SPECIAL REPORT: Production will double in the next ten years.

OUR INDUSTRY: Today and Tomorrow.
MINIFILTERS
New Minifilters provide almost the same characteristics (with attenuation only slightly less) as the industry's standard interstage and line filters immediately below.

BPM band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db ±3% from center frequency, then 35 db per octave.

HPM high pass units, loss of less than 6 db at cut-off frequency, attainment of 30 db at 67 cut-off frequency, 40 db at .6 cut-off frequency. Input and output 10K.

LPM low pass units, loss of less than 6 db at cut-off frequency, attainment of 30 db at 1.5 cut-off frequency, 40 db at 1.65 cut-off frequency. Input and output 10K.

INTERSTAGE & LINE
These six basic types cover most popular filter applications and frequencies.

BML band pass units are 10K input, output to grid; 2:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

HML high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

LML low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

HML high pass filters are similar as HML but 500/600 ohms in and out.

LML low pass filters are similar as LML but 500/600 ohms in and out.

BML band pass units are similar as BML but 500/600 ohms input, output to grid, 9:1 gain.

TELEMETERING BAND PASS
UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, 4 pin header for small Winchester socket.

TMN units are within 3 db at ±7.5% of center frequency...down more than 18 db at ±25%...more than 40 db beyond 1.75 and .58 center frequency.

TMW are within 3 db at ±15% of center frequency...down more than 20 db at ±50%...more than 40 db beyond 2.5 and .4 center frequency.

TELEGRAPH TONE CHANNEL
These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

TGT transmitting filters are within 3 db at ±42.5 cycles from center frequency...down more than 16 db at ±170 cycles...down more than 7.5 db at adjacent channel crossover.

TGR receiving filters are within 3 db at ±42.5 cycles from center frequency...down more than 30 db at ±170 cycles...down more than 15 db at adjacent channel crossover.
BUSINESS

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Mural at North Electric Co. Science Center symbolizes the world of electronics. Left side of oval shows space-age products; right side shows automatic control, communications and data-processing products. See p 67

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THE RECORDING THAT WASN'T

...It's happened to lots of magnetic tape users

Maybe you've been one of these unfortunates...who've spent thousands of dollars...plus many man hours...to record valuable information on magnetic tapes...only to find the data useless from accidental distortion or erasure.

Unexpected exposure to an unpredicted magnetic field, and presto!—your valuable data is filled with irritating odd noises. Distortions may result in virtual data erasure.

Unprepared tape users never realize the danger of loss until it's too late.

Such losses have become increasingly common from damaging magnetic fields during transportation or storage. These fields may be produced by airplane radar or generating equipment or other power accessories. Also by generators, power lines, power supplies, motors, transformers, welding machines, magnetic tables on surface grinders, magnetic chucks, degaussers, solenoids, etc.

Since 1956, many military and commercial tape users successfully avoid such unpleasant surprises. Their solution is shipping and storing valuable tapes in sturdy NETIC Tape Data Preservers.

Data remains clear, distinct and distortion-free in NETIC Preservers. Original recorded fidelity is permanently maintained.

Don't take chances with your valuable magnetic tapes. Keep them permanently clear and distinct for every year of their useful life in dependable NETIC Preservers. Can be supplied in virtually any size and shape to your requirement. Write for further details today.

For complete, distortion-free protection of valuable tapes during transportation or storage. Single or multiple containers available in many convenient sizes or shapes.

MAGNETIC SHIELD DIVISION PERFECTION MICA CO.

1322 No. Elston Avenue, Chicago 22, Illinois

Originators of Permanently Effective Netic Co-Netic Magnetic Shielding
At Burnell & Co., our engineers devote a big part of their thinking to shrinking—reducing the size (and cost) of components to the least common denominator consistent with high performance standards. From this staff have come such components as:

The Kernel ATE Adjustoroid®—This variable toroid contains an actual complete toroid with all the excellent characteristics of the non-adjustable type. Valuable in oscillators, discriminators, variable tuned circuits, etc.

MicroMicroid® Filters— Microminiature counterparts of the popular Burnell TCL and TCH low pass and high pass filters, they range from .5 kc to 100 kc with a standard impedance of 10k ohms. Cascading the MicroMicroid® with the ATE-34 produces excellent response band pass characteristics.

“Cheerio” Toroids—Sub miniature high Q coils in a range of frequencies that make them ideal for transistorized equipment.

Crystal Filters—Advanced engineering techniques enable Burnell to offer at nominal cost, high selectivity, high attenuation crystal filters covering the extraordinary range of 1 kc to 30 mes with considerable latitude in impedance.

Pulse networks, interference filters, active networks and magnetic amplifiers are among the newer additions to our product line.

Write for latest catalog.

Burnell & Co., Inc., has a number of positions available for engineers capable of thinking big and shrinking small. Inquiries are invited.

If you haven't already done so—send for your free membership in the Space Shrinkers Club.
CROSSTALK

SPECIAL REPORT. As shown by the chart on p 73, the forecast for 1970 factory value of U. S. electronics production is approximately $20 billion, and for the entire free world $30 billion. This issue's special report is packed with such statistical data, designed to acquaint you with the outlook for our military, industrial and consumer markets during the next decade.

Prepared in large part by Edward DeJongh, one of our market research specialists, this 38-page report analyzes markets on the basis of data provided by more than 100 industry planners. In addition, you'll find informative discussions of distribution by three Raytheon executives, market planning by two ITT officials, and international trade by top executives of National Cash Register, Sprague Electric, General Telephone and Electronics International, Machine & Products, and the law firm of Baker, McKenzie and Hightower. You'll want to save this comprehensive document—especially the full-color foldout.

NAVIGATION COMPUTER. Navigation of Polaris submarines to an accuracy required for pinpointing missile launchings, after extended periods at sea, is a staggering technical problem. Data from many navigational aids is processed by NAVDAC, a sophisticated digital computer, and used to correct long-term drift in the inertial navigation system. In this issue (p 40) ELECTRONICS gives exclusive details of the computer and system, including a block diagram and a photo of equipment aboard the ballistic missile submarine George Washington.

MORE BUSINESS? The commercial fishing industry's use of electronic gear is put in perspective with this issue. We've investigated market trends and volume, checked field applications of depth finders, radiotelephones, lorans, autopilots, radar and fishfinders, found that modern fishermen must rely heavily on such gear to operate at a profit. Reported on also are tests by the U. S. Bureau of Commercial Fisheries of a British fish-locating sonar that indicates azimuth and range of fish schools out to 2,000 yards, a technique little used stateside. The story starts on p 42.

Coming In Our January 13 Issue

MAGNETICS. Magnetic behavior of materials is receiving considerable attention as researchers investigate theory and such applications as computer and microwave devices. Assistant Editor Lindgren attended the Sixth Annual Conference on Magnetism and Magnetic Materials in New York City recently and heard many papers on this subject. Next week he describes advances in all-magnetic logic, ferrite core and thin-film sub-microsecond memory elements, preparation of thin films, ferromagnetic devices and studies of spiral waves in permalloy films.
Here is another GIANT STEP toward optimum reliability...

☆ Sprague Electric's new COMPULYTIC Capacitors now permit digital computer power supply filtering at operating temperatures to 85°C as standard. This is a full 20°C higher than capacitors offered by other sources. COMPULYTICS will reduce your design headaches and cut down your cooling and ventilating problems.

New! compulytic* capacitors are now designed for 85°C operation

☆ Under normal 85°C operating conditions, Type 32D COMPULYTIC Capacitors display extremely low leakage current, low equivalent series resistance, and have higher permissible ripple current values. Extended shelf life of 3 years and more is another outstanding feature.

☆ Ratings up to 130,000μF at 2.5 volts or 630μF at 450 volts are skillfully packed into the largest standard case size of 3" dia. by 4¾" high. Capacitor banks as large as 1 farad have been constructed, in relatively small space, using COMPULYTIC Capacitors.

☆ Because of their extremely high stability, COMPULYTICS are ideally suited for use in continuously adjustable voltage power supplies since they will not "deform" when operated for long periods at lower than rated voltages.


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HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

January 6, 1961
300% FASTER ULTRASONIC CLEANING*

WITH THE NEW SELF TUNING AUTOSONIC BY POWERTRON

Powertron Autosonics are the only cleaners that continuously tune themselves electronically to give you peak cleaning efficiency. Regardless of load changes, liquid level, liquid temperature, or operator inattention, you get top cleaning performance hour after hour with no controls other than a single switch.

The Powertron self tuning feature is available in a complete line of Autosonic tank units, consoles, cabinet models, immersible transducers, and vapor degreasers that...

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IMPROVE QUALITY
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CIRCLE 6 ON READER SERVICE CARD

COMMENT

Microminiaturization
Just a quick note to compliment you on the fine article on microminiaturization ("Special Report on Microminiaturization," p 77, Nov. 25, '60). I still haven't found time to work my way through the entire piece, but from what I have read and from what other engineers and officials here have said, it was a fine piece of writing...

Stu Gellman
INTERNATIONAL RESISTANCE CO.
PHILADELPHIA

Ions and Health
The space in ELECTRONICS devoted recently to discussion of air ionization and speculation on its biological effects indicates considerable interest in a field long neglected by a large segment of the electronics fraternity.

If reader Warner Clements (Comment, p 6, Dec. 9, '60) is seriously interested in this subject, he may start by obtaining perhaps the latest information on the subject, "The Biological Mechanisms of Air Ion Action," The Journal of General Physiology 1960, Vol. 43, No. 35, pp 533-540. If he will start there and pursue the literature references, he will develop a bibliography of staggering proportions.

This is a difficult route to follow unless one has the time and access to a first-class library. A more satisfactory solution would be for the editors of ELECTRONICS to publish a survey article by men competent in the field.

F. C. Maseles
KIVA EXPLORATIONS INC.
AUSTIN, TEXAS

Following our own negatively-ionized nose, we came to much the same conclusion a few weeks ago and are now pursuing a couple of competent men to get just such an article.

Confusion of U Mu
We were happy to see that you had made use of a release from our client E-H Research Laboratories of Oakland, Calif., in your Nov. 25 '60 issue (p 160). Our enthusiasm dimmed, however, when we discovered that you had unfortunately misprinted the specifications on the instrument. You should have indicated that "widths are variable from 10 µsec to 200 µsec," as did the release we sent you.

Since we sent you the release, by the way, the specifications referred to have been changed to "20 µsec to 1 µsec..."

Walter G. Busse Jr.
Harlan & Steedman
San Francisco

The time designations in the letter are reproduced above as we received them; we printed the original specifications as "10 µsec to 200 µsec." Unfortunately, reader Busse means "µsec," his typewriter can't make a µ. Neither can ours. Unfortunately, too, the letter µ is pronounced "mu," and some engineers of our acquaintance, bemused by the lack of a µ on their typewriters, type "msec" when they mean µsec. Since we've followed a more or less consistent pattern of using the prefix "nano-" for 10", we've grown accustomed to "msec" and almost forgotten that "msec" can mean anything but µsec. Just one more reason for using the Bureau of Standards recommended prefixes.

Kudos: General...

...I want to commend you again on the excellent articles in ELECTRONICS. In the Nov. 11 issue, I cut out six articles that were of immediate interest. Keep up the good work...

J. H. Fooks
WESTINGHOUSE ELECTRIC
METUCHEN, N. J.

...and Specific
Your special report on Microminiaturization (p 77, Nov. 25) is the best I've seen. Congratulations on a job well done.

S. M. Stuhlbarg
P. R. MALLORY & CO.
INDIANAPOLIS

...Thanks for the masterpiece on Tiros II ("How Tiros II Ground Control and Infrared Gear Work," p 38, Dec. 9). It's a real pleasure to see such complete, accurate reporting...

Lucien R. Greif
NEW YORK

CIRCLE 7 ON READER SERVICE CARD→
Robinson was the first to design and produce all-metal MET-L-FLEX mounts and mounting systems for the Army's latest vehicular communications and electronic equipment. These mounts are designed for virtually every type of military vehicle—including tanks, trucks, jeeps and helicopters, and will be installed wherever greater reliability of vital equipment must be attained and maintained.

Robinson Models W504-5 and W504-7 were designed specifically for the U.S. Army Signal Corps' new AN/VRC-12 radio receiver and transmitter units produced by Avco Electronics and Ordnance Division. These are the first all-metal mounts to pass the Signal Corps' Ballistic Shock Test (simulating gunfire impact) and the Package Test (simulating repeated road shock). Send for FREE brochure.

Photos Courtesy of Avco Electronics and Ordnance Division
THIS TROUBLE HAS NO FUTURE!

Radiation’s TDMS anticipates circuit failure in telegraph and data transmission links without interrupting traffic

Radiation’s Telegraph Distortion Monitoring System—TDMS—is a compact, self-contained unit for continuous on-line monitoring, testing and analysis of telegraph and data transmission links.

Its sensitivity to signal distortion is so acute that it can locate and describe equipment misalignment before it becomes an operational problem.

TDMS does its job without interrupting traffic and in a language that is easily interpreted by a nontechnical operator. Thus, in our illustration above, a line that is becoming increasingly capacitative can be located and rectified prior to circuit failure.

For detailed information on the TDMS, write Dept. EL-1, Products Division, Radiation Inc., Melbourne, Florida. Refer to Bulletin RAD-E-100B.
Test Air Control System To Handle Terminal Traffic

TERMINAL TRAFFIC system capable of handling up to 24 aircraft in a 90-mile radius of the airport radar was unveiled recently by Avco/Crosley. Dubbed Volscan, the AN/GSN-11 traffic-control system is undergoing tests at USAF's Cambridge Research Laboratory, was developed to control high-density all-weather military operations, may help prevent air collisions such as the recent tragedy over New York.

System provides scheduling to touchdown, scheduling criteria to avoid collision conditions, identification and data displays, precisely computed close-control vectoring. Seven controllers monitor the various consoles. Volscan can provide landing data for 18 inbound aircraft, handle six departing craft at the same time.

Radar provides data on speed, altitude and position of aircraft to an analog computer which vectors the plane to an entrance gate. Analog data are converted to digital form, processed by another computer to determine priority among the 18 inbound craft; the digital system assigns touchdown times to each plane, can bring them in as close as 30 seconds apart.

Automatic voice relay developed by Cook Electric translates the computed path into verbal instructions, assembles the instructions from spoken words recorded on a drum, and relays them automatically to the pilot, giving him course, altitude, point to start descent, landing checkpoints and the location of the entrance gate.

The radar detects deviations from the selected flight path and informs the computer, which calculates new instructions or assigns new priorities in two to fifteen seconds.

Britain Clamps Moratorium On Broadcast Developments

NO NEW DEVELOPMENTS in television or radio broadcasting will be permitted in the United Kingdom until the end of 1961 or early 1962. Postmaster-General J. B. Bevins delivered this verdict after considering BBC's request to start experimental color-tv transmissions next November.

Postal Ministry has set up a special committee to consider such developments as color tv and stereophonic radio in the future pattern of British broadcasting. The ministry wants to let the committee reach its conclusions before permitting any innovations in the broadcasting technology. Two other BBC proposals were turned down for the same cause; one would have set up more radio stations in the larger towns, and the other would have extended the broadcast day.

Both BBC and the setmakers resent the decision. Tv industry in Britain has been suffering a slump for some months due in part to rigid controls on retail credit.

Japan Extends Quotas For Transistor Radios

JAPAN'S Ministry of International Trade & Industry last Saturday announced a six-month extension in the export quotas for transistor radios imposed last summer. Sales to the U.S. and Canada have leveled off due to the imposition of the quotas, while slightly higher sales to other parts of the world market have been recorded.

A few days later, major Japanese manufacturers of transistors agreed among themselves to cut by 20 percent the prices of transistor radio kits in consignments of more than 30,000. The price was fixed last May at $2.50 per kit consisting of six transistors and one diode. Rapidly growing inventories—which in September stood at 26 million kits—are responsible for the price slash. Transistor radio exports to the U.S. have been almost at a standstill since September, when the quotas were filled; monthly production has continued since at a rate of about 12 million kits.

MITI—which officially believes production controls are more desirable than further price cutting—is expected to take remedial action this month. Domestic prices for the kits were fixed at $2.50 last March, but they're being sold in Japan for about $1.65.

Radar Simulator Uses Tv Camera

TRAINING DEVICE to allow jet fighter and bomber pilots to train to fly at low altitudes over hazardous terrain has been developed by ACF Electronics. The NASARR—for North American search and ranging radar—uses a miniature tv camera hooked into a radar scope. A three-dimensional terrain map of the area in which the mission is to be flown is the other major component.

A fine beam of light scans the terrain map in a pattern analogous to the radiation pattern from the aircraft antenna. The position of the light source over the map represents the aircraft position. The tv camera picks up light reflections from the map, relays the video to the radar scope where it is presented in standard plan-position form.

Canadians May Form Space R&D Consortium

NEGOTIATIONS are under way among members of Canada's aviation-electronics industry to form an export manufacturing cooperative, ELECTRONICS learned last week. Object of the plan is to break into the big U.S. market for defense and space R&D contracts. Canadian manufacturers are mostly too small to compete singly against big, diversified U.S. firms.

Soviets Budget $4 Billion For Electronics Research

SOVIET UNION expects to spend 3.8 billion rubles on space and science in 1961 to "ensure implementation of a big program of scientific work and further expand the network of research establishments." At new exchange rates, the budget figure comes to $4.18 billion.

Science budget was announced last week to the Supreme Soviet,
represents a 15.6-percent boost over 1960. Presumably it will stress research in electronics and automatic controls. Government spokesman V. Novikov pointed out that "great attention is being paid to expanding production of selenium, silicon and germanium." Output of "instruments and means of automation" is to increase 21 percent in the new year. Production of transistorized instruments in the Russian Federation alone is slated to climb 60 percent.

Novikov also indicated that top priority will be given to raising the quality level of production controls and instruments. The 1961 plan for the first time includes assignments for the introduction of new production techniques in industry, aimed at getting new technology on the production line more quickly. Quota-conscious Soviet production managers have been loth to try out new gear in the past.

Study Field Defense Against Ballistic Missiles

Army ordnance has awarded a quarter-million-dollar contract to Sylvania to study the feasibility of a field army ballistic-missile defense system. Sylvania has teamed with Ford Motor's Aeronutronics division on the project.

Army wants a missile system capable of moving with and protecting forces in the field from various ballistic and guided missiles. Sylvania has done work on Army's Plato countermeasure, the AN/MPQ-32 counterbattery radar, and the Mobidic mobile computer—all of which might conceivably be part of a field defense system.

Electronic Controls Run Automatic Gasoline Blender

Wilshire Oil subsidiary of Gulf Oil Corp. has placed onstream an automatic gasoline blender developed by C. F. Braun & Co. and Wilshire engineers. Electronic blending controls have been under development for several years; the new installation at Santa Fe Springs, Calif., reportedly is a completely electronic system.

Blender operator sets the blend formulation from pushbuttons; the system then proceeds automatically to deliver the prescribed quantity of gasoline in the specified blend. When finished, the system closes all valves and stops the pumps. If the blender fails to deliver the correct quantity of a particular component, checking devices alert the operator at the supervisory console by warning lights and an audible alarm. If he does not take corrective action, the blender shuts itself.

Gulf spokesmen feel that the electronic system makes for greater formulation accuracy, permits use of longer transmission lines from control console to control valves. Meters, control valves and electronic circuits were designed and furnished by Propionereers division of B-I-F Industries.

Russian Scientist Builds Electrostatic Storm-Warning

SOVIET SCIENTIST I. M. Imyanitov is working on an aircraft storm-warning device that will detect the difference in electrostatic field intensity in thunderheads and other, less harmful, cumulus types. The instrument is based on a study of fields in thick cumulus clouds and thunderheads, and the changes in field intensity during lightning discharges. Apparently it will use a sensitive electroscope with a threshold that recognizes the conditions in thunderheads.

See Need for Computers To Check Out Aircraft

INCREASING system complexity and greater unit cost mean that automatic maintenance checkout by electronic computers reading comprehensive built-in instrumentation is of paramount importance for economical operation of tomorrow's supersonic transports aircraft. That opinion was expressed strongly last month by spokesmen for Convair division of General Dynamics.

Automatic checkout could be performed by ground-based or airborne computer systems, would add an hour a day to aircraft operating time, in one spokesman's prediction. The system could also be made to predict possible sources of future trouble.

Computers would cost less than $1 million, could double for navigation, inflight monitoring or other duties if carried on the plane. Based on 100-plane lots, Convair predicts that building such automatic checkout capability into planes would add 2.8 percent to total cost: 1-percent increase in cost of engineering design to include added instrumentation; 1.5 percent for materials and labor for the instrumentation; 0.3 percent for installation of inflight recording gear. Cost of the maintenance-analysis computer would be added to this. But the use of the analysis instruments during production would bring about at least a 1-percent reduction, Convair figures, resulting in a net increase of 1.8 percent plus the computer cost.

NBS develops Antenna To Scan Ionosphere

National Bureau of Standards scientists at Boulder, Colo., have developed a rapid-scan vhf antenna system using all-electronic controls which has "high potential for . . . experimental studies of the ionosphere."

The device works into seven 5-element Yagi antennas, swings a 5.8-deg beam through a 42-deg azimuthal scan 20 times a second. Scan is accomplished by phase control over the r-f fed to the antenna elements. A cathode-ray oscilloscope is synchronized to the scan pattern to permit viewing and photographing.

System can provide instantaneous bearing data on ionized meteor trails. Boulder lab men have it trained on the NBS field station in Havana, Ill., to observe and record best-path data on vhf forward-scatter transmissions.

