D, testing and manufacturing operations throughout the U. S. and eight foreign lands. (358)

FIXED RESISTOR CTS Corp., Elkhart, Ind. Data sheet 185 describes and tabulates extensive tests of the microminiature Ceradot fixed resistor. (359)

D-C POWER SUPPLIES Electro Products Laboratories, Inc., 4500 N. Ravenswood Ave., Chicago 40, Ill. Bulletin PS-561 features a selection chart, characteristics and performances of a line of low voltage d-c power supplies. (360)

SEMICONDUCTORS Syntron Co., Homer City, Pa. "The How and Why of Certifying Syntron Semiconductors" is the title of bulletin 200 now available. (361)

SPECTROMETERS Varian Associates, 611 Hansen Way, Palo Alto, Calif. A 12-page catalog covers a line of nuclear magnetic resonance and electron paramagnetic resonance spectrometer systems and components. (362)

ADJUSTMENT POTENTIOMETERS Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif. A four-page brochure, designed for quick reference, summarizes key information on 20 basic models of adjustment potentiometers. (363)

ELECTRONIC TIMING Slip Ring Co. of America, 3612 W. Jefferson Blvd., Los Angeles 16, Calif. An illustrated descriptive brochure covers a series of electronic timing devices which includes time delay relays, electronic timers, pulse generators, and flashers. (364)

CAPACITANCE CALCULATOR General Electric Co., 1285 Boston Ave., Bridgeport 2, Conn., has issued an easy-to-use capacitance calculator printed on laminated acetate for long use and complete with see-through plastic ruler. It is available to electronic design engineers when requested on company letterhead.

Madigan: a lighted future . . .

FROM farming in Minnesota to sailing with the Navy to setting up and running a thriving electronics business is a very long way . . . as Bill Madigan, president and chairman of Madigan Electronic Corp., Carle Place, N. Y., can tell you.

Naturally inclined towards business operations, Bill found an opportunity at about the time he "graduated" from the Navy in 1945. He set up a 2-man shop to make and maintain mobile radio equipment for municipal vehicles. Times were tough for electronics in 1945-46. Government contract cancellations and the resulting glut of unused facilities created keen competition and high company mortality. Here, Bill's farm boy background of hard-working stoicism paid off. By aggressively taking on a wide variety of electronic work, he nourished his enterprise on up to multi-million-dollar stature. The firm produced, among others, handie-talkies, stable platforms, computer components, electronic testing units and equipment manuals. It sends contract field service engineers all over the world.

During the last few years, Madigan (center of photo) has seen the mushrooming electronics industry becoming more and more fiercely competitive, particularly in manufacturing and production. Feeling that further growth would need to occur along other lines, he and his board took a hard look at their business, deciding to consolidate profitable lines and to make a start in a promising new field, molecular electronics. With the hiring of an authority in this field, Dr. Arsene Lucian (right of photo), the particular area to be researched pointed toward electroluminescence. A new general manager, S. D. (Steve) Gurian (left of photo), was brought in. Madigan expects his company's "sandwich of light" to be an important part of tomorrow's electronics picture.

LFE Electronics Promotes Mosher

RICHARD K. MOSHER has been promoted to the new post of vice president in charge of the systems division of LFE Electronics, a major operating group of Laboratory For Electronics, Inc., Boston, Mass. He had previously been assistant vice president.

Mosher joined LFE in 1947, following three years with Continental Television Corp., Boston. With LFE, he advanced from senior engineer in the engineering division, to manager of the mechanical division to director of customer relations. He was appointed assistant vice president in 1960.

Dalmo Victor Names Gates V-P, Products

WILLIAM F. GATES has been appointed to the newly established position of vice president, products, of Dalmo Victor Co., Division of Textron Inc., Belmont, Calif. He will have responsibility for three major departmental functions—engineering, marketing and product research.

Gates joined the company in 1944 as a design engineer and was appointed vice president and chief engineer in 1948.