Air Force to Probe November's Solar Flare

SOLAR ERUPTION last November 15-17, which bunged up radio communications and caused auroral displays as far south as Miami, Fla., will be the subject of a conference next month at USAF's Cambridge Research Lab.
Quality Features of
OHMITE VITREOUS ENAMELED RESISTORS

Balanced Thermal Expansion prevents crazing and moisture entrance

In Ohmite resistors, spot welding replaces soldering, brazing, and mechanical fastening. Spot welding produces strong connections that are not affected by vibration or high temperatures. Ohmite welded construction also produces an almost flush connection between the resistance wire and terminal. This prevents thin spots or bulges in the vitreous enamel coating which might cause future trouble and failure. Many different types of terminals are available besides the lug illustrated.

Ohmite can supply all of your resistor needs

The almost endless variety of Ohmite resistors in many sizes and types—in a wide range of wattages and resistances—makes it possible to meet each individual need. Many of these can be supplied from the world's largest factory stock. Whatever your resistor requirements may be, chances are you will find exactly the type you need in industry's most complete line of high-quality resistors.

Axial Lead
Brown Devil™ Wire Lead
Fixed, Lug Type
Dividohm® Adjustable
Thin Type
Noninductive
Powr-Rib™, High Current, Round or Ribbon Wire, Open Wound
Corrib®, High Current, Corrugated, Edgewound Ribbon
Resistors with Heat Conducting Slugs
Ferrule Mounting Resistors
Live Bracket Mounting Resistors
Edison Screw Base Mounting Resistors
Riteohm™ Wire-Wound Precision Resistors, Encapsulated; Vitreous Enamelled; Molded Jacket; Hermetically Glass Sealed
Riteohm® Metal Film Resistors
Resistors to meet MIL Specifications
High-Shock Resistors

Write on company letterhead for Catalog 58
NEW SEMICONDUCTOR-DIODE
Test Unit
for measuring recovery characteristics

TEKTRONIX TYPE S PLUG-IN UNIT

You can now display semiconductor-diode switching characteristics on your Tektronix Type S Unit. The Tektronix Type 540-Series and Type 550-Series Oscilloscopes that you can find:

Effective lifetimes to 2 nanoseconds
Stored charge to 10 picocoulombs
Junction capacitance to 2 picofarads
Base resistance to 0.25 ohm

The Type S Unit describes the diode in terms of its parameters, while the other currently available methods describe the diode in terms of its performance in a particular circuit—not necessarily the one in which it will be used. With the Type S method you can predict the behavior of many diodes in many circuits, as well as compare diodes for performance in a particular circuit.

A Type S Unit, plugged into your Tektronix Oscilloscope, can save you many hours of experimentation. Call your Tektronix Field Engineer for a demonstration in your application.

MAIN CHARACTERISTICS

Calibrated Forward Currents
1, 2, 5, 10, and 20 milliamperes.
Calibrated Reverse Currents
0, 0.1, 0.2, 0.5, 1, and 2 milliamperes.
Diode Shunt Capacitance
5 picofarads.
Amplifier Sensitivity
0.05 V/cm and 0.5 V/cm calibrated.

Type S Diode Recovery Unit:

For factory:

S250

Note: Risetime of the Type S Unit depends on the capabilities of the oscilloscope with which it is used, therefore the ability to analyze fast diodes with Tektronix Type 530-Series Oscilloscopes will be affected by the lower risetimes of these instruments.

Tektronix, Inc.
P. O. Box 500 • Beaverton, Oregon
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TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington, Tektronix is represented in twenty overseas countries by qualified engineering organizations.

In Europe please write Tektronix Inc., Victoria Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country.

NOTE: The above waveform photos are multiple exposures.

CAREER OPPORTUNITIES now exist at Tektronix in the following fields: Instrument design, Circuit design and engineering, Cathode ray tube, Electronics physics, Solid state and semiconductor devices. For information write to... Irving Smith, Professional Placement.
all different

...all the same

Crosby-Teletronics is active in many different areas. But despite the different products there is a fundamental similarity...the background of engineering skill and know-how that's applied to the solution of every problem.

SPECIAL EQUIPMENT

Participation in military projects and special work with prime contractors is a strong point at Crosby-Teletronics. Shown here is a facsimile memory storage recorder developed as part of the AIRCOM Project Quick-Fix.

TESTING EQUIPMENT

Ground testing plays a great part in the nation's missile development, and Crosby-Teletronics is playing its part with a full line of test equipment. Shown here is a telemetering test oscillator (model TO-258) which has become a standard in many U. S. missile programs.

SINGLE SIDEBAND

and diversity transmission and reception equipment is a forte of Crosby-Teletronics. Extensive research in long range communications has made the company the foremost name in this area. Shown here is a single sideband signal generator—model SG-262.

VACUUM RESEARCH

This newly formed Crosby-Teletronics division has developed an ultra sensitive, mass spectrometer leak detector which has 1000 times the sensitivity of any other helium actuated device now on the market.

Let Crosby-Teletronics help solve your problems in any of these basic areas of activity.

Contact your local representative or:

Crosby-Teletronics Corporation
54 Kinkel Street, Westbury, L. I., New York
WASHINGTON OUTLOOK

COLLISION OF TWO AIRLINEES over New York, the worst disaster in the history of commercial aviation, has put new urgency behind a drive to automate air traffic control and much of air navigation through electronics and other scientific techniques.

The Federal Aviation Agency is conducting research on various warning devices, which would alert pilots when they move onto a collision course, and also on collision-avoidance devices, which would not only warn the pilot but tell him what corrective action to take.

A collision-avoidance system designed by Bendix will be tested soon at FAA's Atlantic City research center. It makes use of instruments which exchange coded information on altitude and bearing by bouncing signals between the planes and the ground. It is designed to furnish both warning of collision and suggested evasive action.

The Bendix system functions only on relatively straight flights, cannot work in holding patterns. Sperry Gyroscope is working on a system that would be able to handle stacked aircraft awaiting landing clearance. Another device intended for collision warning is an r-f system designed by Motorola. FAA expects to learn much from it in tests that will be conducted this month.

FAA has publicly stated that the best insurance against collision is not an airborne instrument, but positive traffic control from the ground. The Agency has three major developments in the works:

A data-processing system to free air controllers from much of the paperwork involved in keeping track of flights. The machine will not only do this bookkeeping, but also warn the controller of impending flight conflicts. The system was developed by General Precision.

Three-dimensional radar to provide simultaneous information on speed, bearing and lateral separation, and altitude. This system, now in preliminary test, was developed by William L. Maxson Corp.

An automatic data-communications system which will take altitude and identity information from all planes in a certain area on roll call, relieving the controller of another chore and freeing radio frequencies for urgent messages.

FINAL EISENHOWER DEFENSE BUDGET will increase spending for major hardware procurement from the current $13.8-billion level to more than $14 billion. Outlay for aircraft production will drop to below $6 billion for the first time since the Korean War. Missile expenditures will top the $4-billion mark as production of Atlas, Titan and Polaris goes into high gear. Shipbuilding expenditures will follow the current $1.7-billion rate.

Expenditures for weapons research, development, test and evaluation will rise about 10 percent above the present $4.1-billion level; increases will be for missiles, electronics, and satellites.

Air Force's Minuteman ICBM and B-70 Valkyrie bomber projects will receive healthy boosts. New money request for Polaris will be at this year's appropriation level. No new funds will be sought for Air Force's Skybolt air-launched ballistic missile, Navy's Missileer interceptor aircraft, or the B-52 or B-58 bombers.

Recent administration approval of an additional $400 million for fiscal 1962 brings total defense spending for the new fiscal year (starting next July 1) to $42.9 billion, up $1.4 billion over the current rate. Budget Bureau originally planned to hold the Pentagon to the current rate, but gave in to Defense Department pressures a few months back and approved a $1-billion increase. The additional $400 million was squeezed in just before the final budget figures were approved; Defense Secretary Gates said it would be needed to prevent stretchouts or curtailment of programs under way.

The incoming administration of President-elect Kennedy will undoubtedly jack up the defense budget, but the increase will be nothing like the $2.5-to-$3-billion figure that was bruited about during the campaign. Increase will probably run closer to $500 million; the added outlay would be used to step up the level of effort in research projects.
“Really demanding specifications call for
DALE
Type RS Resistors”

You can place the utmost confidence in Dale precision resistors even when today’s new and unprecedented standards of “missile reliability” are the goals towards which you are designing.

Under any and all conditions, Dale resistors retain their stability because it has been “firmly infixed” by Dale design and methods of manufacture . . . methods which have now reached new levels of achievement as part of Dale’s super-high reliability development program.

SPECIAL PROBLEMS? Let us help you with your requirements for special resistance products. We make modifications of standard products, resistor networks, matched pairs, etc. Send us your specs.

PROMPT DELIVERY. Whether your need is for a short “test run” or a large production release, Dale offers prompt service, direct from the factory and through a widespread network of distributors.

Write for Bulletins R-33, R-25 and R-30 with handy cross-reference file cards

DALE ELECTRONICS, INC.
1300 28th Ave., Columbus, Nebraska, U.S.A.
A subsidiary of HATHAWAY INSTRUMENTS, INC.

You can place the utmost confidence in Dale precision resistors even when today’s new and unprecedented standards of “missile reliability” are the goals towards which you are designing.

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1300 28th Ave., Columbus, Nebraska, U.S.A.
A subsidiary of HATHAWAY INSTRUMENTS, INC.

DALE
TYPE RS RESISTORS
WIRE WOUND • PRECISION • POWER
Designed for advanced electronic circuits where space is at a premium. Three configurations: Type RS with axial leads and in most ratings and resistances shown; Type RLS with radial leads; Type RSE for clip mounting.

• Rated at 1/2, 1, 2, 2½, 3, 5, 7, 10 watts
• Resistance range from .05 ohm to 175K ohms, depending on type
• Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%
• Temperature coefficient within 0.00002/degree C.
• Operating temperature range from —55°C to 275°C.
• Smallest in size, ranging from 5/64” by 5/16” to 3/8” by 1-25/32”. Ten choices
• Completely protected, impervious to moisture and salt spray
• Complete welded construction from terminal to terminal
• Silicone sealed, offering high dielectric strength and maximum resistance to abrasion
• Meet functional requirements of MIL-R-26C

January 6, 1961
WHAT HAPPENS
WHEN A NATION
SPENDS MORE
ON GAMBLING
THAN IT SPENDS FOR
HIGHER EDUCATION?

If you can find any Romans around, ask them. They lived pretty high on the hog in their day. That is, until some serious-minded neighbors from up North moved in. The rest is ancient history.

You'd think their fate would have taught us a lesson. Yet today we Americans spend twenty billion dollars a year for legalized gambling, while we spend a niggardly four-and-a-half billion for higher education. Think of it! Over four times as much! We also spend six-and-a-half billion dollars a year for tobacco, nine billion dollars for alcoholic beverages, and billions more on other non-essentials.

Can't we read the handwriting on the wall?

Our very survival depends on the ability of our colleges and universities to continue to turn out thinking men and women. Yet today many of these fine institutions are hard put to make ends meet. Faculty salaries, generally, are so low that qualified teachers are leaving the campus in alarming numbers for better-paying jobs elsewhere.

In the face of this frightening trend, experts estimate that by 1970 college applications will have doubled.

If we are to keep our place among the leading nations of the world, we must do something about this grim situation before it is too late. The tuition usually paid by a college student covers less than half the actual cost of his education. The balance must somehow be made up by the institution. To meet this deficit even the most heavily endowed colleges and universities have to depend upon the generosity of alumni and public spirited citizens. In other words, they depend upon you.

For the sake of our country and our children, won't you do your part? Support the college of your choice today. Help it to prepare to meet the challenge of tomorrow. The rewards will be greater than you think.

It's important for you to know what the impending college crisis means to you. Write for a free booklet to HIGHER EDUCATION, Box 36, Times Square Station, New York 36, New York.
HIGH VACUUM COMPONENTS & EQUIPMENT
If you want to make your product lighter, stronger, smaller, more dependable, or change its appearance at low cost, try high vacuum. If sub-miniaturization is your goal, high vacuum is your answer. If purer, stronger metals are needed, high vacuum will produce them.

All NRC equipment is designed primarily for simplicity and reliable performance in the field. The problems that usually beset the uninitiated in the use of high vacuum equipment have been engineered out. You don't have to be a high vacuum expert to enjoy the advantages of NRC high vacuum equipment. In our 20 years' experience, we have learned how to build the most dependable equipment as well as how this equipment can be used most profitably by our customers.

Let us help you enjoy the benefits of using high vacuum in your plant or process. When you buy from NRC you get the advantage of specialization, a complete line, and the latest in high vacuum technology. Let us help you improve your product with high vacuum now.

<table>
<thead>
<tr>
<th>Pumps</th>
<th>Capacity CFM</th>
<th>&quot;Clean&quot; Vacuum</th>
<th>Remarks</th>
<th>Torr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary Gas Ballast:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Stage</td>
<td>1.25-400</td>
<td>no</td>
<td>Gas ballast keeps pump oil free of condensables</td>
<td></td>
</tr>
<tr>
<td>Two Stage</td>
<td>1.25-400</td>
<td>no</td>
<td>Very high speed throughout micron range</td>
<td></td>
</tr>
<tr>
<td>Mechanical Booster</td>
<td>250-4500</td>
<td>yes</td>
<td>Oil and mercury</td>
<td></td>
</tr>
<tr>
<td>Booster Diffusion</td>
<td>25-6000</td>
<td>no</td>
<td>For special purpose tubes</td>
<td></td>
</tr>
<tr>
<td>Molecular Drag</td>
<td>150</td>
<td>very</td>
<td>Oil and mercury</td>
<td></td>
</tr>
<tr>
<td>Diffusion — Untrapped</td>
<td>70-70,000</td>
<td>no</td>
<td>Very reliable</td>
<td></td>
</tr>
<tr>
<td>With Cold Trap</td>
<td>10</td>
<td>yes</td>
<td>Intermittent operation</td>
<td></td>
</tr>
<tr>
<td>Titaniam Adsorber Ion</td>
<td>2</td>
<td>very</td>
<td>For small UHV systems</td>
<td></td>
</tr>
</tbody>
</table>
Rotary mechanical pumps are the prime movers in most high vacuum systems. NRC mechanical pumps were designed to take full advantage of gas ballasting. As a result, they can handle higher concentrations of water and other condensable vapors than any other mechanical pump. Such vapors condense in, and contaminate the oil of conventional pumps, thereby reducing their capacity and ability to produce low pressures.

NRC Diffusion Pumps assure a higher, cleaner, faster vacuum. They combine top performance characteristics with the ability to deliver this performance under a wide range of field conditions. High peak speed, low backstreaming, high fore-pressure tolerance, and low ultimate pressures are not affected by the variations in line voltage, cooling water supply, and oil level which can be expected in normal operation.

Contributing to their ability to deliver prolonged maintenance-free operation are stainless steel bodies, fractionating jet assemblies, long-lived cast-in heaters and silver soldered cooling coils.

---

**MECHANICAL VACUUM PUMPS**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Capacity CFM</th>
<th>H.P.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SINGLE STAGE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-S</td>
<td>1.3</td>
<td>4/</td>
</tr>
<tr>
<td>4-S</td>
<td>3.3</td>
<td>6/</td>
</tr>
<tr>
<td>6-S</td>
<td>6.6</td>
<td>1</td>
</tr>
<tr>
<td>15-S</td>
<td>16.5</td>
<td>1.5</td>
</tr>
<tr>
<td>30S</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>100S</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>200S</td>
<td>202</td>
<td>10</td>
</tr>
<tr>
<td>400S</td>
<td>404</td>
<td>20</td>
</tr>
<tr>
<td><strong>DOUBLE STAGE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2D</td>
<td>1.3</td>
<td>4/</td>
</tr>
<tr>
<td>4D</td>
<td>3.3</td>
<td>6/</td>
</tr>
<tr>
<td>6D</td>
<td>6.8</td>
<td>1.5</td>
</tr>
<tr>
<td>30M</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>100M</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>200M</td>
<td>202</td>
<td>25</td>
</tr>
</tbody>
</table>

**DIFFUSION PUMPS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Max. Speed liters/sec</th>
<th>Max. Forepressure microns</th>
<th>Recommended Forepump Capacity (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-2-P</td>
<td>70</td>
<td>180</td>
<td>3</td>
</tr>
<tr>
<td>H-2-SP</td>
<td>85</td>
<td>250</td>
<td>4</td>
</tr>
<tr>
<td>A-2-P</td>
<td>80</td>
<td>200</td>
<td>4</td>
</tr>
<tr>
<td>C-4-P</td>
<td>300</td>
<td>200</td>
<td>6</td>
</tr>
<tr>
<td>H-4-P, H-4-SP</td>
<td>340</td>
<td>200</td>
<td>6</td>
</tr>
<tr>
<td>H-6-P</td>
<td>675</td>
<td>200</td>
<td>15</td>
</tr>
<tr>
<td>HS6-1500</td>
<td>1,500</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>H-10-SP</td>
<td>2,800</td>
<td>300</td>
<td>15</td>
</tr>
<tr>
<td>H-16-SP</td>
<td>5,200</td>
<td>200</td>
<td>30</td>
</tr>
<tr>
<td>H-20-SP</td>
<td>6,800</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>H-32-SP</td>
<td>13,500</td>
<td>550</td>
<td>100</td>
</tr>
</tbody>
</table>

**BOOSTER PUMPS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Max. Speed liters/sec</th>
<th>Max. Forepressure microns</th>
<th>Recommended Forepump Capacity (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>11.5</td>
<td>300</td>
<td>15</td>
</tr>
<tr>
<td>B-2</td>
<td>80</td>
<td>800</td>
<td>15</td>
</tr>
<tr>
<td>B-4</td>
<td>240</td>
<td>800</td>
<td>100</td>
</tr>
<tr>
<td>B-6</td>
<td>675</td>
<td>800</td>
<td>100</td>
</tr>
<tr>
<td>B-10</td>
<td>1,500</td>
<td>450</td>
<td>200</td>
</tr>
<tr>
<td>B-12</td>
<td>2,800</td>
<td>800</td>
<td>200</td>
</tr>
</tbody>
</table>
Both standard and special high vacuum valves are available for systems of all sizes. Write for bulletin VB60.

To get "clean" vacuum and very low pressures without undue sacrifice in pumping speed, specify NRC optical baffle cold traps. Write for bulletin No. 0314.

Minimum impedance to gas flow is offered by NRC slide valves. They are used both to isolate diffusion pumps and with air locks. Write for bulletin VB60.

NRC Rotary Bellows seal type 1301 for imparting motion into high vacuum chamber. Complete line available. Send for bulletin US-1300.

Isolate vibration with flexible connectors designed for high vacuum systems. Sizes 2"-6". Bulletin No. FC 5000.

NRC VALVES

NRC offers you a wide choice of high vacuum and air release valves. Standard types and sizes are listed in the table. Special valves can be furnished on request.

Design and fabrication of NRC valves emphasize low impedance to gas flow, low outgassing of valve parts, high resistance to contamination, easy installation and operation, and freedom from maintenance.

NRC VACUUM VALVES

| SIZE — INCHES | 1/8 | 1/4 | 1/4 | 1/4 | 1/2 | 3/4 | 1 | 1 | 1 | 1 | 1
|---------------|-----|-----|-----|-----|-----|-----|---|---|---|---|---
| Hand-Operated | Cast Bronze — Globe | X | X | X | X | X | X | X | X | X | X
| Cast Bronze — Angle | X | X | X | X | X | X | X | X | X | X | X
| Ball | X | X | X | X | X | X | X | X | X | X | X
| Slide | X | X | X | X | X | X | X | X | X | X | X
| Air-Operated | Cast Bronze — Globe | X | X | X | X | X | X | X | X | X | X
| Cast Bronze — Angle | X | X | X | X | X | X | X | X | X | X | X
| Ball | X | X | X | X | X | X | X | X | X | X | X
| Slide | X | X | X | X | X | X | X | X | X | X | X
| Fabricated Angle | X | X | X | X | X | X | X | X | X | X | X
| AIR RELEASE | Angle-Operated | Cast Bronze — Globe | X | X | X | X | X | X | X | X | X | X
| Cast Bronze — Angle | X | X | X | X | X | X | X | X | X | X | X
| Ball | X | X | X | X | X | X | X | X | X | X | X
| THROTTLE | X | X | X | X | X | X | X | X | X | X | X

NRC ACCESSORIES

BAFFLES AND TRAPS

Optical baffle cold traps are used between the diffusion pump and the vacuum chamber to keep backstreaming diffusion pump oil vapors from contaminating the work. They also permit reaching pressures several orders of magnitude lower than possible with untrapped pumps. NRC cold traps provide a short, optically dense path with a full-flow cross section so as to combine efficient trapping with minimum impedance to gas flow. Available in 2, 4, 6, 10, 16, 20 and 32 inch sizes they can be cooled with water, mechanical refrigeration or liquid nitrogen.

SEALS AND FEED-THRU'S

High vacuum seals and feed-thru's are used (1) to transmit power, water, mechanical motion or instrumentation signals through the walls of a vacuum chamber, and (2) to make it easy to connect a gauge or tube to a vacuum system. NRC offers a wide choice of standard and special seals and feed-thrus.

FLEXIBLE CONNECTORS

Flexible connectors are used to connect adjacent vacuum components in a system. The flexible stainless steel center section of the connector isolates vibrating parts in order to reduce system vibration and matches parts which do not line up properly. One end of the flexible connector has a floating flange which is used to connect adjacent parts on which the bolt holes are not on the same center line.
The two basic types of vacuum gauge are the thermal and ionization types. The principle behind thermal gauges is the heat conductivity of the gas that decreases with pressure. The NRC thermocouple gauge is an inexpensive, rugged thermal gauge with a measurement range of from 2 Torr to 1 micron absolute. This gauge is often used to indicate and control rather than to measure. The Pirani vacuum gauge is an extremely accurate thermal gauge over a range of 1 Torr to 1 micron.

Ionization gauges work on the principle that gas molecules produce a small current when they are ionized and attracted to a collector. The current produced is a direct indication of pressure in the system.

The Alphatron® Ionization Vacuum Gauge is a linear, stable gauge which measures pressure from atmospheric to $10^{-4}$ Torr. The Redhead magnetron gauge is an ionization gauge with high sensitivity over a wide range, from $10^{-4}$ Torr to less than $10^{-13}$ Torr.

NRC portable pumping systems are complete units which incorporate rotary gas ballast pumps, diffusion pumps, optical baffle cold traps, valves and gauges, plus optional components if desired. The systems are ready to operate after making connections to power, water, and the vacuum chamber. The NRC portable pumping systems are capable of producing and measuring a clean vacuum to pressures below $10^{-4}$ Torr.

All components have been matched for maximum efficiency and effective pumping speeds over wide pressure ranges, despite variations in power and cooling water. The welded frames of the portable pumping systems are light and strong.

All components are mounted for ready accessibility to permit ease of operation, cleaning, and maintenance.
VERSATILE PACKAGED MODEL 3144 VACUUM COATER

Vacuum Coating is an NRC specialty. Functional coating applications include solid state work; micro-miniaturized, high-reliability, and/or precision-value electron components; deposition of thermally reflective, optically transparent coatings; non-embrittling corrosion protection; optical effects; and many others. Decorative coatings, usually applied over a lacquer base (to get a low-cost, high gloss finish), are widely used on plastic and metal automotive components, appliances, novelties, toys, jewelry, etc.

NRC offers a full line of standard vacuum coaters, ranging from an inexpensive tabletop model, through highly versatile bell jar research and development units, to high capacity production equipment. Special models include ultra-high vacuum and electron beam units. Also, NRC coaters emphasize short-cycles, “clean” vacuum, and convenient, low-cost operation.

CRYSTAL-GROWING FURNACES

NRC Crystal-Growing Furnaces make it easy to grow single crystals of germanium or silicon by the Czochralski method. Resistance-heated for low initial and operating costs, they have become the industry’s favorite standard unit because of their ability to turn out large numbers of consistently high quality crystals.

Features of these units are precise temperature control, vibrationless operation, and freedom from contamination. In addition, they are easy to operate, clean, and provide excellent visibility.
VACUUM FURNACES

Tantalum sintering and electron beam melting furnaces are two of the outstanding types among NRC's complete line of vacuum heat-treating and melting equipment. NRC, which has built and operated more high vacuum furnaces than any other manufacturer, also offers a variety of induction, cold-mold and skull arc, medium and high (to 4500°F) temperature resistance and levitation units. Capacities range from several grams to several tons. Standard and special units can be furnished for batch or semi-continuous operation.

Among the NRC-pioneered features which make these furnaces unusually safe, productive, and trouble-free are co-axial induction power leads, special electrode and cold mold designs, long-lived, non-shorting heating elements and shields and a variety of ingenious charging and work-holding devices.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>CAPACITY</th>
<th>LBS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2575</td>
<td>4 to 28</td>
<td>12-17</td>
</tr>
<tr>
<td>2511-B</td>
<td></td>
<td>100-200</td>
</tr>
<tr>
<td>2555-B</td>
<td></td>
<td>200-300</td>
</tr>
<tr>
<td>2501</td>
<td></td>
<td>300-600</td>
</tr>
<tr>
<td>2503</td>
<td></td>
<td>700-1000</td>
</tr>
<tr>
<td>2506</td>
<td></td>
<td>1000-2000</td>
</tr>
</tbody>
</table>

RESISTANCE

<table>
<thead>
<tr>
<th>MODEL</th>
<th>HOT ZONE</th>
<th>MAX. TEMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2904-B</td>
<td>2 3/4&quot; ID x 3&quot;</td>
<td>4400°F</td>
</tr>
<tr>
<td>2911</td>
<td>12&quot; x 12&quot; x 12&quot;</td>
<td>4400°F</td>
</tr>
<tr>
<td>2914</td>
<td>3&quot; ID x 6&quot;</td>
<td>4400°F</td>
</tr>
<tr>
<td>2915</td>
<td>6&quot; ID x 10&quot;</td>
<td>2000°F</td>
</tr>
<tr>
<td>2917</td>
<td>54&quot; ID x 144&quot;</td>
<td>2000°F</td>
</tr>
<tr>
<td>2936</td>
<td>36&quot; ID x 36&quot;</td>
<td>2000°F</td>
</tr>
</tbody>
</table>

ARC

<table>
<thead>
<tr>
<th>MODEL</th>
<th>BUTTON-8 LBS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2702</td>
<td>18</td>
</tr>
<tr>
<td>2703</td>
<td>50</td>
</tr>
<tr>
<td>2715</td>
<td>100</td>
</tr>
<tr>
<td>2721</td>
<td></td>
</tr>
</tbody>
</table>

ELECTRON BEAM WELDERS

NRC's Electron Beam Welders have solved problems posed by welding heat-sensitive assemblies; tungsten, tantalum, and other difficult metals; dissimilar materials; and unusual geometry. Freedom from contamination, porosity, and distortion; spot size controllable from 10 mils to 3"; depth width ratios of 4/1; and precision welding at the bottom of 1/32" wide slot are some of the advantages of this new, proven process. A unique electron gun arrangement and other design features provide excellent visibility and ease of use. Arcing and other annoyances are eliminated. Short-run and sample welding service are available (on a time and material basis) in the NRC Electron Beam Welding Lab.

Simple low-cost electron beam welder for precision welds in reactive, refractory, and high performance materials. Send for bulletin No. 2405.
NRC Altitude Chambers that can simulate altitudes up to 400 miles \((1 \times 10^{-8} \text{ Torr})\) are widely used to test space-destined electronic and other components. Standard as well as custom-engineered systems, from a 12" Bell jar to 8' diameter tank, are available and can be furnished with automatic pressure and temperature programmers.

NRC has a long history of freeze drying accomplishments, among which are the development of frozen juice concentrate and installation of 90% of the free world's penicillin drying capacity. Recent developments promise significant savings in drying foods, pharmaceuticals, biologicals, and other heat-sensitive materials.

NRC's Freeze Drying Laboratory is available (on a contract basis) to establish the most economical drying process for your product. In addition, NRC offers standard laboratory units and custom-engineered production systems.
FACTS ABOUT

MYCALEX CORPORATION OF AMERICA

... the world's largest manufacturer of glass-bonded mica, ceramoplastic and synthetic mica products ... important and versatile materials used to solve high-temperature insulation applications up to 1550°F in electrical, electronic, and nucleonic industries.

Machinable formulations:
- SUPRAMICA® 620 ceramoplastic
- MYCALEX® 400 glass-bonded mica

Precision-molded formulations:
- SUPRAMICA 560 ceramoplastic
- MYCALEX 410 glass-bonded mica

Affiliated Companies

MYCALEX ELECTRONICS CORPORATION

... manufacturer of electromechanical commutators for time-division multiplex tele-metering, timing, and control switching. Since 1948, when MYCALEX ELECTRONICS CORPORATION pioneered the first precision-molded MYCALEX 410 glass-bonded mica, 180-contact commutator plate, MYCALEX switches have introduced exceptional accuracy and dependability never before approached in mechanical switching. Recent advances have produced commutators with as many as 450 contacts on a 3" commutation plate.

COMMUTATION SWITCHES

SYNTHETIC MICA COMPANY

... in 1955, MYCALEX CORPORATION OF AMERICA formed the Synthetic Mica Company and opened the first plant in the world for commercial production of synthetic mica—freeing America from any threat of a critical mica shortage in war or peace. Now industry and the military are assured an adequate supply of this critical and basic material. An intensive and diversified Research and Development Program is carried on by MYCALEX CORPORATION OF AMERICA at its technical center located at the Synthetic Mica Company facility. This broad scale program is constantly developing new manufacturing techniques and materials to supply the ever-increasing demands and rigorous requirements of the electronics and allied industries.

SYNTHAMICA® 202 synthetic mica
SYNTHAMICA paper (with and without binder)

And other synthetic mica formulations ... for use up to 1832°F.

MYCALEX TUBE SOCKET CORPORATION

... produces a superior line of miniature and subminiature tube sockets and transistor sockets, precision-molded of glass-bonded mica and ceramoplastic. These advanced components feature close tolerances, low dielectric loss with high dielectric strength and high arc resistance. They exhibit high dimensional stability over wide humidity and temperature ranges.

TUBE SOCKETS

TRANSISTOR SOCKETS

Engineering and Design Assistance

From its inception, MYCALEX CORPORATION OF AMERICA has maintained a staff of experts in the production and engineering of electrical and electronic insulating materials. Their experience includes both commercial and military projects, and present activities encompass both applied research and product development. Mechanical and chemical skills are available to assist customers in the design and evaluation of components for virtually all insulating purposes. You are cordially invited to make use of these and our other services, established for your convenience.

General Offices and Plant: 120 Clifton Blvd., Clifton, N. J.
Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y.

World's largest manufacturer of glass-bonded mica, ceramoplastic and synthetic mica products
He's not on your payroll ... he takes up no desk space in your office ... and he doesn't hang around the water-cooler talking to your secretaries. But this man works for you — and for every other advertiser.

What does he do? He helps to safeguard your advertising investments in print media — by providing audited circulation facts and figures on 2,900 publication members of the Audit Bureau of Circulations*. Assuring an accurate accounting, he tells you how many people purchased the publication ... where they live ... how much they paid ... and the answers to many other questions about the publications and your markets.

He gives you factual marketing information as the basis for your advertising investments. He walks into every ABC-member publication's office and audits its circulation — just as carefully and as objectively as a financial auditor might check your books.

When he is finished, the guesswork is gone! He gives you facts — no opinions, pleasant statistics, maybe projections, or fancy figures — just plain old fashioned circulation facts.

Who is he?

He is the ABC auditor — and he works for you!

* Through the reports issued by the Audit Bureau of Circulations, this publication, along with other publisher members of ABC, voluntarily and regularly give the buyers of advertising more verified factual information than is available for any other media at any time.
Silver, in many forms and alloys, is a necessity in the electronics and electrical industries. To meet this need on a high quality level, Handy & Harman manufactures powder, flake, paint, paste, sheet, strip, wire, etc., for printed circuits, wiring, resistors, condensers, thermistors, contacts, printed terminal strips on glass, ceramics, plastic laminates, etc.

Another "At Your Service" Division of the Handy & Harman Silver Supermarket is our Research and Engineering Department. Always ready to help you with any problem or project you may have involving silver for any application.

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We have five Technical Bulletins giving engineering data on the properties and forms of Handy & Harman Silver Alloys. We would like you to have any or all of those that particularly interest you. Your request, by number, will receive prompt attention.

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Silver-Magnesium-Nickel ...................... Bulletin A-3
Silver Conductive Coatings .................... Bulletin A-4

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HANDY & HARMAN
General Offices: 82 Fulton St., New York 38, N.Y.
Year-end Dividends Announced

YEAR-END DECISIONS on dividends are making themselves felt as a number of electronics companies prepare mailings this week. Here are some present announcements as well as some made in the recent past.

Directors of Controls Co. of America, Schiller Park, Ill., have declared a dividend of 20 cents a share on common shares. It will be payable on Jan. 14 to stockholders of record at the close of business Dec. 28.

A 2½-percent stock dividend on common shares to stockholders of record of this date will be paid to shareholders of Bell & Howell on Jan. 7. This dividend is an addition to the regular cash dividends totaling 40 cents per common share this year. B&H has previously declared stock dividends in this amount in Dec. 1957 and 1958. In Jan. 1960, a 7-for-4 common-stock split was declared when Consolidated Electrodynamics was merged with B&H.

Clarostat Mfg. Co., Inc., Dover, N. H., has declared a three-percent stock dividend. It will be payable to shareholders of record as of the close of business Dec. 30. The dividend will be payable on Jan. 20, 1961. The same dividend was declared a year ago. Company spokesmen say fractional shares will not be issued.

Continental Connector Corp., Woodside, N. Y., announced a dividend payable Jan. 3 this week of 12½ cents in cash, and a 1½-percent stock dividend on Class A shares to holders of record on Dec. 16. Company directors say both dividends are a regular quarterly policy.

Viewlex Inc., Long Island City, N. Y., will pay its third consecutive quarterly dividend of 7½ cents to shareholders of record of Jan. 3. Payment will be on Jan. 15. The company, which manufactures photographic, mechanical and electronic products, has developed several items for visual aid and instruction use. Its sales for the first half of fiscal 1960/61 were $1,630,000, a rise of $30,000 over the comparable period a year before.

Universal Controls, New York, announces a dividend of 7½ cents per share payable Jan. 31 to shareholders of record Jan. 16. This is a regular quarterly dividend.

Terminal-Hudson Electronics, Inc., New York, has declared a 6-cent dividend on common stock payable to stockholders of record Jan. 9. The payable date is Jan. 20. Company spokesmen say the dividend is the same as was paid four times in 1960 by T-H and one of its predecessor companies, Hudson Radio & Television Corp.

Last week, shareholders of Assembly Products, Inc., Chesterland, O., received a dividend of 10 cents per share payable Dec. 28 to shareholders of record Dec. 19. At that time, company president John D. Saint-Amour predicted that net earnings for 1960 will be between $250,000 and $260,000, a 20-to-24 percent rise over the 1959 figure.

Republic Foil stockholders received a dividend of 10 cents a share payable Dec. 28 to shareholders of record Dec. 19. This was the regular quarterly dividend of the Danbury, Conn., company.

Clevite Corp. in Cleveland, O., paid a dividend of 30 cents per common share on Dec. 28 to stockholders of record at the close of business on Dec. 16. The dividend is the company’s 154th consecutive quarterly cash payment to stockholders. It brings the company’s 1960 dividends to a total of $1.20 a
share as compared with $1.15 a share in 1959.

**Fairchild Camera & Instrument**, Syosset, L. I., last week paid a cash dividend of 50 cents on the 1,219,768 shares outstanding. The dividend was payable on Dec. 28 to shareholders of record of Dec. 16. The total dividend amounts to $609,884 and represents the largest annual cash disbursement of dividends in company history.

**National Aeronautical Corp.,** Ft. Washington, Pa., shareholders received a yearend stock dividend of two percent on Dec. 30, payable to stockholders of record as of Dec. 15. Cash is being paid in lieu of fractional shares at the rate of $28 per share. NAC paid cash dividends of 5 cents per share in each quarter of 1960, and a 2-percent dividend in stock in December of 1959.

**Radio Corp. of America** will issue a cash dividend of 25 cents per share on common stock and a two-percent stock dividend to shareholders of record as of Dec. 16. The cash dividend will be payable Jan. 23, the stock on Jan. 30. At the same time a dividend of 87 1/2 cents per share has been declared on first preferred RCA stock for the period Jan. 1 to Mar. 31, 1961, payable Apr. 1 to holders of record as of Mar. 6, 1961.

Directors of **High Voltage Engineering Corp.,** Burlington, Mass., have voted a three-percent stock dividend payable Jan. 27 to stockholders of record on Dec. 30. Fractional shares may be made up to a full share or paid in cash at the option of the stockholder.

**Daystrom, Inc.,** Murray Hill, N. J., has declared the regular quarterly dividend of 30 cents per share payable Feb. 15 to shareholders of record on Jan. 27.

**Victoreen Instrument Co.,** Cleveland, will pay a four-percent stock dividend on Jan. 16 to stockholders on record on Dec. 30.

In addition to their regular stock and custom transformers for the electronic industry, ADC has long been a dependable source of transformers and filters to the telephone and telegraph industry. When Western Electric announced they would no longer supply these components to manufacturers, ADC put their 24 years of experience to use designing and tooling a series of "coils" which are electrically and physically interchangeable with similar components made by The Western Electric Company. Many of these are in stock. If you use such components, we suggest that you write for more information. We believe you'll be pleased with both the price and delivery.

**WRITE TODAY FOR TELEPHONE COIL LITERATURE**

**ADC INCORPORATED**

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PACIFIC BRANCH NORTH HOLLYWOOD, CALIFORNIA

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...with off-the-shelf components

Delco Radio can design, develop and deliver digital computers with the speed you need, for airborne guidance and control as well as a wide variety of other special applications. With off-the-shelf Delco transistorized digital circuits, we have, for example, built a computer for a military application in less than three months. These miniature modules contain standard components. They satisfy all MIL-E-5272D (ASG) requirements, which assures extremely rugged, reliable computers. Continuing life tests on these computer circuits now exceed four and one-half million transistor hours without a failure. And where space is no problem, you can have these same, reliable digital circuits packaged on plug-in circuit cards. Delco Radio has six sections of highly experienced people with the necessary capabilities to produce complete computer systems: Application Analysis, Systems, Logic, Memory, Circuit Design and Advanced Development. May we review your requirements? Just contact our Sales Department. Physicists and Electronics Engineers: Join Delco Radio's search for new and better products through Solid State Physics.

PIONEERING ELECTRONIC PRODUCTS THROUGH SOLID STATE PHYSICS

Division of General Motors • Kokomo, Indiana
In addition to plotting cartesian coordinates from DC electrical information, the new Moseley Model 2D Recorder also plots functions of time, accepts AC input data, and operates with a variety of Moseley Autograf accessories including punched tape and card converters, keyboards and logarithmic converters.

A magnetic curve follower is also available. Operating controls are readily accessible on the sloping front panel. A variable range smoothly covers step changes and permits setting the scale to any value within the instrument's range. Zero may be set anywhere during plotting, or suppressed to one full scale on a vernier control. Amplifiers are compact plug-in units. Filters suppress effect of extraneous noise. An integral vacuum system holds the chart paper firmly in place. The pen, driven by two independent potentiometer servos, is lifted by a front panel control.

**SPECIFICATIONS**

- **DC Voltage Ranges**: 15 calibrated fixed ranges on each axis: 0.5, 1, 2, 5, 10, 20, 50 mv/in. Also 0.3, 0.5, 1, 2, 5, 10, 20 v/in. Times-5 vernier expander. Max. input 750 v on X axis; 500 v on Y axis.
- **AC Voltage Ranges**: 8 calibrated fixed ranges on each axis: 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 v/in. Vernier as above.
- **Accuracy**: DC, 0.2% of full scale. AC, 0.5% from 20 cps to 20 KC. Useful upper frequency range to 100 KC.
- **Linearity**: CO, 0.1% of full scale. AC: 0.1% from 20 cps to 20 KC.
- **Time Base Intervals**: 7 calibrated sweeps on X axis: 0.5, 1, 2, 5, 10, 20, 50 sec/in. Vernier stepless control.
- **Slew Speed**: 20"/sec full scale, both axes.
- **Paper Size**: 11" x 17", or 10" roll paper on accessories.
- **Recording Mechanism**: Independent servo-actuated drives for X and Y axes.
- **Size**: 17½" wide x 15½" deep x 6½" high. Weight 43 pounds.
- **Power**: 115 v, 60 cps, 115 watts. (Other voltages and frequencies to order)
- **Price**: $2,350.00 f.o.b. factory.

Data and price subject to change without notice.

**F.L. MOSELEY CO.**

Dept A5, 409 N. Fair Oaks Avenue, Pasadena, California

**Field representatives in all principal areas**

January 6, 1961

**CIRCLE 31 ON READER SERVICE CARD**
You'll save time, trouble...

...by turning FIRST to BUSS for fuses of unquestioned high quality

By relying on BUSS as your source for fuses, you can quickly and easily find the type and size fuse you need. The complete BUSS line of fuses includes: dual-element "slow-blowing", single-element "quick-acting" and signal or visual indicating types... in sizes from 1/500 amp. up — plus a companion line of fuse clips, blocks and holders.

**BUSS fuses are made to protect — not to blow needlessly**

When you specify BUSS fuses — users of your equipment receive maximum protection against damage due to electrical faults. And just as important, users are safeguarded against irritating, useless shutdowns caused by faulty fuses blowing needlessly.

A component part that operates as intended helps to maintain the reputation of your equipment for quality and service. That's why it pays to rely on dependable BUSS fuses.

If you should have a special problem in electrical protection ... the world's largest fuse research laboratory and its staff of engineers are at your service — backed by over 46 years of experience. Whenever possible, the fuse selected will be available in local wholesalers' stocks, so that your device can be easily serviced.

For more information on BUSS and Fusetron small dimension fuses and fuseholders ... Write for bulletin SFB.

**BUSSMANN MFG. DIVISION,**
**McGraw-Edison Co.,**
University at Jefferson, St. Louis 7, Mo.

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**BUSS fuses are made to protect - not to blow, needlessly.**

BUSS makes a complete line of fuses for home, farm, commercial, electronic, electrical, automotive and industrial use.
3 new Gold Brand types expand industry's widest line of 26.5V SUBMINIATURE TUBES

Sylvania Gold Brand 26.5 Volt Subminiature Tubes afford dramatic opportunities for improved design of compact, reliable communications, telemetering and guidance equipment using a 26.5 volt energy source. Now, the Sylvania premium subminiature tube line includes 3 new types **featuring:** New Rugged-Design 26.5V Heater • High Uniformity, Stability • Shock Resistance to 750g • Thermal Resistance to 220°C • Intense Radiation Resistance and offering: Compact Equipment Design • Significant Circuit Economies • Improved Equipment Reliability.