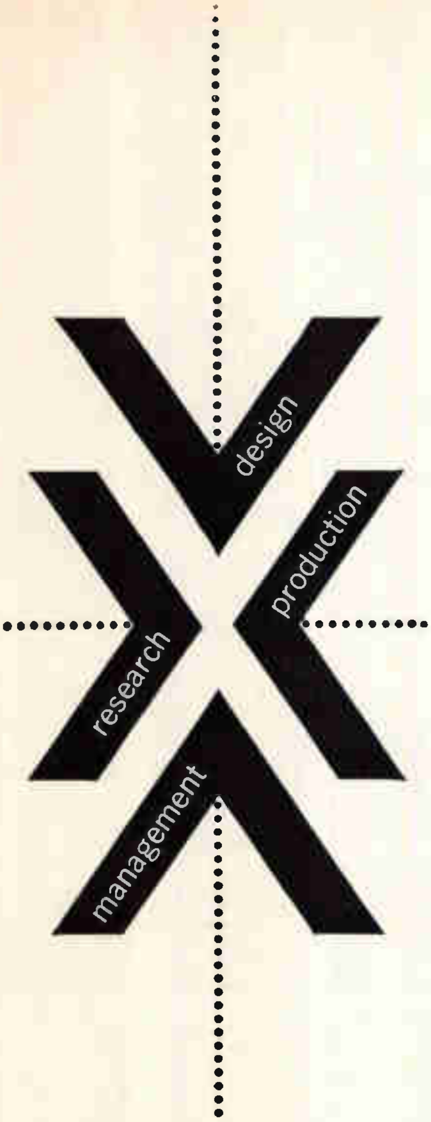
Babcock Appoints V-P, Engineering

BABCOCK ELECTRONICS CORP., Costa Mesa, Calif., has appointed W. W. Smith vice president, engineering.

Smith was chief of engineering development prior to assuming his new post. Before coming to Babcock, he was associated with the Gonset Division of Young Spring & Wire Corp.

Alan Bailey Joins TIC of Acton

ALAN D. BAILEY has joined the staff as senior electronic engineer in the



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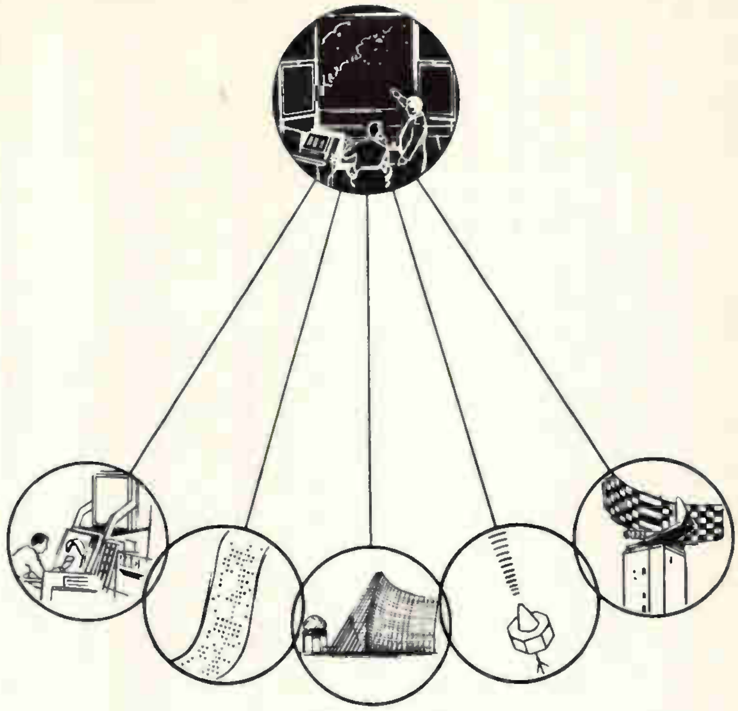

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THE MITRE CORPORATION

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin space instrument division of Technology Instrument Corp. of Acton, Acton, Mass. He is responsible for electronic and electrical instrumentation flown on research sounding rockets, deep space probes and satellite vehicles.

Bailey was formerly an assistant professor at Northeastern University in electronic research.

Edgar Wimpy Moves To Clarostat Mfg.

APPOINTMENT of Edgar K. Wimpy as assistant chief engineer of Clarostat Mfg. Co., Inc., Dover, N. H., is announced. In his new position he will direct much of the company's R&D on new potentiometer and resistor designs.

Wimpy comes to Clarostat from CBS Electronics where he had been engaged in various capacities since 1946.

Appoint Tucci V-P Of Two Companies

OWNERS and directors of the Leach & Garner Co. and General Findings, Inc. of Attleboro, Mass., announce the appointment of Gerald F. Tucci as vice president for both firms. Companies are engaged in the aircraft, missile and space programs.

With the organization since 1953, Tucci will continue to function as general manager, industrial division, of both companies in addition to carrying out his new responsibilities as vice president.

Wanlass Joins Packard Bell

S. DEAN WANLASS recently joined Packard Bell Electronics, Los Angeles, Calif., as group vice president, defense and industrial group. He has been associated with the Aeronutronic Division of Ford Motor Co. in Newport Beach, Calif., since 1956.