At the heart of each Gold Brand Tube is a remarkable advance in 26.5 volt heater design. This new Sylvania design makes practicable quantity-produced heaters with low heater-power requirements and high mechanical strength. The heater base is a heavy support rod (mandrel) coated with a high-temperature insulator. Extremely fine heater-wire is wound over the base, and the entire assembly recoated to form an efficient folded coil heater. In addition to utilizing the new heater design for 26.5 volt heater operation, five Gold Brand subminiature types operate with a B-supply of 26.5 volts, making them ideally suited for hybrid designs.

Sylvania 26.5 volt subminiature tubes simplify circuitry and reduce or eliminate components ordinarily required for the conversion of the "natural" supply voltage. Series string and associated problems can be eliminated. Too, inherent tube resiliency to plate and screen voltage surges eliminates the need for compensating circuits. Result: enhanced equipment reliability, significant cost reductions.
New, Improved Specifications assure uniform, reliable, high-performance tubes capable of withstanding impact acceleration tests of 750g, fatigue tests of 2.5g and ambient bulb temperatures of 220°C. All Sylvania Gold Brand Subminiature Tubes are rigidly disciplined by tighter controls on lot variables, improved AQLs and increased test requirements. As an example, plate current and Gm must meet an AQL of 0.4%. Life tests for 100, 500 and 1000 hours provide a quantitative determination of end-points such as shorts, heater current, plate current, Gm, insulation resistance, interface impedance. Further, Gold Brand subminiature types are capable of withstanding radiation dose rates (fast neutrons) of $10^{12}$NV and accumulated radiation of $10^{14}$NVT.

**Specify Sylvania Gold Brand Subminiature Tubes.**

Other Gold Brand types that can be designed with the Sylvania 26.5 volt heater include prototypes: 5719, 5899, 5977, 6205 and 6206. Learn more about the advantages of Sylvania subminiature types for your critical design from your Sylvania Sales Engineer.

For data on specific types, write for the FREE 84-page Gold Brand 26.5 Volt Subminiature Tubes Booklet to Electronic Tubes Division, Sylvania Electric Products Inc., Dept. M, 1100 Main Street, Buffalo 9, N.Y.

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**SYLVANIA—7887.**

Medium-mu double triode; 26.5V, 90mA heater with 100V Eb; designed for oscillator, amplifier and low-power servo circuits.

**SYLVANIA—7888.**

High Gm, medium-mu triode; 26.5V, 45mA heater with 100V Eb; designed for use as a UHF oscillator as well as low-frequency oscillator and amplifier applications.

**SYLVANIA—7889.**

High-mu double triode; 26.5V, 45mA heater with 100V Eb; intended for low level audio circuits.

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### CHARACTERISTICS

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**UNITS**

- V
- mA
- Vdc
- Ohms
- φmhos
- mAdc
- µAdc

*Each Section

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Typical test results for the Sylvania 26.5 volt heater compare very favorably with a 6.3 volt heater of known high reliability. Testing for both types was performed at 120% of rated heater voltage.

---

**Sketch shows enlarged view of new Sylvania 26.5V heater.**
ENGINEERED COMPONENTS
for the Electronics Industry

Now—Garlock Electronic Components are immediately available wherever and whenever needed!

Through a new, widespread distributor organization, Garlock now offers fast delivery of CHEMELEC Stand-off and Feed-Thru Insulators, Subminiature Tube and Transistor Sockets, and Connectors. Here, too, is an increased opportunity for close-at-hand assistance from Garlock distributors experienced in applying electronic products.

Take advantage of on-the-spot availability—specify these skillfully engineered Garlock electronic components. Reliable under the most severe conditions, they are ideal for high temperature, high voltage, high frequency service on missile guidance, fire control, tracking, and radar systems.

Garlock has the technical personnel and modern facilities to produce components of all materials—Teflon™ TFE and FEP, Nylon, Delrin®, C.T.F.E.™—and in a range of sizes, designs, and tolerances to fit your exact needs.

At your disposal, too, for development of new electronic products, Garlock maintains complete electrical, chemical and physical laboratories staffed by top-flight engineers. Your Garlock Electronic Products representative will be glad to discuss specific products and service with you. Call him at the nearest of these locations:

You may also obtain more information by writing for Catalogs AD-169 and AD-171, Garlock Electronic Products, Garlock Inc., Camden 1, New Jersey.

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DuPont Trademark

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1200 SWITCHING POINTS IN LESS THAN 23 INCHES

The 10x10x12 matrix configuration of the North Crossbar Switch, providing up to 1200 switching points, gives the design engineer new efficiency, capacity and versatility in a component that requires minimum space and is economical in cost.

Already being used successfully in analog and digital computer functions, as a memory device for programming and sequencing, for high traffic communications, machine tool control and programming, data storage and reduction, digital to analog conversion, automatic test programming, computer readout, cable and circuit testing, and high capacity selector switching, imaginative engineers are finding new applications for the North Crossbar Switch every day.

If you are looking for a component that delivers an almost limitless range of switching capabilities, ask for the detailed specifications on the North Crossbar Switch by writing...

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NORTH ELECTRIC COMPANY
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Infrared communication products today are saving money with hydraulic and grinding equipment. Servo hydraulic, and grinding components are made in the U.S.A. Infrared made in America—Servo has kept its bullseye on outstanding quality, simple design, and research, backed by 25 years of experience.

**Infrared Domes**

Largest infrared dome ever manufactured in one piece. Measuring 12 inches in diameter, SERVORAX® arsenic trisulfide dome is used on classified Navy search equipment.

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Standard and special optical shapes available in all sizes and in all transmitting materials. Single elements of Servo-manufactured SERVORAX® glass as large as 18" in diameter, as well as multi-element units unlimited in size. Also meniscus and achromat lenses. Infrared wave lengths from less than 1 to more than 20 microns. Exceptional optical properties assure excellent refractives for research, laboratory, industrial, and military applications.

**Servotherm® IR Detectors and Associated Circuitry**

Uniformly sensitive thermistor bolometers and immersed bolometers for fast, accurate, remote infrared radiation detection from ambient to 1000°C. Sealed housings; rugged construction. Response time as low as .001 sec. SERVORAX windows from 2-12 microns. (Other window materials and time constants available.) SERVOTHERM® circuitry exploits speed, sensitivity, wide range, low noise, compactness, and flexibility of heat detector cells.

**Servo IR Systems**

Industrial and laboratory models with fastest infrared mirror-optical system available. Extremely fast response. Give full coverage of infrared spectrum—from 1-12 microns—with control accuracy of ±1%. Range from sub-ambient to 2800°F. Sealed sensor heads; rugged construction. Accessories: lenses, sights, relay controllers, liquid reference coolers. Ideal remote temperature measurement and control for targets that are near, far, moving, tiny, broad. Research and industrial applications in: primary metals, fabricated metals, stone, clay, glass, chemical, paper, textile, and many other industries.

**What's your problem?** Ask for the Servo solution by phone or letter. A Servo applications engineer will be glad to call on request. Detailed technical literature available.
With over 70 advanced projects in the works, the Northrop atmosphere is so stimulating that ideas often refuse to wait—they compel attention wherever the inspiration strikes. Missile guidance, rendezvous and maneuverability in space, bioastronautics, universal checkout systems, laminar flow control for aircraft present insistent, gratifying challenges. If you have sharp creative abilities in these lines, investigate the intellectually invigorating environment and rewards offered by Northrop's current and future programs. We seek exceptional engineers, physicists, and mathematicians to join our thinkers and doers. Send us a card today with your name, address, and area of special interest. Northrop Corporation, Box 1525, Beverly Hills, California
New Broadband Klystrons

140 MEGACYCLES - (1db) BANDWIDTH AT L-BAND
10 MEGAWATTS - PEAK POWER OUTPUT

New additions to the Litton Industries Broadband Klystron family extend broad-band performance to even higher power levels as shown in the typical performance curves to the right. These tubes, like all those produced by Litton Industries, are conservatively designed and rated; and rigorously processed to provide many thousands of hours of reliable operation. Using Litton developed broadbanding techniques, it is now possible to achieve wide bandwith, high peak and average rf power output and linear phase shift versus frequency characteristics simultaneously. This latter feature enables the radar equipment designer to utilize pulse compression techniques to attain improved system performance.

Litton Klystrons providing these outstanding performance characteristics can be supplied in both the L and S-bands at peak rf power levels ranging from 2 to 20 megawatts. Typical of the performance obtained with Litton Klystrons is that of the L-3035, a 2.2 megawatt L-band Klystron, whose average operating life in field service is approaching 3,000 hours. Some of these tubes are continuing to provide excellent service after having operated for more than 17,000 hours.

Should you require high power broadband amplifier tubes to satisfy your system requirements, please write to us at Litton Industries, Electron Tube Division, 960 Industrial Road, San Carlos, California. Our telephone number is LYTELL 1-8411.

LITTON INDUSTRIES
Electron Tube Division
MICROWAVE TUBES AND DISPLAY DEVICES

January 6, 1961
NAVDAC-equipped Polaris submarine Robert E. Lee underway. Computer will maintain navigational accuracy aboard FBM subs even when periscope exposure is not possible.

Complete navigation computer, NAVDAC installed on Polaris submarine George Washington. Cabinet design allows easy passage through a submarine hatch.

The navigation system for Polaris submarines. NAVDAC computer ties into real time operational pattern of system, which includes all tactical and casualty modes that may arise during patrol.

Navy's sophisticated digital computer system, NAVDAC (Navigation Data Assimilation Computer), is now operational with the Polaris submarine fleet. The computer can pinpoint missile-launching position to an accuracy within yards anywhere under the earth's 140 million square miles of ocean. This precision is needed to obtain accurate trajectories for the 1,200-mile solid-fueled Polaris missile.

Fed by a battery of navigation aids, the computer corrects for long-term drift inherent in the Ship's Inertial Navigation System, SINS, (Electronics, Mar. 7, '58), providing a highly automated and versatile tool for the navigation officer.

A complete Polaris submarine navigation center, which includes NAVDAC, costs $7 million. The USS George Washington, now on station is equipped with this system. Three other subs in various stages of try-out have NAVDAC, and it will go aboard all other FBM (Fleet Ballistic Missile) subs now under construction. NAVDAC built by Sperry Gyroscope Co., Great Neck, N. Y., obtains information from many sources. It checks each input against the other, rejects illogical data completely, finally picking the most accurate from among its sources.

Data included are: vessel speed through the water with correction for ocean currents; star tracking with optical instruments operating through the periscope that are able to work night and day; radiometric sextants that automatically track signals from the sun and moon under adverse weather conditions; ground speed measurements; (Electronics, Jan. 20, '57, May 7, May 2, '58) observation of ocean-bottom topography using sonar; radio aids similar to loran with improved accuracy and underwater reception capability; and a precise time and frequency standard.

In star-sighting the navigational
Subs Navigate

equipment picks the celestial body best suited for sighting. The computer searches its memory of some 500 stars, locates the one roughly sighted in the periscope, allowing the navigator to center it in the cross hairs. The computer then picks a second star, repeats the process. This entire sequence will be achieved automatically in the future by a tv-camera star-finding system now under consideration. The final fix is given to NAVDAC for analysis along with figures obtained from other inputs. The computer selects the best information from all sources: radio aids, star trackers, topography, radiometric sextants, and at command of the navigator it realigns SINS.

Time sharing in the computer permits many navigational techniques to be carried out at once to avoid overlong periscope exposure, allowing the nuclear powered sub to remain hidden for long periods.

Design tests run in a Sperry-built replica of a nuclear sub navigation room allowed land-based evaluation of NAVDAC (ELECTRONICS, July 24, '59). It can be described as a general-purpose digital computer with special-purpose inputs and outputs. The magnetic-drum memory can retain over 13,000 25-bit words, revolves at 8,000 rpm. The computer can make 1,000 computations a second, will calculate a star fix in less time than it takes to push the operating buttons. Completely transistorized it employs modular construction, has a built-in circuit tester that allows it to test memory circuit and computer logic boards, and converter packages.

A paper-tape reader sets the program into the computer, allowing program changes at sea.

Conventional ocean bottom navigation is being improved upon, using new sonar techniques, and possibly magnetic ones to aid precise position location as an adjunct to NAVDAC.

These may take the form of passive or active markers on the ocean floor.

MIT LINCOLN LABORATORY scientists plan to bounce millimeter-wave radar signals off the moon in the next two months to measure reflective properties of the moon’s surface and gain significant new data about the natural satellite, ELECTRONICS learns this week.

It is planned that a 50-watt K-band transmitter will operate in region of 35.6 Gc, and an 8-mm wave maser developed at Lincoln Lab will amplify reflected signals (ELECTRONICS, p 62, Nov. 4).

Recent research has led to better understanding of atmospheric absorption, the nemesis of mm wave applications in the past.

A 28-foot spuncast parabolic reflector fabricated for Lincoln Lab by D. S. Kennedy & Co. will be installed atop a Lincoln Lab building in Lexington, Mass. Evaluation of the new-type dish will be made by tests due to begin in the next two weeks. The surface of the reflector will be sufficiently smooth for use with millimeter waves.

A parabolic surface of near-optical precision is said to be obtained by the spincasting process, in which a huge pool of plastic is spun on an industrial merry-go-round to produce a parabolic surface accurate to between 5 and 10 thousandths of a wavelength.

The 28-foot dish, believed to be the largest ever produced by the spincast process, was fabricated in a giant octagonal silo. Heat and humidity control was maintained within the silo during the process.

Spincasting is based on long-known physical principles. The surface of the pool of any liquid, spinning horizontally about a vertical axis, will, under centrifugal force and gravity, assume a paraboloidal shape with a focal length dependent upon the speed of spin.

Problem of “freezing” the surface accurately with stable materials is solved by new synthetic resins and novel techniques. Liquid resin is mixed with a suitable catalyst at the beginning of the spin. As the liquid resin surface assumes its shape it gradually hardens until, at the end of the operation, it has become rigid. Surface can then be coated with any of a variety of reflecting materials. Photographs of light rays reflected by the mirror-like surface of the 28-foot dish reportedly indicated near-optical perfection.

Spincast dishes will have applications, in addition to high-resolution radar work, for infrared detection and tracking, solar energy conversion and research-type solar furnaces.

Millimeter Waves to Map Moon
Commercial Fishing Leans on Electronic

Right now the Bureau of Commercial Fisheries is testing directional fish locating sonar aboard its trawler Delaware.

The equipment, able to locate fish in azimuth and indicate range out to 2,000 yards, is made by the British firm of Kelvin and Hughes.

Trial runs begun in October have been successful, and may lead to recommendations by the Bureau that domestic fisheries investigate gear of this type, which is not presently manufactured by American companies.

The annual electronics market among commercial fishermen has been estimated by industry marketing experts to be slightly over $3 million. Sales of radar and depth sounders account for roughly one-third each of the total. Radiotelephones, loran and autopilots, in that order, complete the last third. At least a dozen companies are supplying various types of marine electronics.

Increased operating costs of fishing combine with an increasing flood of imports from overseas, notably Japan, to cut fishing industry profits. Manufacturers report a growing realization among fishermen that electronics can provide more efficient operation of their vessels—indeed is a must to remain in business. This marks a turning from the stern opposition oldtime mariners often gave to the use of electronic gear.

Experienced fishermen consider the depth finder their most basic piece of electronic equipment, are apt to purchase one ahead of a radio telephone.

A paper chart model (priced around $1,000) is favored. It allows the operator to leave the wheel house. Less expensive flashing light indicator models are also sold. Fish are indicated and their concentration can be determined. Net towing can be held at a constant depth; underwater wrecks and hidden reefs are detected. Such obstacles can damage expensive nets that may cost above $10,000. Navigation is performed with the depth sounder and prepared bottom charts. This technique is preferred by many skippers.

The radiotelephone is especially valuable to novice fishermen anxious to learn by “eavesdropping” on experienced seafarers.

Vessels working together to protect themselves arrange a speaking code to avoid revealing favored fishing spots to other ships.

The instrument also affords safety to ships now going farther out to improve their catch, by providing vital weather information.

Loran is used for long range navigation and also permits return to an exact local fishing spot that has proven productive. Wrecks can be avoided where noted on charts and fuel savings are affected. A high degree of accuracy is achieved with this navigation system. In popular fishing areas there are many shore-based transmitters.

The autopilot is indispensable to a one-man ship, and on runs of many hours will free one of a larger vessel’s crew for net mending or

With the supply of wartime surplus units disappearing, loran is popular with manufacturers. This unit by Sperry uses pulse recurrence rate of transmitting station as a time base.

The Kennebec, a modern fishing vessel operated by Maine Marine Products, goes to work fully equipped with electronic aids: a Bendix depth recorder, RCA radar, radiotelephone and loran and a Kelvin & Hughes echo sounder.

electronics
Many smaller fishermen will make sacrifices elsewhere to have a depth recorder. Raytheon unit is shown.

Equipment

other recurring duty. This, in turn, effects a saving in operating cost.

Where fishing is done in fog-plagued areas, radar becomes important to ship and crew safety. Entering unlighted harbors at night demands radar. Many buoys are not lighted.

Concentrations of other fishing boats can be detected by radar. And such groupings usually point to good fishing grounds.

The most sophisticated instrument available to fishermen is a sonar device often called a fishfinder. A crt which allows reading down to the noise level is often used. On some designs a recording indicator is preferred or supplements the crt. Variable expanded scales are provided. They can display the bottom few fathoms and expose in detail fish feeding on the bottom. Some models use a blanking technique for sharp bottom delineation.

After long use of the fishfinder some operators can identify the type of fish picked up on the instrument.

from $-60^\circ F$ to $+185^\circ F$

VC-42 subcarrier oscillator

UED's brand-new achievement in subcarrier oscillator performance. Ultra-stability ELIMINATES the need for EXTERNAL ADJUSTMENTS. Center frequency, sensitivity and linearity are unaffected by:

- TEMPERATURE — from $-60^\circ F$ to $+185^\circ F$
- TIME — tested for stability over a period of 6 months
- SUPPLY VOLTAGE VARIATION — from 24 volts to 32 volts

The VC-42 has been designed to give the telemetry systems engineer a feeling of pride in his system design accomplishments. The unit combines the following advantages that are most essential to system integration:

- SMALLER than any high-performance oscillator previously available
- HIGH LEVEL OUTPUT eliminates the need for mixed signal amplifier
- NO EXTERNAL ADJUSTMENT required because of new ultra-stable circuit design

United ElectroDynamics, Inc.

220 Allendale Road Pasadena, California

January 6, 1961
IN COMMUNICATIONS...
THE SIMPLER
THE BETTER

New Hallicrafters all-modular
SSB strip receiver cuts costs,
increases reliability.

• 50% less maintenance
• Far greater stability and reliability
• Down time almost entirely eliminated
• Lower initial cost

Hallicrafters' new SX-116 SSB Receiver is the essence of simplicity—key to reliability in the Hallicrafters Series 116 communications system.

The SX-116 is entirely modular in construction, virtually eliminating "down time" and cutting maintenance cost by over 50%. The unit is quickly and easily adaptable to existing systems, entirely compatible with future requirements.

It is extremely stable—1 part in \(10^6\) per month (standard) or 1 part in \(10^8\) per month (special) ... it permits, for the first time, continuous, unattended operation with maximum reliability.

The SX-116 weighs in at just 36 lbs.—equally practical for fixed, mobile, air or seaborne installations. And its initial cost is very substantially lower.

Finding a better and simpler solution to complex communications problems has been a Hallicrafters habit for over a quarter-century.

Hallicrafters
Military Electronics Division, Chicago 24, Illinois

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100% modular construction—
only seven basic components

RF Module. Image and IF rejection maintained at better than 50 db. Simple tuned circuits between antenna and RF grid. Four-channel, continuous-tuning 2.0 mc. 10-30 mc. range.

HF Crystal Oscillator Module. Stability: 1 in 10^8 per month. Capacity is four crystals, designed for HC-S/U metal or glass crystal holders. Oven temp. varies less than \(\pm 0.001^\circ\)C.

Injection Amplifier Module. AGC-controlled wide-band video amplifier provides constant injection level.

IF Module. Allows simultaneous reception of upper and lower sideband, independent AGC control of upper and lower sideband.


Power Supply Module. Separate transformers provided for regulated and non-regulated voltages. Local oscillator and BFO filament supply are regulated for \(\pm 10\%\) line voltage variation.

Write for complete specifications on the SX-116.

Looking for a challenging opportunity? We have openings for communications systems and equipment design engineers at all levels! Please write to William E. Frankart, Director of Engineering.
FIRST AIRBORNE TESTS of Air Force's $35-million project ALRI are going into countdown as this issue of ELECTRONICS goes to press.

Deriving its name from Airborne Long Range Input, the system consists of airborne radar stations equipped with computers to process reconnaissance data and telemeter them to Sage network ground stations. When fully operative, the ALRI system will extend the effective range of Sage over the continental waters of both coasts. The new system will automate many of the functions now performed by the Air Defense Command's 24-hour radar-reconnaissance flights.

The initial ALRI contract was released a little more than a year ago with Burroughs Corp. as prime contractor. Six other companies are affiliated with the project as subcontractors: Lockheed, General Precision, AC Sparkplug, Packard Bell, Electronic Communications and Philco Corp. These six firms are performing between 50 and 60 percent of the work. Completion of the project was called for within 42 months of contract signing. Burroughs spokesmen tell ELECTRONICS they expect to better this schedule by "a considerable margin."

Responsible for modifying the RC-121D aircraft that will carry the equipment, Lockheed Aircraft Service is working under a $3.8 million subcontract. Work is being done at Ontario, Calif., where similar work on prior versions of airborne early warning systems has been done by the company. Lockheed will also be responsible for system flight tests.

Doppler radar equipment forms a vital part of the ALRI system because of the degree of navigational information that the project requires as part of its computer input. This phase of operations is being handled by GPL division of General Precision, Inc., under a $3.8 million contract. GPL is supplying RADAN-500 doppler radar units, navigational position keepers and combiner units for the two systems. The subcontract calls for delivery of two prototype and 65 production models.

Working closely with the doppler radar suppliers is AC Sparkplug division of General Motors. Contract with the division calls for airborne inertial reference units. Being supplied are three-gimbal gyro-stabilized inertial platforms for providing true heading for the aircraft through continuous airborne gyro-compassing. The system weighs 75 pounds and is packaged within three cubic feet, has a heading accuracy within 0.17 degree of arc. The AC Sparkplug portion of the ALRI contract comes to $6.3 million.

The data link for air-to-ground communications is rated at one Kw, and forms part of the equipment being supplied by Electronic Communications, Inc. Other items in ECI's $10.3 million share of the work include a complete ground receiver, an antenna positioning system, and airborne one-Kw data link and a steerable antenna for air-to-ground communications. Also being provided are two 50-w voice communication systems and a data receiver system coupled to the one-Kw transmitter for interceptor data relay.

Packard Bell's Technical Products division has a subcontract for $4 million to modify the identification radar that will be used in ALRI, and also to produce the hardware and modification kits for equipment related to the Mark X SIF/IFF units. PB spokesmen report that the decoding functions of the radar system use solid-state components.

Under a $3 million contract, Philco Corp. is charged with responsibility for design and factory modification of ALRI's height finder radar gear including the addition of counter-counter measure capability, a feature not present in air reconnaissance installations of Sage.

Remaining funds are being used by Burroughs for airborne data processing equipment and associated amplifiers, displays and clutter mapping modifications. Design and ground test of much of the data processing gear is complete now with Air Force acceptance already logged. The data processors in addition to processing raw video data, make statistical determinations of real targets. They also determine true target azimuth by combining radar input information with aircraft heading data as obtained from the inertial navigation system. The computer also compensates for aircraft roll and pitch in determining target position. Circuits are also provided to eliminate extraneous video data such as caused by storm clouds and other weather conditions.
Electronic Flash Stops Bullet

HALF-MICROSECOND flash stops flight of 0.30 caliber rifle bullet going 2,800 ft per sec.

In equipment designed by MIT professor H. E. Edgerton (at left in photo showing camera), peak beam light of 50 million candles-power of daylight-color light is produced when an 18,000-volt capacitor discharge flashes the lamp.

Edgerton’s ultrahigh-speed photography package consists of two units, one housing the lazar and entire high voltage circuit, the other containing electronic trigger and delay circuits for commanding the instant of flash.

Brief exposure permits photographs of high resolution to be taken of subjects which appear as a blur with conventional electronic flash equipment. The gear has also photographed spray-gun particles and bursting turbine wheels.

Sun-Powered Traveling-Wave Tube May Be Orbited Within Two Years

DEVELOPMENT of a traveling-wave tube that may run up to 10 years on a few watts of solar energy helps make launching of a microwave communication satellite possible within the next two years.

Currently orbiting Echo is only the first step toward meeting the need for developing more communications, J. R. Pierce, director of research in communications for the Bell System, recently told Chicago Economics Club. Overseas telephone messages are expected to increase 800 percent in next 15 years.

Even the limited Echo tests are proving the value of such advances as a maser amplifier so sensitive a special horn antenna had to be designed to shield it from the microwave-range heat of earth.

Because they’re less susceptible to jamming, passive satellites of the Echo type may prove useful for military applications, Pierce said during a press conference. But Echo’s efficiency is too low for commercial use—it reflects only about one billionth of a billionth of the power beamed at it.

Next advance in microwave satellite-communications will be to orbit a longer-lived active satellite fitted with low-powered solid-state circuits. Lessons learned from launching the prototype of such a satellite within the next two years will open the way for a system of about 50 active spheres, orbiting 5,000 miles out, beyond the worst of the radiation belts—each new sphere rising to provide communications for a fraction of an hour, just as the preceding satellite sets. This system would provide 100 times the capacity of present transoceanic circuits, Pierce suggests.

Traveling wave tube at 6,000-7,000 Mc will be the only vacuum tube in the 1962 prototype satellite. Transistors will be supplied ten watts or less of power by solar cells distributed along the outer surface. Heater of the twt will require less than two watts. Output from the satellite will range from one to two watts, beamed at a 60-foot horn planned as the ground antenna.

Commercial uses for a system of these satellites will have to wait for solutions of such technical problems as developing radiation-resistant solar cells and batteries, and for more information on rates of degradation of cells at fringes of the Van Allen belt and on reliability.
360° of versatility

The precious metal ring shown above is the heart of a Gamewell style SG-270 Precision Rotary Switch. Cut into as many angular segments as required, it provides the precise basis for a highly versatile switching component.

Custom-designed, the SG-270 Switch is ideal for circuit sampling, sequencing, programming, digital generators, etc. Connections to the segments are made through terminals adjacent to the segments on the periphery of the housing. Precious metal rings and brushes provide smooth, trouble-free action with either Make-Before-Break (MBB) or Break-Before-Make (BBM) contacts. Multiple gangs can be assembled to provide multi-pole switches. Cased in special plastic, the SG-270 Switch is inherently fungus resistant... stable at high temperatures... sizes ⅜" — 1¼" — 1⅝" — 2" — 3" — 5" diameter in various mounting styles. It can be used with confidence over a wide range of environmental requirements.

Investigate their outstanding operating characteristics for use in your products. Write, stating requirements, to The Gamewell Company, 1383 Chestnut Street, Newton Upper Falls 64, Mass.—A Subsidiary of E. W. Bliss Co.
Computer Controls Teaching Machine

COMPUTER-CONTROLLED response to a student's learning efforts help him profit by his achievements and mistakes in an experimental teaching machine developed and recently demonstrated in New York by the Systems Development Corp. of Santa Monica, Calif.

Working in conjunction with a general-purpose Bendix G-15 computer are an alphanumeric typewriter and a cam-coded random access projector, which was developed by SDC.

Teaching begins with a "basic series" of multiple-choice projector-displayed questions which the student answers by pressing a key on the typewriter. He is told at once if his answers are right or wrong, with the computer keeping a record of his performance. If he falls below a specified level, he is branched to a special remedial set of questions along with explanations.

When performance on the remedial set is satisfactory, the student is given items from the basic series again until he finishes the multiple-choice questions. Remedial branching is programmed so that when excessive branching occurs, the machine may take the student out of the original series completely and into another basic series.

Such a major change in the teaching sequence supposedly approximates what a human tutor might do in response to an individual student's needs.

SDC spokesmen admit there is no substitute for direct teacher observation of a student's difficulties in arriving at solutions to learning problems. But they feel the machine will help a teacher find out which students are having trouble earlier than otherwise in a large class.

The machine is programmed to allow the bright student to skip items if he answers basic questions rapidly. From time to time, the machine may ask him how confident he feels about the information he's learned.

If the student expresses doubt or confusion, he is taken to a remedial branch even though his performance record may appear to be above average. If too much time is taken in answering questions, the student is branched to less difficult material.

Application of the experimental system will be undergoing further research. How to phrase questions properly and how to interpret responses are specific problems yet to be solved.

Another danger is that student motivation during the learning process may flag. Some students may have an aversion to mechanized
devices. Others may be confused because of the machine's inability to anticipate individual needs and shortcomings. Lack of conversational give-and-take may also confuse the student and cause loss of direction in the learning process.

How to measure the factor of discouragement in not attaining correct answers, and how this influences the answering of later questions, must also be evaluated.

SDC engineers emphasize that much research remains to be done before the full value of a flexible teaching machine is attained.

A centralized computer would handle almost any number of individual students. The Torrence, Calif., school board has requested a microwave link with its school system and the SDC computer, with each student having access to a projector and a typewriter.

Computer-controlled learning machines are also being developed at the Carnegie Institute of Technology, and at Bolt, Verank & Newman, an acoustics firm in Cambridge, Mass.

Sensitive Infared Scanner Uses Ultracooled Detector

INFRARED scanning device with enough sensitivity and resolving power to form a picture of a human body from emitted heat has been developed by Avco's electronics and ordnance division. The device, dubbed Avscan, has reportedly been used to detect jet-aircraft exhaust at "several miles" range.

Small versions of Avscan can be built to weigh about 40 lb, carry a 3-in. display tube. Scanning head includes a refractive optical system of four infrared achromats on a rotating drum. Rotating system is mounted behind a 6½-in. i-r dome, scans with a resolution of 0.1 deg. Detector is mounted in a side-looking metal dewar flash cooled by liquid nitrogen to −196 C. Infrared cell is made of indium antimonide.

Electronics include a signal-processing unit and the display unit, are all-transistor plug-in modules.

Avco is ready to produce the units for both industrial and military uses, says a missile nose cone could be picked up "at very long ranges."

THERE'S A
NORTH ATLANTIC INSTRUMENT
TO MEET YOUR REQUIREMENTS, TOO...

Now—from North Atlantic—you get the complete answer to AC ratio instrumentation problems—in the laboratory, on the production line, in the field.

Specialists in ratiometry, North Atlantic offers a complete line of precision instruments to handle any ratio measurement task. All are designed to meet the most demanding requirements of missile age electronics—provide high accuracy, flexibility, component compatibility and service-proven performance. Some are shown above.

If your project demands total solution to ratio measurement problems, write for Data File No. 10X it provides complete specifications and application data and shows how North Atlantic's unparalleled experience in ratiometry can help you.
WHAT IS RELIABLE RELAYABILITY?
IT'S ELGIN ADVANCE'S ABILITY TO BUILD A RELIABLE QUALITY RELAY LIKE THE SENSITIVE MQ SERIES.

THE MQ SERIES CRYSTAL-CAN-SIZE HERMETICALLY SEALED RELAY IS AVAILABLE IN THREE SENSITIVITIES TO MEET VARYING MILITARY AND INDUSTRIAL REQUIREMENTS. THESE CURRENT-OPERATED RELAYS COME WITH PLUG-IN PINS FOR PRINTED CIRCUIT USE, SOLDER HOOKS AND 3-INCH LEADS AND A VARIETY OF MOUNTING ARRANGEMENTS. ALL CONNECTIONS ARE SPACED ON 0.2 INCH GRID.

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INTERESTING EXHIBITS at the Conference on Vehicular Communications, held in Philadelphia last month, included equipment introduced during the past year.

In the upper left hand photo is a hand-held all-transistor transmitter by Motorola. Weight of the transmitter is less than 1 lb, output power is ½ watt and range is several miles. Essentially a mate to a matching receiver introduced earlier, the transmitter is professional grade equipment and requires FCC licensing.

At upper right is the Hoffman roadside pager. The small control box, partially obscured, mounts by the side of the road. It is powered by batteries fed by solar cells and broadcasts a signal that is received and decoded by the base monitor station (at right in the photo). The type of help required, and information locating the origin of the call, are displayed on the base monitor.

Relatively low-cost ($125) transceiver by Globe Electronics, division of Textron Electronics, for citizens band use is shown at lower left. Transmitter range is a to 1 mile, useful for construction projects, hospitals, etc.

At lower right is a display of Bell Telephone's Bellboy receivers. The units produce a tone that informs wearer he should telephone his answering service or office for a message. The receivers will be available on a subscription basis, similar to regular telephone service, with a cost of about $12 to $15 per month.
CLECOMATIC
the automatic torque control tools that made industry stop, look and examine their methods of setting screws, nuts, and bolts.

Cleomatic No. 10 Series Screwdriver—Nut-Runner: These are the tools that enable you to set torque to the most critical specifications...then forget it. Torque is positively maintained by a non-drift locking device. A long wearing, non-friction clutch is quickly adjusted when torque change is desired. This is the only torque control air tool that starts and stops automatically! Operator merely engages the screw with bit, the tool starts. When torque is reached, the tool stops. Motor operates only during rundown. Less air is used. Wear is reduced. There is no quality let-down at the end of a shift because control is in the tool. This tool has little impact, is shorter, and weighs less than competitive tools. No. 10 Cleomatic Screwdriver—Nut-Runners are available in pistol grip or straight handles in speeds from 400 to 2,900 r.p.m. Reversible or non-reversible.

Cleomatic Right Angle Nut-Runners: You get uniform tightness in every nut or bolt rundown with a Cleomatic 14 or 16 Series Nut-Runner. Torque is preset. When specified foot pounds are reached, air is automatically shut-off at the driving spindle. The hazardous, tiring torque kick usually found in tools of this type is substantially reduced, your operators can produce more without extra effort. As for maintenance, there's practically none. Cleco's non-friction clutch operates for very long periods, completely maintenance free. Torque adjustment is made externally, no need to disassemble the tool. Cleomatic Nut-Runners are available with both recessed socket heads and double-end spindles (reversible). Speeds range from 250 to 1,000 r.p.m.

NOW AVAILABLE! Cleomatic No. 6 Series Screwdriver—Nut-Runners: Essentially the same tool as the Cleomatic No. 10 Series—but smaller and lighter. No. 6 Series is equipped with the same unique torque control principle. The same automatic start and stop mechanism. They enable you to make even greater cost savings in the production line operations of automotive, aircraft, appliance, and electronic industries. Cleomatic No. 6 Series Screwdriver—Nut-Runners are available for delivery.

To find out how big an improvement a Cleomatic can make in your operation, call your local Cleco* representative for a tryout-demonstration. For detailed literature, write:

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January 6, 1961
ACADEMICALLY SPEAKING

Organic Semiconductor Conference

COSPONSORED by Armour Research Foundation and ELECTRONICS magazine, a special interindustry conference will be held in Chicago's Morrison Hotel on April 18 and 19. Purpose of the conference will be to present a comprehensive coverage of organic semiconductors, including the latest results of research in industrial and government laboratories. Research areas to be discussed: organic semiconductor physics, molecular crystals, charge transfer complexes, pyrolyzed polymers, photoconductivity, electrical and thermal transport, surface and contact effects, and organic semiconductor devices. Plans for the conference were formulated by the co-chairmen, James J. Brophy, assistant director of physics research at Armour, and W. W. MacDonald, editor of ELECTRONICS. Program chairman is John W. Buttrey, supervisor of solid state physics at Armour. Inquiries should be sent to Dr. Brophy.

Graduate schools should continue to aim at training the skilled specialist not at producing the cultured man. So said Bernard Berelson, director of the Bureau of Applied Research at Columbia University, recently. According to him, if the critics had had their way two or three decades ago and the graduate school had turned primarily to the production of undergraduate teachers of great breadth, we would be worse off today with respect to scholarship and knowledge, both pure and applied. The current emphasis on research training of doctorate candidates is of particular importance to industry, he intimated. DuPont, he said, employs more PhD's than any other organization in the country. G.E. has more than twice as many as Princeton. Shell has more than M. I. T., Union Carbide, Eastman and IBM all have about as many as Northwestern or Cal Tech. Firms employ more than all the liberal arts colleges.

New Antenna Saves Space

Lightweight uhf antenna for space-ground communication and frequency surveillance has capabilities of parabolic dish types, according to Avien Inc. inventor R. D. Bogner (l), shown with VP-technical director Norman Pickering. Firm has Signal Corps contracts for prototype models.
The Avnet System changes the Concept of Inflation

Avnet cannot control inflation. No single company or industry can. But Avnet can control the value you receive.

In the same Avnet package with your components are some extras at no additional charge... assurance that the product is the right one for your requirement... extra days or hours to use the product, having received it sooner from Avnet than from any other major source of supply... availability of complete application information... selection from one of America's largest inventories... plus the knowledge that Avnet's first interest is in the complete success of your total product.

Although Avnet cannot control the nation's price structure, it can control its own value structure. And it certainly does. This new Concept of consistently giving more for the same price is one of the many advantages in The Avnet System. Contact your nearest Service Center for additional specific benefits to your business.
Report No. 15
Type IL2000 Alpha-Numeric Display Module

Developed as a company-sponsored project, and the result of many years of visual readout system experience, this small, lightweight device can present from one to 64 individual characters within a maximum change time of 50 milliseconds. Its basic function is converting digital computer outputs into visual display. The alpha-numeric display module is designed to incorporate versatility, clarity, speed, wide-angle viewing, and reliability. A mechanical locking device holds a character display until an erase input is received. Thus it is able to present information continually without any drain on the command input circuit. A memory circuit can be provided so that the module may be interrogated for the character being displayed. The module is internally lighted and each character can be read with clarity from a distance of 30 feet with an included viewing angle of 90°. In addition to 36 alpha-numeric characters, 28 additional character formats may be selected by the customer.

Character Size
Height — 1/2"
Width — 5/16"
Maximum number of characters displayed
6 bit binary input — 64
4 bit binary input — 16

Nominal Operating Data
Voltage — 28 V.D.C.
Power Requirement — .6 watt seconds per bit
Reset Power — .6 watt seconds
Steady State Power — 0 watts
Life Estimated — 5 x 10^6 random indications
Lamp Voltage — 28 volts

Dimensions
Length — 4.5" including connector
Height — 1.5/16"
Width — 1"
Weight — 5.5 oz.

For more information and complete operating specifications, write or wire SM/1 today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

MEETINGS AHEAD


Jan. 9-11: Reliability & Quality Control, ASQC, AIEE, EIA, PGRQC of IRE; Bellevue-Stratford Hotel, Phila.


Jan. 16-18: American Astronautical Society, Annual; Sheraton-Dallas Hotel, Dallas.

Jan. 17-19: Instrument Automation Conf. & Exhibit, ISA; Sheraton-Jefferson Hotel, Kiel Auditorium, St. Louis, Mo.


Jan. 31-Feb. 2: Cleveland Electronics Conferences; Engineering & Scientific Center, Cleveland.

Feb. 1-3; Military Electronics, PGMIL of IRE; Biltmore Hotel, Los Angeles.

Feb. 1-4: Electronic Representatives Assoc., Annual Convention; Ambassador Hotel, Los Angeles.

Feb. 7-9: Electrical Manufacturers Assoc.; Veteran's Memorial, Columbus, O.


Mar. 20-23: Institute of Radio Engineers, International Convention, All PG's; Coliseum & Waldorf-Astoria Hotel, New York City.
Bourns Trimpot®
Puts the Proof in Humidity-Proof

Plunging a potentiometer into near-boiling water is just one of the ways Bourns puts the proof in humidity-proof. Every Trimpot unit made takes this 60-second bath with the water simmering at 90°C. Air expanded by the heat creates four pounds of pressure inside the potentiometer—enough to cause bubbles—if it leaks. Only if the unit is completely leak-free does it pass the test.

Bourns humidity proofing starts at the beginning—with original design and selection of materials. The plastic chosen for Trimpot cases, for example, displays the unusual properties of high insulation resistance and extremely low moisture absorption.

Further protection against humidity results from manufacturing procedures, such as internal potting of the resistance element and sub-components. Finally, Bourns samples all production for compliance to MIL-STD-202A, Method 106 as a routine part of a Reliability Assurance Program. As a result, Trimpot does more than “resist” moisture; it keeps moisture out.

For more information about the industry’s largest selection of humidity-proof adjustment potentiometers—wirewound and carbon in a variety of sizes, power ratings, operating temperatures, etc.—write for new Trimpot summary brochure and list of stocking distributors.
How American Industry Points The Way To Sustained Prosperity in 1961

Something new and very constructive is happening in American industry. It promises to add a major element of strength to business not only in 1961 but right along over the years ahead.

What is happening is essentially this. American industry is planning to continue to invest heavily in new and better producing facilities in spite of the fact that it has an excess of capacity to produce its present range of products. And, by doing so, business is helping to shape a stronger American economy. For the continuation of a high level of capital investment by business is one of the most important keys to sustained prosperity.

News of this major new development in American industry is provided by the results of the McGraw-Hill Fall Survey of Business Investment Plans for 1961 and 1962, presented in detail at the right. The McGraw-Hill investment surveys, now in their 13th year, cover a broad cross-section of American industry.

How American industry is aiming to go ahead with a big investment program in spite of its present burden of excess producing capacity is highlighted by the plans of manufacturing companies. The McGraw-Hill fall survey finds that, on the average, these companies are using slightly less than 80 per cent of their producing capacity. They would like to be using well over 90 per cent.

Dramatic New Departure

If historic investment patterns were being followed, our manufacturing companies, with only about 80 per cent of their capacity being employed, would be cutting back new investment programs drastically, and cutting down prosperity in the process. But — and here is the dramatic new fact — they plan almost no cut-backs in their investment programs. They plan to invest almost as much (within 3%) in 1961 as they are investing this year. And this year they are investing 19 per cent more than they did in 1959.

There are two major reasons why American industry is unwilling to let its excess produc-

<table>
<thead>
<tr>
<th>INDUSTRY</th>
<th>1959 Actual</th>
<th>Estimated</th>
<th>Planned % Change</th>
<th>1962 Planned</th>
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(1) Figure based on large chain, mail order and department stores, insurance companies, banks and other commercial businesses.
"R And D" Paves The Way

The steel industry provides a good case in point. Despite an operating rate of little more than 50 per cent during the last six months, steel companies plan a total investment of nearly $1.4 billion in 1961. And though this is 10 per cent below their capital expenditures in 1960, it will still be the third highest year on record.

Also, new investment is required to tool up for the manufacture of the new products being spawned by the continuing boom in industrial research and development. This year, we are spending about $13 billion (that's billion) for all research and development, about $9.6 billion of it through industry.* And out of it is coming the "know-how" for a veritable flood of new products, processes and equipment, most all of these calling for new producing equipment. Next year, American manufacturers plan to get 12 per cent of their sales in products that did not even exist four years ago.