Warren Takes Over Additional Post

JAMES D. WARREN, vice president, engineering, of Dorsett Electronics, Inc., Norman, Okla., has been appointed general manager of the company's Electronic Laboratories division in Norman. He also continues as chief engineer.

Warren joined the company in 1955, as a design engineer. He has been engineering vice president for the past three years.

Elm Instrument Names Two to Key Posts

MORRIS H. SHAMOS, NYU professor of physics, has been elected to the board of directors and Walter A. Kirsch has joined Elm Instrument

Corp., Hempstead, N. Y., as assistant to the president, a new position.

Shamos is a consultant to the Atomic Energy Commission, the National Broadcasting Co., Tung-Sol Electric Co., and is a director of National Radiac, Inc.

Prior to joining Elm Instrument, Kirsch had been assistant to the president of ID Precision Components Corp., Jamaica, N. Y., and defense products manager of Telechrome Mfg. Co., Amityville.

Burns Takes New Post At Siegler Corp.

DAN W. BURNS has been appointed vice president in charge of defense activities for The Siegler Corp. He has been with Siegler's Hufford Division at El Segundo, Calif., since 1956. He became president of Hufford in 1958.

Siegler manufactures military and commercial electronics and aerospace components.

Sperry Microwave Advances Ely

APPOINTMENT of Paul C. Ely, Jr. as engineering head of Microline operations at Sperry Microwave Electronics Co., Clearwater, Fla., is announced.

With Sperry since 1953, Ely will now head a team which is responsible for all engineering phases of Microline . . . from initial concept through setup and tooling for manufacture.

Amperex Promotes Four Executive Engineers

EDUARD G. DORGELO, director of engineer, Amperex Electronic Corp., Hicksville, N. Y., has announced the following four promotions:

James McKenzie to manager, gas tube and semiconductor departments; Kenneth Spitzer to manager, microwave tube development department; Selig Gertzis to manager, tube & semiconductor applications laboratory; and Walter Bosse to manager, quality control department.

PEOPLE IN BRIEF

John J. Graham of RCA's electronic data processing division promoted to division vice president. **Hugh Christian**, formerly with Diamond Power Specialty Corp., joins Electron Corp. as administrative engineering assistant. **Walter W. Kunde Jr.** moves up at Dresser Electronics' HST Div. to vice president of engineering. **Jay M. Bedrick** leaves Integron Inc. to become manager of electromechanical research and development at Minneapolis-Honeywell's Boston Div. **Dane T. Scag**, previously with C. Stellarator Assoc., appointed assistant director of research by Allis-Chalmers' research division. **Vincent DiNapoli**, ex-General Precision, named vice president and general manager of Hermetic Seal Corp.'s Eastern operations. **Lester M. Field** advances at Hughes Aircraft to assistant head of the components group. **Robert P. Bennett** promoted to manager of the relay marketing dept. at Cornell-Dubilier Electronics. **Arthur Vassiliadis** transfers from Stanford Research Institute to Kane Engineering Labs as senior electrical engineer. **Royal Weller** leaves General Dynamics to join Lockheed Missiles and Space Co. as director of engineering for the space systems division. **Frank G. Stefkovich** moves up to assistant plant manager and **R. C. Babbit** advances to quality control manager at American Enka Corp.'s Brand-Rex div.

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ESQUIRE PERSONNEL, Chicago, Illinois	120	5
GYRODYNE CO. OF AMERICA INC., St. James, L. I., New York	76*	6
LITTON SYSTEMS INC., Guidance & Control Systems Div., Beverly Hills, California	16*	7
LITTON SYSTEMS INC., Guidance & Control Systems Div., Woodland Hills, California	50	8
LYCOMING, Div. of Avco Corporation, Stratford, Conn.	118	9
MALLORY ELECTRONICS COMPANY, Div. of P. R. Mallory & Co., Inc., Indianapolis, Indiana	76*	10
McDONNELL AIRCRAFT, St. Louis, Missouri	75*	11
THE MITRE CORPORATION, Bedford, Mass.	113	12
SANDERS ASSOCIATES, INC., Nashua, New Hampshire	118	13
SIKORSKY AIRCRAFT, Div. of United Aircraft Corp., Stratford, Conn.	119	14
TELEREGISTER CORPORATION, Stamford, Conn.	120	15
TROPICAL RADIO TELEGRAPH CO., Hingham, Mass.	120	16

*These advertisements appeared in the 9/1/61 issue.

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HOME ADDRESS..

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

HOME TELEPHONE..

Education

PROFESSIONAL DEGREE(S)..................................