Key Role Of Depreciation Reserves

A major reason why American industry can combine the desire to carry out big new investment programs with the necessary financial capacity to do it is to be found in the growth of its reserves for depreciation. This year, (1960), business has been in a squeeze between costs and the prices it could get for its products. This cost-price squeeze has reduced profits sharply. The total of profits for the year will be down about 5 per cent.

Allowances for the depreciation of existing plant and equipment, however, have continued to rise. The result is that the so-called cash flow of corporations (their retained profits plus their allowances for depreciation) is the same this year as last. And this cash flow, shown in the chart above, makes a decisive contribution to financing new investment.

Inflation Would Be Deadly

If the sort of profit squeeze that has prevailed this year were to become chronic, it would blight both the incentive and wherewithal to continue a vigorous program of new investment. In addition, if price inflation were to begin surging again, it would eat away the power of depreciation reserves to purchase new plant and equipment.

The allowances now permitted American industrial firms for the depreciation of their producing facilities are lower than those made in any of the industrial countries with which we are in increasingly tough competition. More adequate allowances would speed up the job of modernizing American industry. An earlier McGraw-Hill survey indicated that it would cost only slightly less than $100 billion to bring our nation's plant and equipment up to date.

But at this juncture, American industry's eagerness and capacity to maintain a high level of investment capital is adding a great new element of constructive strength to the nation's economy.


This message was prepared by my staff associates as part of our company-wide effort to report on major new developments in American business and industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

Donald M. McGraw
PRESIDENT
MCGRAW-HILL PUBLISHING COMPANY
Gudelace takes the slips out of lacing

Try this simple test. Tie a piece of Gudelace around a pencil in a half hitch and pull one end. Gudelace's flat, nonskid surface grips the pencil—no need for an extra finger to hold Gudelace in place while the knot is tied!

Gudelace makes lacing easier and faster, with no cut insulation, or fingers—no slips or rejects—and that's real economy. Gudelace is the original flat lacing tape. It's engineered to stay flat, distributing stress evenly over a wide area. The unique nonskid surface eliminates the too-tight pull that causes strangulation and cold flow. Gudelace is made of sturdy nylon mesh, combined with special microcrystalline wax, for outstanding strength, toughness, and stability.

Write for a free sample and test it yourself. See how Gudelace takes the slips—and the problems—out of lacing.

GUDEBROD BROS. SILK CO., INC.
Electronic Division
225 West 34th Street
New York 1, N.Y.

CIRCLE 200 ON READER SERVICE CARD

For that NEW IDEA visit the IRE SHOW

March 20-23, 1961
New York
Coliseum and Waldorf-Astoria Hotel
Members $1.00, Non-members $3.00
Age limit—over 18

For all types of process control systems, Hagan PowrMag (magnetic amplifier) analog computer control offers high stability and simplified construction.

- All solid state—no tubes or transistors.
- Interchangeable plug-in elements.
- Rate, proportional band, reset action—all other control functions built-in.
- Space saving panel stations—easy to maintain.

Write for Bulletin MSP-163

CIRCLE 202 ON READER SERVICE CARD
"How much is enough for advertising?"

JOHN R. SARGENT, partner in the nationally-known management consultant firm of Cresap, McCormick and Paget, points the way toward solution of one of top management's knottiest problems.

"Good sales management generally knows the crucial sales problems faced by each one of its products. Through good advertising advice plus experience, trial and error, and some judicious advertising testing, sales management also can come to have a good understanding of what advertising can and cannot do.

"At the same time, sales management should be sure to take a careful look at what each of the other sales producing factors are supposed to be doing.

"If all these elements of the sales plan are carefully evaluated, and the key assumptions are checked regularly, you're off to a strong start in making sure that your advertising appropriations are neither so high as to be wasteful, nor so low as to penalize your marketing effort."
NEW MINIATURIZED Electrolytic CAPACITORS

Our high volume production, especially developed for this new BMT line, enables us to offer these small, rugged, dependable, quality electrolytic capacitors priced to fill the needs of low cost, economic designing.

Ideal for transistor applications . . . size ranges diameters 3/16" up to 9/8"; capacity 1 mfd. to 2,000 mfd.; 3 volts to 50 volts; operating temperature range from —30°C to +65°C. Units have low impedance at —30°C and low leakage throughout the entire temperature range.

WRITE for technical information and illustrated literature.

ILLINOIS CONDENSER COMPANY
1616 N. Throop Street Chicago 22, Illinois
Telephone: Everglade 4-1300

CIRCLE 203 ON READER SERVICE CARD

MODEL 4005

Colorado...CENSUS-PROVEN OUTSTANDING NEW INDUSTRIAL MARKET

Census-proven one of the fastest growing states in the nation...survey-proven one of the outstanding new industrial markets, Colorado offers new industry Profits with Pleasant Living.

Discover the new markets and opportunities awaiting your company in Colorado. "Site-See!" Industrial Colorado now...right at your desk.

Send for Free Executive Portfolio "INDUSTRIAL COLORADO"

Newly revised 9-booklet portfolio with up-to-the-minute data on Colorado's industrial sites, assets, opportunities and weekend vacation wonderlands. All inquiries held confidential.

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CIRCLE 204 ON READER SERVICE CARD

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2S26 For Audio Frequency Power Amplification
2S45 For Intermediate Frequency Amplifier Service
2S52 For Converter Service
2S49 For Intermediate Frequency Amplifier Service
2S50 For Switching Purpose
2S52 For Converter Service
2S53 For Intermediate Frequency Amplifier Service
2S826 For Audio Frequency Power Amplification
2S847 Low Noise Factor with Audio Frequency Amplifier
2S854 For Low Frequency Amplifier Service

2S556 For Audio Frequency Power Amplifier Service
2S8189 For Medium Power Output Service

Germanium PNP Alloy Type DRIFT TRANSISTORS

2SA57 For High Frequency Amplifier Service
2SA58 For High Frequency Amplifier Service
2SA59 For High Frequency Amplifier Service
2SA60 For Converter Service
2SA92 For Local Oscillator Service
2SA93 For Mixer Services
2SA175 For High Frequency Amplifier Service

For complete information, write to
TOKYO SHIBAURA ELECTRIC CO., LTD.
2, Ginza Nishi 5-chome, Chuo-ku, Tokyo, Japan
In electronics, you have to look twice at Japan

Japan's capability in electronics is more than pocket radios. It's also communications systems matching in sophistication and reliability those produced anywhere in the world. Microwave systems and multiplex-carrier equipment are two examples. In either, NEC can offer the most advanced systems commercially available. This 60-year-old company is the only one offering microwave systems in all bands, from 800 to 14,000 mc. Capacities go to 2,400 voice channels. Its unique over-the-horizon system, requiring 1/100 of the power of conventional systems, is drastically reducing the cost of this type of link. NEC makes multiplex-carrier equipment for all modes of transmission—wire line, coaxial cable, power line, radio, and microwave. Much of it is completely transistorized, resulting in the world's smallest carrier equipment. This capability in medium- and large-capacity communications systems is what you see when you take a second look at electronics in Japan.

Helping to advance the state of the art

Nippon Electric Co., Ltd.
Tokyo, Japan
RATCHET-RELAY STEPPING SWITCH

for automatic switching, circuit selection, and timing control

- Occupies small mounting space.
- Does not overheat.
- Accurate, dependable, sturdy.

Features:
36 steps per second on self-interruption.
20 steps per second from external pulses.
Operation on 75V nominal voltage.
Life in excess of 50,000,000 steps.

For complete information on the new ratchet-relay stepping switch and other Genalex precision products, write:

11 UNIVERSITY ROAD, CAMBRIDGE 38, MASS.

CIRCLE 206 ON READER SERVICE CARD

IF PREAMPLIFIERS

for

MICROWAVE MINIATURIZATION

An ideal component for a solid state microwave receiver, the LEL IF-86 Preamplifier features germanium mesa transistors to provide minimum noise figure.

Noise Figure ........................................ 4.25db
Frequency ..................................... 60mc
Bandwidth ...................................... 20mc
Gain ............................................. 26db
Low Power Requirements ...................... -4-20v @ 8ma
-20v @ 8ma
Lightweight ..................................... 6 oz.
Small Size .................................. 2-9/16" x 2-1/4" x 1-1/8"

Send for comprehensive Microwave, IF, RF Amplifier Catalog.

CIRCLE 207 ON READER SERVICE CARD
Four ways to reduce metallic whiskers —
Troublesome whiskers tend to grow from surfaces of electrical and electronic components in close proximity.

Example of metallic whisker growth on angle bracket

By bridging gaps between contact points, the whiskers cause shorts. As a result of research fostered by telephone companies and the tin industry, it has been determined that whisker growth can be reduced in any of four ways:

- Tin coatings can be increased to an ideal thickness of .005 in.
- Components can be flow-melted
- Components can be hot tin dipped rather than electrolytically coated
- Lower ambient temperatures can be used to inhibit whisker growth

Superior solderability can be obtained with a hot dipped or electroplated coating of .0003 in. This thickness is least influenced by factors of basis metal, undercoat layers and after-treatment — according to solderability studies of various coatings of tin, alloys of tin with lead, zinc, cadmium, and cadmium and silver.

FREE Brochure
16 interesting pages of information about the latest uses of tin in U.S. industry. Write today for your copy.

The Malayan Tin Bureau
Dept. S-64A, 2000 K St., N.W., Washington 6, D.C.

For the semiconductor field a wire such as Nickel may be Gold plated and subsequently electroplated with either a Group III or Group V metal, thereby providing a "doped" electroplate. Another application is the electroplating of a high melting point wire such as Nickel with Indium as a low melting point solder. Many other combinations are achievable.

Write for list of products

SIGMUND COHN MFG. CO., INC.
121 SOUTH COLUMBUS AVE. M.T. VERNON, N.Y.

CIRCLE 208 ON READER SERVICE CARD

ONE Flick Resets this HIGH Speed Electric Counter

Model "YE" by DURANT

[ adversitement for DURANT ELECTRIC COUNTERS ]

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CIRCLE 209 ON READER SERVICE CARD
### REGATRAN® SEMICONDUCTOR POWER SUPPLIES

**SPECIFICATIONS**

- **REGULATION:** 0.03% or 0.01 V from no load to full load and 105 to 125 V line. (0.1% or 0.01 V for 3-amp models.)
- **RIPPLE:** Less than 1 millivolt rms.
- **INPUT:** 105 V to 125 V, 50 to 60 cps.
- **CIRCUIT PROTECTION:** Four-year field-tested electronic and electrical circuit protection.
- **MOUNTING:** Rack and table.
- **0.01% or 0.003 V regulation available on special order. REQUEST BULLETIN 721A.**

### TABLE:

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*All Narrow Range Models are Programmable.*
shift phase

FAST

with

AM&C

FAZE-BOX

Here is a low-cost precision instrument that lets you shift phase from 0 to 180° in a matter of seconds. No more time-consuming construction of make-shift circuits every time a new phase shift problem arises — AM&C FAZE-BOX is there when and where you need it. Compact, easy-to-use, dependable.

Input Voltage Range: Up to 30 volts rms
Frequency Range: 25 to 10,000 cps
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Output Voltage: Same as input
Controls: Fixed-Phase selector, Coarse phase selector, Fine phase vernier
Size: 3"h x 6¼"w x 3¾"d overall
Weight: 1.5 lbs.
Price: $69.50
Delivery: Immediate

YOU CAN ORDER ONE TODAY

AMERICAN MEASUREMENT & CONTROL, INC.
240 Calvary St., Waltham 54, Mass.
Twinston 4-6212

FAZE-BOX

CIRCLE 66 ON READER SERVICE CARD

FAZECIRCLE

Voltage Range
Input Range
Input Impedance
Voltage Output
Controls
AM&C to-use, when
shift every
of
sion
AMERICAN
Weight
Price
Delivery

AM&C
180°
make-shift
Calvary
shift
instrument

FAZE-BOX
ORDER
....
FAZE-BOX
15,000
No
phase

AMERICAN
Weight
Price
Delivery

AM&C
180°
make-shift
Calvary
shift
instrument

FAZE-BOX
ORDER
....
FAZE-BOX
15,000
No
phase

IEICO41961

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STEREO
AND MONO
HIGH FIDELITY
TEST INSTRUMENTS
HARDWARE
CITIZEN'S TRANSCEIVERS
RADIOS

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New 1961
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EICO ELECTRONICS

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RECORDING ENGINEERING COMPANY

CIRCLE 210 ON READER SERVICE CARD

REC'S 800 SERIES,
PRESSURE TRANSDUCERS

• FAST RESPONSE
• HIGH ACCURACY
• VERY LOW Hysteresis
• MAX. RESISTANCE TO SHOCK & VIBRATION

Model 800C

REC's Model 800C Capacitance Type Pressure Sensor utilizes a free-edged, circular diaphragm of Ni-Span C. Full scale ranges are from 1 to 100 psi and differential or absolute pressure measurements can be made.

The 15 psi range features 100 percent over-pressure, no resonances less than 2500 cps, and a pneumatic greater than .004 seconds. Maximum excitation voltage is 110V rms and the capacity ratio change is such as to directly produce an output equal to 25 percent of this voltage.

Write for Bulletin No. 35010

ROSEMOUNT
ENGINEERING
COMPANY

CIRCLE 211 ON READER SERVICE CARD

electronics
keep your signals clean with engineered magnetic shielding

Keep stray magnetic fields out of your high gain input transformers and cathode ray tubes. Keep your signals free of noise, hum, cross-talk and distortion. You can do it only with engineered magnetic shielding.

These high-permeability shields are made from existing tools in a broad variety of single and multiple structures—cylinders, spheres, truncated cones—for applications ranging from dc into the audio range and higher. They can be used with almost all conventional transformer core and coil assemblies to provide any degree of magnetic, electrostatic or RF shielding against undesired signals of all classes. Reduction of field strengths to 100 db and beyond is common.

With Magnetic Metals shielding, both the electrical and mechanical engineering is already done for you. Simply let us know your requirements... We'll engineer the exact type of shielding you need. In selection of raw material, design, fabrication, annealing, testing and gaging, Magnetic Metals has amassed a great backlog of shielding experience. For a better understanding of shielding and help in specifying it, write for our informative booklet, "Magnetic Shielding of Transformers and Tubes."

Magnetic Metals Company
Hayes Avenue at 21st Street, Camden 1, N.J.
853 Production Place, Newport Beach, California
transformer laminations • motor laminations • tape-wound cores
powdered molybdenum permalloy cores • electromagnetic shields

January 6, 1961
the scope of
FROM A CONCEPT TO DEMONSTRATED WORLD-WIDE
CAPABILITIES IN LESS THAN TWO YEARS

Alpha Corporation in its systems engineering and management role is playing a vital part in highly diversified communications, instrumentation and control systems for government and industry.

Pacific Missile Range instrumentation, communication and data handling systems serve the nation's largest missile range, stretching from Point Mugu westward, by way of islands and range ships.

Satellite and deep space probe air transportable tracking and communications systems for NASA, JPL and the Signal Corps have been engineered to handle a wide range of missions.

Naval Tactical Data System makes possible rapid transmittal and display of radar, fire control and similar types of data simultaneously between all elements of a naval task force deployed at sea.

Short Order system provides positive two-way voice contact needed to control all airborne elements of Strategic Air Command through any of four widely dispersed HF single sideband station complexes.

Air Transportable Communication Central allows Marine Corps command post to route teletypewriter, voice and telegraph communications between landlines and self-contained HF single sideband station with complete switching flexibility.

Project Echo passive satellite communication experiment successfully transmitted voice, teletypewriter and facsimile between Collins at Cedar Rapids and Alpha at Dallas in joint company-financed tests of feasibility of satellite relay communication.

Far East Tropospheric Scatter System provides multiple channels for voice, teletypewriter and data communication between Formosa and Okinawa, a 410-mile over-water link in the Armed Forces Pacific Scatter Network.

Asiatic Petroleum 500-mile communication system combines Tropospheric Scatter and Microwave to link Shell Oil's Venezuelan Headquarters at Caracas with its refinery at Cardon, and its western oil operations area.
EDO, specialist in underwater electronics, designs and manufactures a wide range of echo-ranging and listening sonar equipments for the Navy's surface ships and submarines. Edo-built sonar "eyes"—looking upward, downward and ahead—have helped the nuclear submarines NAUTILUS, SKATE, SARGO and SEADRAGON navigate ice-surfaced polar seas. Edo sonar units give surface ships outstanding ASW capability. AN/UQN units—deep depth sounders in quantity production by Edo—are standard equipment on every class of Navy ship for precise bottom scanning, and are also in world-wide use commercially. For long range navigation, Edo also manufactures airborne and marine Loran that is standard equipment aboard airliners and surface vessels the world over.
Our Industry
Today and Tomorrow
By EDWARD DeJONGH
market research


Our Markets (1960 to 1970)
Military electronics markets
Industrial markets
Consumer markets
Market for components

Distribution — A Lever for Higher Profits
Company sales forces
Selling through representatives
The distributor link

Market Planning in the Electronics Industry
Introduction
Changing picture in the electronics industry
Electronics industry market planning still in infancy
The market planning function
Market planning in action — a case history

International Trade — A Vital Concern of Every Electronics Manufacturer
Economic and political background
Exports
Imports
World electronics production
Financing export sales
Investments abroad
Joint ventures — a lawyer’s view
Licensing
Export-import tables

FACTORY VALUE
ELECTRONICS
PRODUCTION

BILLIONS OF
DOLLARS

FREE WORLD

UNITED STATES


$10

$20

$30
**OUR MARKETS**

(1960 to 1970)

The U. S. electronics industry will ride through any downturn in 1961. Both domestic and world electronics sales will more than double during the next decade.

Electronics markets will be untouched by any business-wide downturn this year.

That's the consensus of opinion of 125 electronics industry marketing professionals who recently gave ELECTRONICS magazine their opinions on expected changes in the size of electronics markets for the years 1960, 1961, 1965 and, in some cases, 1970. This group included managers of market research and company planning, marketing directors and a few management consultants.

Estimates of industry-wide sales supplied by electronics marketers show total industry factory sales (as defined by Electronic Industries Association) increasing by 11 percent in 1961 to $11.3 billion. In 1960, regarded as a normal year, neither boom nor recession, sales were up seven percent over the preceding year the marketing experts reported. Outlook is for 1960 sales to increase 47 percent by 1965 and 106 percent by 1970.

The marketers' opinions check with previously reported predictions of economists who said the nation's industrial production will drop 10 to 15 percent in the first quarter of 1961. But, aside from consumer goods, the electronics industry will be scarcely affected. See ELECTRONICS, p 24, Oct. 14, 1960.

**TEN-YEAR TREND**—Here's a thumbnail sketch of the trend of electronics industry sales by major industry segments over the next ten years:

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Military Electronics</td>
<td>6%</td>
<td>13%</td>
<td>50%</td>
<td>92%</td>
</tr>
<tr>
<td>Industrial Electronics</td>
<td>13%</td>
<td>22%</td>
<td>83%</td>
<td>177%</td>
</tr>
<tr>
<td>Consumer Electronics</td>
<td>3%</td>
<td>No change</td>
<td>14%</td>
<td>82%</td>
</tr>
<tr>
<td>Replacement Parts</td>
<td>10%</td>
<td>10%</td>
<td>40%</td>
<td>60%</td>
</tr>
</tbody>
</table>

As this summary shows, industrial electronics will be the fastest growing sector of the electronics industry with sales expected to increase almost twice as fast as any other industry segment. It also shows that the average annual sales increase of military electronics over the next decade will be almost 10 percent a year. One of the factors in the maintenance of strong rising trend of military expenditures is the fast-rising amount of space expenditure. National Aeronautics & Space Administration spending is joined with military in the above figures.

**SALES AND PROFITS:** Although profits were not a specific concern of this report, they cannot be ignored. A picture of rising sales is economically attractive only if sales carried out can be translated into higher profits.

Managers of electronics companies will have to pay more and more attention to operating more efficiently unless they want a profitless prosperity over the next ten years.

The three sections of this report, largely written by electronics industry top-management representatives deal with distribution, market planning and international trade. All these sections reveal a strong concern of electronics industry management with falling profits.

Main force behind efforts to develop more efficient systems of distribution is the desire to offset falling profit ratios by squeezing the fat out of selling and marketing costs, an area that has in the past received relatively little attention by our product oriented industry.

The section on market planning strengthens this argument by pointing out that no longer is it enough to know how to manufacture or develop a product. In most cases scores of competitors can do the same. The organization that will prosper over the next ten years is the one that can gear its production to the needs of the market and will be skilled in selling its product.

The international trade part of the report constantly touches on the profit question and indirectly refers to the fact that the company that does not remain alert to the changing international trade picture will endanger its profits. Imports are rising rapidly. Exports, except for a few specialty products, are rising slowly, if at all.

However, many executives in our industry are alert to the problem of declining profit margins and are doing much to make their operations more efficient and their management as astute as any in the country, all of which may reverse the falling profit trend.

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**Military Electronics Markets**

Gradually rising defense expenditures plus steadily increasing electronics share of DOD spending mean more military dollars.

Behind military electronics expenditures, expected to rise from $5.2 billion to $10.0 billion between 1960 and 1970, are three main trends:

1. Department of Defense spending, now about $41 billion, is rising slowly but steadily, despite the pressure to hold down spending because of rising costs and the increasing intricacy of military equipment. Economists generally concur that total DOD spending will rise to about $45 billion by 1965.
2. The electronics share of the DOD dollar will amount to nearly 32 percent in 1965. Last year it was estimated at 27.5 percent and compares with 15.8 percent five years ago. The historical trend is shown on the accompanying chart, Department of Defense Expendi-
January 6, 1961

Total Department of Defense Expenditures for Production Procurement and Research (FY1955-1960)

TOTAL BILLIONS OF DOLLARS


TOTAL PRODUCTION PROCUREMENT AND RESEARCH

$25 ELECTRONICS SHARE

$25 ELECTRONICS SHARE

Electronics, which contrasts total expenditures with expenditures for electronic equipment.

(3) National Aeronautics & Space Administration expenditures are climbing rapidly. NASA expenditures for communications and checkout and test equipment amounted to $184 million last year; will amount to $330 million in 1965 and will approach the billion-dollar mark by 1970.

Basic force behind the trend in military electronics buying is the nation's military-political policy of maintaining military retaliatory capability at least equal to the offensive capability of any potential aggressor plus the development of early warning and countermeasures equipment.

Long-term Trends—Following are some of the basic facts affecting the level and makeup of military expenditures:

1. The shift from manned aircraft to missile weapons systems.

2. The shift in the mix of weapons-system cost away from airframes and off-the-shelf hardware items to systems and subsystems.

3. The shift in emphasis from production to research and development. However, this shift varies with product and time. Many missiles recently in the research and development stage are now in production for operational use.

4. The shift in demand from production workers to technical and managerial personnel.

5. Finally, there is the question of the long-term trend of military spending: Some men in our industry take the view that the trend of military spending is slowing; however, others take the view that costs of military equipment are rising so sharply that the higher rates of spending required to meet basic military needs will be one of the country's major problems in the next decade.

Industrial Markets

Industrial markets and computing systems sales are leading the way to giant gains in industrial electronics sales.

Two product groups, computing systems and industrial controls, are providing the main drive for industrial electronics sales. Test and measuring equipment, much of which is used with computers and controls is a third major industrial electronics sales builder.

Here's a sampling of what some of the industry's market planners say about the future for industrial equipment:

"The industrial commercial electronics market estimated at $1.6 billion for 1959 will more than double by..."
1965. The expected growth is due to industry's ever increasing demand for greater product yields, improved product quality and more economical operation. Rising factory wages, and the serious threat of deeper penetration of U. S. markets by foreign competition have given more immediate impetus to the demand for electronic equipment by U. S. industry."

"Annual sales for products within the test and measuring equipment group, which together amounted to $515 million dollars in 1959, are expected to reach $1.2 billion dollars by 1965. They constitute the fastest growing segment of the industrial-commercial market during the next five years." The $515 million figure mentioned above represents either an unusually broad definition of this market or includes sales to the military. Most marketers currently estimate this market at about $300 million.

"Industrial process control computer systems repesent a relatively new and fast developing market."

"Substantial market growth is expected over the next five years for static power inversion and conversion equipment."

"Biggest of all the industrial-commercial markets is computing systems currently growing at the rate of 50 percent a year, sales are expected to jump from $500 million to $1.8 billion by 1965."

### Markets for Components

**Total components sales will account for 27 to 28 percent of industry volume over next decade. Prospects for many components may change drastically**

**Indications** are that total component sales will continue to account for 27 to 28 percent of total electronics industry sales as they have in the past.

Big question in the minds of most component manufacturers today is what effect will micromodular, molecular, and other microminiaturized component developments have on components?

Consensus of opinion of manufacturers both of conventional and microminiaturized components is that we will start seeing the new-type components used in advanced military equipment within the next two years. But it won't be until 1965 that they will make a substantial dent in components dollar volume.

Industry market planners carefully explained the assumptions underlying their component-market forecasts. Here's a few examples:

**Connectors:** "In past connectors have followed same general trend as all components. They should continue to do so until 1965."

**Magnetic Amplifiers:** "See little growth in volume over the next five years because static systems are likely to preempt many of the markets for magnetic amplifiers."

**Printed Circuits:** "Sales to double in 1965, with a 15 percent increase due in 1961."

**Silicon Controlled Rectifiers:** Major growth in silicon-controlled rectifier market will be in industrial-control and automation applications."

**Semiconductors:** "The market for semiconductors will not increase as fast in the next five years as it did in the last five years. While unit volume will increase considerably, prices will decrease rapidly. Increase in dollar volume will come from new applications."

**Transistors:** "There is a continuous decline in the unit price of various transistors. At the same time there is also an increase in usage of silicon transistors and a decline in germanium transistors. Silicon types are priced 2 to 6 times higher than germanium."

**Zenner Diodes:** "Price decline expected to begin in late 1961."

**Backward-Wave Tubes:** "Show the greatest promise for all classes of military end use."

**Tubes, Gas and Vapor:** "Gas and vapor diode use will decrease because of competition from semiconductor devices."

**Hydrogen Thyatrons:** "Modest increases indicated for this class of tube which is used almost exclusively in military end equipment."

**Klystrons:** "Market should increase substantially due to need for military tubes in high-power radar equipment."

**Traveling-Wave Tubes:** "Show the greatest promise for all classes, for military end use in microwave communications."
DISTRIBUTION—
A Lever for Higher Profits

In coming years success in the electronics industry will depend more and more on marketing skills

By HOMER R. OLDFIELD, Jr., STEWART D. COWAN and JOHN T. THOMPSON

INTRODUCTION—Success in the electronics industry will depend more upon marketing skill in 1961 and the years following than it has in any previous period. The well-engineered product is no longer a sole guarantee of adequate sales and profits in an industry that is coming of age and shaking out the less sophisticated companies.

Today's biggest customer for electronic devices is the U. S. government, which will account for more than half of the 1961 purchases. This specialized market involves a two-pronged sales program aimed at non-technical management and at the technical specialist. Although government sales are a major market for electronics companies, in this discussion commercial distribution will be emphasized.

Electronic products reach the user through three basic distribution channels: factory salesmen sell $9.5 billion (which includes $5 billion in government sales), manufacturers' representatives sell $2.5 billion, and distributors handle another billion. (Total of salesmen and reps sales exceed accepted industry sales total by about $2 billion because value of both OEM and replacement components sales are listed.)

Electronic merchandise for individual consumers follows the distributor channel but, in addition, flows on to a retail dealer. Some larger accounts, such as major chain stores and department stores qualify as associate distributors and buy directly. Similarly, quantity sales are often made directly to discount houses. Another channel, mail order, has been utilized with great success by kit manufacturers such as Heath Company to reach selected segments of the general public. Heath now also sells through selected distributors.

EMPHASIS ON MARKETING—Marketing is receiving more attention in virtually every company. Like a puppy learning to use its oversized paws to hold a bone, our
Company Sales Forces

Increasing number of electronics firms sell through company sales forces. But selection of the best channel of distribution varies with companies and company divisions.

Mounting sales of individual electronics firms indicate to many electronics manufacturers that company sales forces are the most efficient basic method of selling their products.

It would be absurd to state that selling through a company sales force is always the most effective way of selling electronic or other products as selecting the best channel or road to the marketplace varies with companies and within a particular company—if it manufactures several product lines.

However, the largest percentage of electronics industry factory sales is made directly to users—$8.5 billion out of approximately $10 billion worth of total industry sales, as shown in the bar graph. Therefore, the question of how most effectively to organize, select and employ a company sales force is one major concern to our industry.

Organizing the Sales Force—The company that elects to sell directly with its own sales force must first define the marketing organization to be used:

1. A field sales force representing each product line
2. A consolidated sales force representing the full line.

Centralized Sales Force—The alternative to product-line sales forces is one sales force to represent all divisions of the company, usually under the direction of a vice president of sales at corporate level. This centralized organization is the least expensive means of providing broad customer coverage and preventing undesired overlaps. By necessity it substitutes sales generalists for product specialists, requiring that each division provide supporting application engineering and close supervision from headquarters.
Salesman training is a continuous job. Meeting with groups like this Curtis R. Hammond, commercial vice-president, marketing development, Raytheon, periodically briefs salesmen on new objectives

The scheme works superbly in the case of well-established products that can be sold from a catalog. As the products become more complex in their concept or application, the lack of specific knowledge on the part of the sales generalist becomes a definite handicap.

Inherent in either a product-line or centralized organization is the concept of the region. Large numbers of field salesmen cannot be directed by remote control from headquarters. Thus establishing the requirement for a certain number of regional managers, each with his assigned territory, product line and sales quota. When a multi-division company has a product-organized sales force, it is necessary to have a multiplicity of such managers in each region. This is expensive and, more important, requires duplication of scarce management talent. The unified sales force requires but one manager in each region, making it possible to optimize the use of the most competent managers.

An elementary block diagram illustrates the product-organized sales force, giving the most important advantages and disadvantages. Another chart gives the same information for the centralized sales force.

Many electronics companies are organized into operating divisions, each specializing in certain product lines. The trend has been to make these divisions semi-autonomous, with the division management being assigned profit and loss responsibility along with the authority needed to do the job.

This concept poses one of the most controversial problems that can be faced in organizing the sales force. Should the sales organization be set up on a divisional basis so each division manager has complete responsibility for sale of his product line or should it be structured on a company basis to permit a unified approach to the market place?

Each approach has advantages and disadvantages. Un-
Practically speaking, it is usually necessary to employ a mixture of the two types of sales forces. The delicacy with which this is accomplished can have a profound impact on the effectiveness of the field sales organization.

One method is to establish a corporate staff executive to coordinate separate divisional sales forces and thus permit a uniform approach to at least the major customers. If this executive is truly outstanding he can informally create a company spirit through personal visits, publications and sales meetings and thus solve a portion of the problem. Lacking line responsibility, he must achieve results chiefly through the impact of his own personality. But, in the long run, this is a nearly impossible mission.

An extension of this method is to establish staff regional managers reporting to the corporate executive and to assign divisional salesmen under their administrative control.

Again, talented and respected staff regional managers can exert a coordinating influence, but the split responsibility limits their effectiveness.

Probably the only sound organizational approach is based on the specific characteristics of the business itself. Here's a simple example: assume that the five operating divisions of company A cover the five broad product lines off: computers, semiconductors, receiving tubes, communications equipment and industrial products.

Assume also that the broad product lines break down as follows:

- **Computer Division**—(a) Business machines, (b) Process control computers, (c) Analog-digital converters, (d) Machine-tool control computers.
- **Semiconductor Division**—(a) Industrial transistors, (b) Entertainment transistors, (c) Entertainment diodes, (d) Industrial infrared sensors.
- **Receiving Tube Division**—(a) Entertainment receiving tubes, (b) Industrial receiving tubes.
- **Communications Equipment**—(a) Industrial microwave relay, (b) Industrial tv.
- **Industrial Products**—(a) Industrial instrumentation, (b) Control equipment, (c) Welders.

The company's products move into three major markets: the industrial market, the business machine market and the entertainment market. Furthermore, two entirely different parts of the industrial market are involved: manufacturers of equipment (OEM's), and end-equipment purchasers (usually plant equipment for basic process industries). Also, certain products (such as business machines and industrial transistors) are highly sophisticated technically and require a high level of sales engineering, while others (such as welders, industrial tv, and entertainment receiving tubes) are more easily handled by the average sales engineer. Finally, certain products can best be sold in combination—-as parts of an integrated system (instrumentation, control equipment, industrial infrared and process control computers).

Now, an intelligent sales organization pattern can be developed with the following generalizations:

1. **Effective market coverage dictates a departure from organizational purity, and the establishment of sales concepts that cross divisional lines.**

2. **From a marketing standpoint the computer division is in two completely different businesses.** So are the

Fortunately there is no general solution to the problem. Each company must analyze its sales problems in depth and pick the method or compromise that best meets its needs at a particular point in time.

**PRODUCT-ORGANIZED SALES FORCE**—The product-organized sales force has the major advantage of being under the direct control of the division manager. He can tailor the amount and direction of the marketing effort to the needs of his segment of the business. Also, it permits a high degree of product specialization by sales force, so that it can operate in the field with a minimum of technical backup.

On the negative side: a company with several divisions and several autonomous sales forces may give too much coverage to certain customers and too little to others. Most purchasing agents prefer to deal with one man representing a particular company, and may be irked at being told that salesman Y does not handle a certain product line, and that he must contact salesman X or Z. His reaction, sometimes, is to call in a less decentralized competitor.

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**HOW $10 BILLION WORTH OF ELECTRONIC PRODUCTS WENT TO MARKET IN 1960**

(Factory sales value: original equipment and replacement components)

[Diagram showing sources of sales:
- $0.6 billion: Company salesmen
- $0.2 billion: Distributors
- $0.9 billion: Total market
- $0.1 billion: Replacement components market]

Source: Lewis & Galper, Raytheon
(3) Effective market coverage in this situation appears to dictate four generally independent sales forces:
   (a) An industrial-products sales force for process-control computers, analog-digital converters, machine-tool control computers, infrared sensors, microwave relay, industrial tv. instrumentation, control equipment and welders.
   (b) A business-machines sales force.
   (c) An entertainment components sales force. for entertainment receiving tubes, transistors and diodes.
   (d) An industrial components sales force for industrial transistors and tubes.

(4) Because industrial products involve four out of the five divisions, there is logic to organizing this sales activity on an industry basis without regard to divisional separation.

(5) Because business machines represent a special sales problem, this sales force should be organized on a divisional basis.

(6) The same is true of the semiconductor industrial sales activity. Because (in our example) the industrial-tube volume is a small portion of the receiving-tube business, it is logical to move these products through the large semiconductor sales force, which has exactly the right market coverage.

(7) On the other hand, the receiving tube division has the sales organization to reach the entertainment market and can easily add entertainment-type semiconductor diodes to its line.

The final chart shows the industrially organized sales organization in block diagram form, along with its advantages and disadvantages. Naturally there are many subtle factors. This discussion is, however, illustrative of the kind of departure from organizational purity necessary to reach a practical and economical solution.

STAFFING THE SALES ORGANIZATION—But well-considered organization charts can't in themselves insure greater sales. Having graduated from the period in which management's chief concern was to make the product to the problem of selling it most efficiently, management everywhere is taking a critical look at the talents of its marketing people.

The high dollar cost of salesman-turnover is of such significance that too much attention cannot be given to the selection, training, compensation and evaluation of the sales force. This also applies, in varying degree, to the sales forces employed by distributors and manufacturers' representatives.

SELECTION—The three sources of salesmen are new college graduates and other similar candidates, company personnel such as applications engineers, and men recruited from competitors. The difficulty of selecting men who will pay off as salesmen can be reduced by certain steps:

Review Job Description—Too many job descriptions are not up-to-date, and are not reviewed with the man. Match the man to the job.

Study Application Blank and Resume—In the interview, ask questions not answered on these forms and clarify your doubts. Do not judge the candidate by
TRAINING—A primary responsibility of a manager is the development of the people under him to build the company's management depth, and to satisfy the human need to grow in ability and prestige.

Training and development first start in the selection interview when company objectives and standards are outlined. Later, the manager, as shown in the photo, uses every available occasion to motivate and train the salesman, to develop his skills and attitudes. These opportunities include sales meetings, field trips, formal training seminars, home study programs, phone calls and correspondence.

Sales training programs break into product knowledge, people knowledge—selling techniques, markets and product applications and management of time to achieve maximum productivity. The first involves instilling in the salesman broad knowledge of the products he sells—technical features, customer benefits, comparison with competition, etc. The second deals with people relations—how to present the product story, how to motivate people, how to answer objections, sales psychology and the infinitely elusive area of what makes one man an outstanding salesman and another only mediocre. The short-term Billy Sunday type of sales training sometimes used is not a substitute for a long-term, sound educational program.

EVALUATION—When you peel away the complicated theory on performance appraisal, it comes down to the simple fact that all of us have a basic need to know how we're doing. Maximum sales performance cannot be achieved without a program to evaluate a salesman’s performance on a regular basis, discussing his work with him, praising good areas and suggesting improvement in others.

The appraisals should be in writing, and should be made against standards of actual performance. Frequency of evaluation varies but it is seldom more often

his resume—too many are professionally written and experiments show there is only a random chance of picking the right man by his resume.

Check References—When possible, check sources that are not listed on the application blank. Use the telephone, don’t write (many people hesitate to commit themselves in writing). Include a credit check.

Have Applicant Tested—Psychological testing is far from the final word, but properly done it can be helpful in evaluating a man before you invest thousands of dollars in him.

Reaching Agreement—To satisfy the human need for security and a sense of belonging, do not delegate the responsibility of orienting the new employee too far down the line. The salesman needs a first-hand understanding of his job.
than quarterly and more usually twice a year. A few companies use annual evaluations but this is not frequent enough. Many companies, unfortunately, have no evaluation program.

COMPENSATION—The stacks of articles, consultant studies and company plans on this subject boil down to one simple fact: some form of incentive compensation, under which the better a salesman's performance the more he gets paid, is highly desirable. Some incentive plans are so complex they require a Ph. D. to understand, while others, fortunately, can be understood by the salesman—an essential ingredient of the successful plan since a man should be able to see easily how his incentive pay was computed.

Detailed discussion of incentive plans is not within the scope of this article, however, a few key-points should be mentioned. It is important that the incentive portion not be too high a percentage of a salesman's annual income. It is a poor idea to pay a low base salary and have an incentive plan that enables the man to earn additional compensation equal to 50 percent or 100 percent of his base. Most incentive plans pay a salesman an equitable base salary and then give him a chance to earn 10 to 20 percent extra income—and more—through good performance. Incentive pay ought to be distributed at least twice a year.

The characteristics of the electronics industry often make it difficult to establish an incentive pay plan based strictly on the dollar volume the man produces. Large OEM orders and other vagaries of the industry may result in a windfall one year and thin pickings the next; frequently, there are factors in the sale other than simply the salesman's efforts. Therefore, most companies have a judgment factor in their plans to compensate for violent swings, and this is explained carefully to the salesmen. Strict measurement against a sales quota is often not realistic.

The simplest, most workable incentive plan might be one which measures a man against, perhaps, these eight factors:

1. sales volume, 2. new accounts called on, 3. new accounts sold—volume, 4. planning use of time: reports, 5. product knowledge, 6. market knowledge, 7. cooperation with other divisions and 8. salesman's expenses (travel, telephone etc.).

These eight factors are each assigned a range of point values (1-8 or 1-15, etc.) and the salesman given a certain number of points for each depending on his performance. His total number of points determines the amount of his incentive pay from the bonus pool.

Incentive compensation is often tied closely to a man's semiannual evaluation by his supervisor.

There is little doubt that an equitable, easily-understood incentive pay program is a key factor in building a well-motivated field sales force.
## Selling Through Representatives

The electronics manufacturers' representative is often the most efficient and economical solution to the field-selling problem.

If the manufacturer decides not to hire and train his own sales personnel, which can be a formidable financial burden for a small company, or a firm with a limited number of products for a particular market, the manufacturer's representative may offer the most efficient and economical solution to the field-selling problem.

Reps operate on a commission basis. Usually from 2 percent to 5 percent for components, 10 to 15 percent for equipment and systems, and 15 percent for test equipment and other specialty items requiring seminars and demonstrations. The rep offers his services on a no-sale, no-pay basis. Manufacturers' representatives offer many advantages to a company, either large or small, depending on the economies both of the industry and the sales problem.

The representative usually offers years of experience in the industry and wide personal contacts.

### CHARACTERISTICS OF REPS

A manufacturer's representatives has these typical characteristics:

1. Demonstrated sales ability.
2. Substantial experience in the electronics industry.
4. A realist in terms of the role he plays in the industry.

The rep usually understands the economic significance of the sales expense incurred by a manufacturer through use of his service.

As the electronics industry has grown, certain procedures have been developed, both by manufacturers and representatives, to overcome the inherent disadvantages of manufacturers' representatives as their client's volume reaches the crossover point beyond which the manufacturer feels that his own sales force is more economical. Some of these may be: reduction in commission percentages after certain volume levels are reached, employment of additional salesmen by the rep to give greater coverage, and the assumption of responsibilities over and above the pure selling function such as warehousing and physical distribution of product, invoicing and even credit extension.

### TRAINING REPS

The training of manufacturers' representatives and their salesmen should be carried out on the same basis as the training of a factory sales force. Actually the only difference between a sales force of a manufacturer's representative and a factory force is in the manner of compensation and the percentage of time spent selling the products of other manufacturers. Training should be based on an evaluation of the individual representative's capabilities and his particular needs.

Training implies communications, and clear two-way

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**HOW $3 BILLION WORTH OF ORIGINAL EQUIPMENT AND REPLACEMENT COMPONENTS WENT TO MARKET in 1960 (factory sales value)**

<table>
<thead>
<tr>
<th>Distributors</th>
<th>$0.7 Billion Distributors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.1 Billion Company Salesmen</td>
<td></td>
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<tr>
<td>$1.5 Billion Representatives</td>
<td></td>
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<tr>
<td>$0.6 Billion CO, SLSPM</td>
<td></td>
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<tr>
<td>$2 Billion Orig. Equip. Market</td>
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</tbody>
</table>

Source: Lewis & Galper, Raytheon

Not a picture of total volume by this channel of distribution; $1 billion renold within the electronics industry. See Fig. 3.
WHAT CAN THE MANUFACTURER DO TO IMPROVE RELATIONS WITH HIS REPS?

(1) Select reps wisely. Consider the other lines he carries and his established customer contacts. Beware of the rep who’s too interested in a guaranteed fee. Seek out the aggressive rep whose incentive is not satiated by past successes. Proven success is an asset. Self-satisfaction is a liability.

(2) Support your rep with advertising and sales promotion aids and adequate technical material.

(3) Listen and act when your rep reports feedback from the field.

(4) Answer his communications promptly.

(5) Back him up with a first-line, policy-making contact whom he can call for immediate, decisive answers. Don’t put office boys on the other end of the line.