MAJOR(S) ....

UNIVERSITY ....

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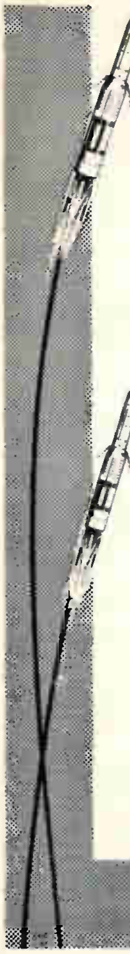

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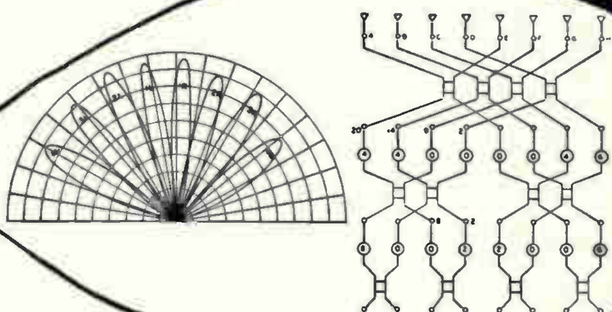

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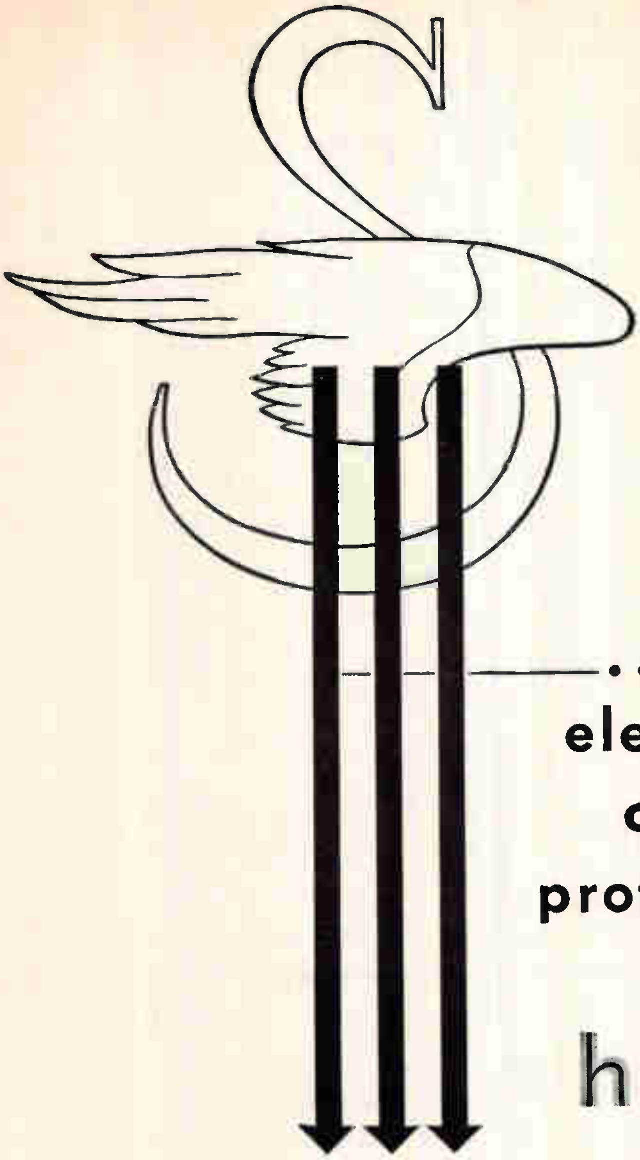

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Size of display	________
Degree of environmental resistance	________
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7183	Magnetic Deflection.	5.19	4	—	12000	50
7315	Slow writing speed. Excellent integrating and half-tone capabilities. Electrostatic Deflection.	5.31	3.8	3,000	2500	50
7448	High writing speed to "freeze" microsecond transients. Electrostatic Deflection.	5.31	3.8	300,000	2500	50
C73904	Two writing guns for simultaneous writing of two independent signals. Electrostatic Deflection.	5.31	3.8	75,000	2500	50
C73922	Increased display area. Selective erasing gun erases specific parts of stored signal without affecting other parts. Electrostatic Deflection.	7	5.2	8,000	750	45
C73959	High-resolution capability with slow writing speed. Electrostatic Deflection.	5.31	3.8	3,000	200	110

For information that will solve your display storage problem, call your RCA Field Representative, or write to Marketing Manager, RCA Industrial Tube Products, Lancaster, Pa.

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