(6) Tell him all you know about your product. He welcomes training that helps him to sell your product. A painless technique: send a factory man out occasionally to make calls with the rep. The interchange of information improves relations and the time in the car between calls can be used for personalized, informal training.

(7) Define your commission agreement and live up to it.

WHEN DOES AN ELECTRONICS COMPANY SELL THROUGH REPS?

(1) When the manufacturer has an engineered product.

(2) When he is selling to OEM accounts.

(3) When application techniques are required for product use.

(4) When a factory sales force with adequate geographical coverage would be too expensive to maintain for the sales volume anticipated. The manufacturer pays the rep only when he sells the merchandise.

(5) New companies can quickly gain the advantages of a professional field sales force with much greater experience and market coverage than they could otherwise afford.

(6) Some begin to think of switching over to their own sales force when sales reach $5 to $10 million annually. This is not necessarily the switch-over point but merely a zone for review. Many of the nation’s largest firms continue to use reps for certain of their products because they are the most efficient method of selling these lines.

communications between the manufacturer and the representatives are as essential as with factory sales forces.

Henry J. Geist, president of Geist-Hotz, Inc., manufacturers’ representatives of Stamford, Conn., emphasizes the point. “Front-line, policy-making contact at the factory is essential...someone who can give me a commitment on-the-spot when I call in from a customer’s office.” Mr. Geist’s views on what manufacturers can do to improve their relations with reps are shown in the box.

Communications is a two-way street. Market intelligence and merchandising suggestions should flow back from the field on a continuous basis. Programs which originate from field suggestions should be identified as such. After such a program has been in effect, communications from the field will improve and the timeliness and effectiveness of the sales programs will improve.

FUTURE OF REPS—The manufacturers’ representative will always be in demand in the electronics industry to represent those concerns that cannot provide economically the coverage required to serve their markets with their own salesmen.

With the coming of data transmission by telephone much of the sales clerical work will be eliminated, freeing more time for creative selling.

At times the manufacturer may feel that he is paying too much in commissions to the representative. However, this is a relative fact that can be related only to the manufacturer’s volume, the potential for his product and the geographical dispersion of his potential customers. The manufacturers’ representatives on the other hand feel that sometimes the manufacturer takes advantage of a rep’s long continuity as the firm’s representative through commission reductions and too often fails to provide marketing plans and promotional support—basic selling tools for a rep organization.

Manufacturers’ policies with representatives vary considerably with regard to large orders. In some cases new accounts that are developed become house accounts when they reach a certain volume. Other manufacturers feel that the manufacturers’ representative is entitled to compensation on all of his sales in his area.

Question of when to sell through electronics manufacturers’ representatives has resulted in manufacturers repeatedly raising the question: “Is it better to sell through reps or my own sales force?” There is no answer to this question. But, Robert Asen, president of RMC Associates, New York, manufacturers’ representative, supplies the guidelines given in the box.

Our industry’s reps play a particularly important role in the sale of components as shown in the chart showing distribution channels for selling $3 billion worth of components.

January 6, 1961
The Distributor Link

Widespread use of electronic equipment throughout U. S. industry is creating fundamental changes in the distributor’s role

INTRODUCTION—The distribution of electronic products is becoming more complicated as electronic equipment replaces functions previously performed by electrical and other devices and is being increasingly used in almost all of the nation’s industries.

For example, many electrical control devices are now electronic in design although they perform the same function. In consumer goods many electronic entertainment and specialty items are being used that require specialized distribution techniques.

Electronic equipment and parts are channeled for the most part through the electronic parts distributor and the appliance-television and radio distributor; electronic instruments and components flow through the industrial distributor. The electrical distributor is finding the need to enter the electronics industry as many of his electrical products are replaced by electronic devices.

The growing application of electronic components in other manufactured items has created a logistics problem in serving the original equipment user due to: wide geographical dispersion of plants and an increase from less than 100 manufacturers, pre-World War II, to almost 10,000 today.

Manufacturers of electronic components must depend on the industrial distributor for coverage of many of these customers. This has been reflected by a dramatic change in policies during the last two years which, for the first time, permits competition in this market by the industrial distributor. He is now permitted to sell small OEM orders at the same price at which they would be sold by factory sales personnel.

SELECTION OF DISTRIBUTORS—With the increased importance of the distributor in the electronics industry the problem of selection is more critical. First, a distributor should be evaluated by his organization strength. He must have adequate capitalization and an organization structure that provides for operating efficiency in warehousing and order servicing. He should also provide sales management and sales personnel to cover his area.

It is important also for the manufacturer to have a close liaison between his industrial electronic distribution system and his own smaller OEM sales force so that the two supplement each other rather than vie for the same business.

MANUFACTURER-DISTRIBUTOR AGREEMENTS—Agreements with distributors should clearly define the promotion and product brand emphasis that the manufacturer might reasonably expect. The manufacturer must settle either for exposure with many other product lines or establish more limited distribution with fewer competitive lines, or none at all, being handled by the distributor.

The manufacturer must also be assured when he does agree with a distributor on a franchise relationship that his policies are in writing, and that the distributor understands clearly the responsibilities he must assume as well as those to be assumed by the manufacturer. He must also be assured that orders that are referred to the distributor will be filled with his product rather than a competitor’s.

As the distributor moves into new areas such as citizen’s band radio, hand-carried transceivers, instruments and other end-use items that require service, his responsibility increases. He and the manufacturer must jointly develop service facilities using either dealer service or industrial service organizations. Coupled with this must be backup support by the manufacturer in the form of field engineering and regional facilities for more complicated service problems.

It is the manufacturer’s responsibility to make available technical data and service bulletins as well as

AGGREGATE CHANNEL OF DISTRIBUTION VOLUME IN 1960 EXCEEDS TOTAL INDUSTRY FACTORY SALES BY $3 BILLION

* $3 BILLION ACCOUNTED FOR AS FOLLOWS:

A. $2 BILLION OF COMPONENTS WHICH ARE SOLD TO O.E.M’S FOR USE IN ORIGINAL EQUIPMENT AND WHICH ARE SUBSEQUENTLY INCLUDED IN ORIGINAL EQUIPMENT FACTORY SALES.

B. $1 BILLION OF COMPONENTS AND EQUIPMENT SOLD TO DISTRIBUTORS BY COMPANY SALES AND REPRESENTATIVES FOR RESALE. THIS AMOUNT IS SUBSEQUENTLY INCLUDED AS DISTRIBUTOR SALES.

Source: Lewis and Golpher, Raytheon electronics

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specific training programs for those dealers interested in broadening the scope of their activities. As an example of this, Raytheon is offering a correspondence course that prepares television service dealers for the FCC Class 2 examination. If enough dealers take advantage of this, competent personnel will be available in all parts of the country for servicing the new electronic devices currently being introduced or to be introduced in the future.

MANUFACTURER—DISTRIBUTOR RELATIONS—
With the increasing complexity of the electronics industry the importance of sound manufacturer’s policies for distributors becomes of great significance. Policies should be clearly defined in terms of, and applied to, the particular distributor’s market. Further, they should be fluid enough to react to changes in the marketplace. Policies can become obsolete just as products can.

The manufacturer should follow-up with product, technical and merchandising support. Merchandising support can take many forms, but above all it must be flexible enough to adapt to future needs. Many distributors have stated that the ideal prorating of advertising and sales promotion money should be 20 percent for national use and 80 percent for area use.

CUSTOMER SERVICE SUPPORT—Regardless of the distribution channel selected, the merchandise must leave the factory and be received by the customer on time. This basic consideration introduces the order service procedure. Increasingly called customer service, the procedure starts when the salesman has written the order and ceases when the customer receives his shipment. Since the hard part of the battle would appear to be over once the order is obtained, it is paradoxical that customer service presents so many problems and often results in customer ill will.

If satisfied customers are among a company’s greatest assets—and marketing men almost certainly would agree to this—then efficient order service is just as important a part of the distribution process as its other, and perhaps more glamorous, activities.

The first step in providing prompt, reliable customer service is to be sure that order service people understand the importance of their work. This education can take many forms including training sessions conducted by immediate supervisors, face-to-face meetings with salesmen for discussion of mutual problems, effective supervision, analysis of poorly handled orders, prize contests for the best customer service act of the month, promotion for outstanding work, termination of incompetent personnel, posting letters from customers and publicity in company publications.

Good customer service is difficult if the paperwork system is antiquated and unwieldy. It may pay to have a competent systems-and-procedures study made of your entire order service operation. The answer to many of these problems lies in automated customer service, which is certain to increase.

A growing trend in customer service is the practice of advising the customer on a regular basis (often weekly) of the status of his order and when it will be shipped.

Prompt, accurate replies to customer inquiries concerning orders and related matters are basic to good customer service—and it’s surprising how far short of acceptable standards some electronics companies fall. Salesmen and customer service people in the field need prompt replies from the factory.

The most detailed plans and organization charts accomplish little if follow-through is poor. Good follow-through can best be guaranteed by continuing interest in customer service problems and progress by the company’s top management. As the battle for business gets tougher, the company which furnishes efficient and re-

Using modern data handling equipment to help free the distributor sales force from much of the paper work that takes time away from actual selling.

Jim Dorman, marketing manager of the industrial components division, keeps track of marketing information needed for successful sales backup, including: sales, inventory, orders on hand, shipment and manufacturing schedules and other sales data by product family, customer, geographical territory and by time.
KNOW YOUR MARKETING COSTS

To aid in evaluating your company's marketing costs and assist in providing better controls and forecasts, here are expenses that most experts agree are properly charged to the marketing effort:
(1) Market Research
Salaries of all personnel and outside consultants.
(2) Product Planning
Salary and expenses of product planning personnel involved in new product evaluation, expansion planning or acquisitions but not including direct line management of product lines.
(3) Marketing Administration
Salary and expenses of marketing manager, support functions.
(4) General Sales Expense
Salary and expenses of sales manager, his staff and related functions. Include provision for bad debts.
(5) Engineering Proposal Expenses
Include cost of preparing proposals.
(6) Regional Sales Office Expenses
Administration, rent, telephone, travel.
(7) Field Sales Expense
Salesmen's salaries and expenses.
(8) Commissions Paid to Manufacturers' Representatives
(9) Customer Applications Engineering
(10) Advertising and Sales Promotion
Including shows, exhibits, sales presentations, literature, product publicity and salaries.
(11) Customer Service
(12) Sales Training

Liable customer service will have the jump on its competitors.

REDUCING DISTRIBUTION COSTS—For a variety of good reasons, management often asks, are distribution costs too high? If so, how can we reduce them?
There are two roads over which to attack distribution costs:
(1) Cut costs by stripping away fat in the sales organization—eliminating unnecessary travel and entertainment, getting rid of marginal sales and management personnel, cutting back excessive advertising and promotion, keeping telephone and telegraph costs under control and reducing field office expenses. Extreme care must be taken not to jeopardize future growth for immediate savings.
(2) Cut costs by positive action—obtain greater sales volume with the same sales force and sales cost. This involves securing more business from present customers, opening desirable new accounts, doing a better job in secondary markets without increasing sales manpower and improving sales promotion. Sales training programs and multilevel selling are essential parts of the approach.
Allocation of marketing effort depends on accurate estimates of geographic area and customer potentials, and ranking them in A-B-C-D order of priority. This order then determines the sales firepower directed against the targets in terms of number of salesmen and their frequency of calls on customers and prospects.
Research can disclose which sales are profitable and which unprofitable, why, and what methods might shift problem accounts into black ink. For some companies and products, the answer lies in greater use of distributors and manufacturers' representatives; for others, greater dependence upon and more efficient direction of their own sales forces.
Unfortunately, there is seldom a simple answer to distribution cost problems. The answer usually lies in a combination of direct cost-cutting action and a positive program to sell more without increasing sales expense.

SUMMARY—Our growing industry, which now stands at about $10 billion annually in factory sales, has achieved in half the time the same volume as that enjoyed by the automobile manufacturers, who in 1959 sold cars worth $10.5 billion.
Unlike the automotive industry whose growth depends largely upon population increases, the electronics industry is growing by the increasing use of electronics in diverse fields and the continually increasing number of new devices being invented each year. Last year the electronics industry led all others with 7.7 percent of the sales dollar plowed back into new-product development.
Success in the years ahead will depend more upon marketing skill: determining what products our customers need, creative engineering to design products that satisfy needs, producing these products at reasonable cost, selling customers on these products and their benefits, and making them available quickly and efficiently.
Successful companies will be companies with marketing sophistication and flexible sales organizations that can be adapted to changing markets and product lines. These companies will select the distribution channels that best fit their particular requirements without being limited by preconceived ideas. The factory sales force, the manufacturers' representative, and the distributor all will play important complementary roles in linking the manufacturer with the end user and through their teamwork and marketing skill will make distribution the lever to higher profits.
The bar chart summarizes quantitatively the channels of distribution in the electronics industry, dollar amount of sales flowing from company salesmen, manufacturers representatives and distributors. Because $3 billion dollars worth of components are sold to OEM's for use in original equipment and are counted twice (once in the value of the equipment including the built-in components and again as part of total component sales) the total value of all products flowing through all channels amounts to $13 billion, $3 billion dollars in excess of total industry factory of sales of about $10 billion for 1960.
This last point is shown graphically in the chart which shows aggregate distribution—channel volume exceeding total factory sales by $3 billion.
INTRODUCTION

"Sound market planning serves as the adhesive that binds together all company activities into a competitively strong and enduringly profitable venture," says di Scipio.

MARKET PLANNING is not a subject that can be profitably discussed out of context with the basic philosophy of a business enterprise. For market planning—if it is to be truly valuable—must serve as the adhesive that binds together all activities of a company into a competitively strong and enduringly profitable venture.

This article therefore concerns itself primarily with a look at market planning and the total marketing function from the overall management point of view. Techniques of conducting market planning studies are left to the province of professional marketing researchers.

As we shall see later, this broad perspective is particularly important today, when the dynamic electronics industry is completing its adolescence, and entering an inevitable stage of maturity with the possibility of a shake out in the offing.

The future success of any electronics company—irrespective of size—may well depend on the ability of its management to keep continually and closely attuned to rapidly changing market conditions.

Later in this article, we will show market planning in action from the experience of our company in setting up a new distributor division. The purpose of this case history is to demonstrate practical applicability—in a specific business situation—of the principles set forth.

THE FIRST STEP—The first step toward taking full advantage of the potential benefits of a market planning activity is the establishment of a corporate environment that puts the marketing function into proper balance with such other vital functions as engineering, manufacturing and finance. This is especially important in the electronics industry, where so much of the progress to date has been attributable directly to scientific creativity and technological development.

The establishment of such an environment was one of the first areas to which Harold S. Geneen addressed him-
self after becoming ITT's president and chief executive officer during June 1959. Recognition of this need (and action upon it) was sufficiently important, in Mr. Geneen's opinion, to be called to the attention of the stockholders. Thus, in the president's letter of ITT's 1959 annual report, he wrote: "Your company has established as a basic corporate goal the strengthening of our market planning and marketing activities throughout the worldwide ITT system. The company's future success will be determined largely by our ability to harness ITT's research, engineering, manufacturing and management resources into an effective competitive effort in the world's marketplaces. Considerable attention is being devoted to developing and implementing these marketing policies and programs."

Such a statement from the chief executive permits marketing and market planning to assume more readily a desirable degree of influence throughout a company's operations. It also points out clearly that such recognition can only add to the value of competent research, engineering and manufacturing, and not detract from it.

COPING WITH THE PAST—ITT had its genesis in the scientific miracles of telephony and telegraphy. Throughout its history, the company's successful growth—in most countries of the world—into virtually all phases of communications and electronics has been mainly attributable to its technological strengths.

Is it not interesting, therefore, to contemplate the circumstances that would lead the chief executive of such an organization to make the statement quoted above? This analysis of industrial development has been described before. It is repeated and reemphasized here because of its timeliness with respect to the electronics industry.

THE EARLY STAGES—Historically, business in the U. S. has generally been product oriented. From the days of the Industrial Revolution until the end of World War II, production was nearly always the dominant function of manufacturing organizations. Product development was often based on executive intuition, with the primary aim to utilize production capacity and talents. It remained for the sales force to get out and sell whatever was produced.

With the close of World War II newly-acquired mass production techniques prompted a flow of goods and services that increased to the point where availability not only met the demand, but could readily exceed it.

Additionally, since the mid-40's, thousands of new companies were spawned out of the marriage of science and industry. The origin of many of these newcomers could be traced to the research and discoveries of a small group, or even a single scientist, which led to the establishment of a new business entity. Companies like Applied Science Corporation of Princeton, Ampex, Litton Industries and others came into being, because of their ability to supply technically advanced items or services essential to defense or industrial development.

Competition between foreign and domestic suppliers during this same period rapidly increased and the customer soon learned he could be selective in satisfying his needs. At about the same time business management began to realize the customer more and more demanded that his needs be satisfied in the way he wanted them satisfied, and when he wanted them satisfied.

Therefore, the early part of the 50's saw a major shift or revision in top management thinking, with the realization and acceptance of this basic economic philosophy: produce for market rather than create a market solely for the fruits of productive effort. Also: production is important only in relationship to what can be produced and sold at a profit.

This was particularly true for the burgeoning electronics industry which during that decade emerged as a mighty industrial giant, geared to programs of expansion but faced with a number of complex problems, problems which only competent application and implementation of these new market planning techniques could solve.

Ten years ago electronics firms with gross sales in excess of $100 million could be counted on the fingers of one hand. Because this field offered such unlimited possibilities many firms entered it, some by acquisition, some through mergers. Many small firms were organized with the primary purpose of specializing in one product or providing a single service. Many large firms not formerly associated with electronics—like General Mills, Harris Intertype, and Bulova Watch Company—entered the field through a desire to diversify their activities.

Coupled with these changes there also came a change in the nature of the electronics market itself. This evolution and shifting of interests was due to rapidly advancing technology, changes in military and commercial buying habits, the constantly increasing application, versatility and utility of electronic products and techniques, as well as the condition of the nation's overall economy.

Therefore, during the early 1950's, the traditional "product oriented" approach was put aside and a new economic and operating philosophy was adopted by those firms engaged in the development and manufacture of...
products and services for the electronics market. If they were to continue their growth patterns and hold on to their present names as well as provide for future survival, they had to face up to these realities. The marketing concept offered what the electronics industry was seeking: a sound business approach that would meet the challenge of a new economic environment.

Studies of life cycle of both electronics and all-industry products, which typically showed three stages of activity, are summarized in the chart (see above) that contrasts the life cycle of electron devices with that of automobile body styles.

The chart points up the fact that in early stages of the cycle production know-how or ability to make is all important.

In the second stage, in which most electronics products now find themselves, marketing abilities are the key to success.

Final stage of obsolescence is one in which price cutting and low-cost production are of paramount importance.

**Electronics Industry**

*Market Planning Still in Infancy*

Acceptance of market planning by electronics industry has been slow but is increasing acceptance of market planning as an important tool of operation has been slow. However, today the pace of acceptance is increasing rapidly.

Initially, the early implementation of the marketing concept in our industry amounted to little more than the field salesmen feeding back information as to activities of competitors. Engineering investigation, in those days, was evaluating competitive products to learn what...
made them tick. Manufacturing analysis was examining costs, methods and procedures to determine where the manufacturing department could reduce costs and market research was a part-time sales function to determine markets for existing products.

**MARKETING CONCEPT**—When electronics firms did turn to the marketing concept in their production and their approach to competition and changing market problems, they discovered a lack of reliable information on which to base their plans because of the dynamic and fluid nature of the industry, and because of its relative youth.

Although some companies have undertaken to study the market individually—and with remarkable thoroughness—and certain of the trade associations have endeavored to supply their members with market reports or surveys, the fact remains today that interest in market research, of and by itself is lukewarm.

All too often the studies seek to determine what the market is and ignore the more complex problems such as establishing criteria for evaluating how effective are current sales, advertising, packaging, promotional and public-relations activities, and building up reliable data for setting salesmen’s quotas and measuring distributor and rep performance.

**The Market Planning Function**

**Corporate size and diversification of products and markets determine company use of market-planning techniques**

**MARKET PLANNING** is the key element in the application of the marketing concept. It creates an integrated plan of action that clearly defines the objectives to be met, the overall plans for their attainment, standards of performance, methods of measuring or determining performance and the organization to carry out these plans.

It is concerned with the evaluation and selection of markets, identifying and defining customer needs and wants, and sometimes creating needs and wants.

It sets forth and develops a strategy of making the presentation to the customer and motivating him to buy. It develops a pricing philosophy consistent with business objectives and based upon evaluating market pricing practice and the effects of business objectives on the marketing plan. Advertising and sales promotion requirements are also established.

**DISTRIBUTION PLANNING**—This special area of market planning defines the required sales organization, appropriate channels or methods of distribution, as well as support functions required in the customer service area to attain market-plan objectives.

Coordination of marketing activities with research and development programs and integration of product planning activities with markets selected, proposed dis-

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**HOW MARKET PLANNING FITS INTO THE ORGANIZATION**

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**NOTE**: FUNCTIONS and jobs outlined in color play an important market planning role. Number of color squares on chart demonstrate the importance of market planning in a marketing oriented organization

**SOURCE**: ITT Corporate Marketing Department
Market Planning in Action—
A Case History

Market planning was a decisive factor in decision to set up new ITT Distributor Products division; also played key role in shaping character of the division and day-to-day operations.

BUSINESS PLAN & STUDY for U.S. Electronic Distributor Market is the name of a market planning study that has already made a name for itself in market planning. Information turned up by the study resulted in the formation of the ITT Distributor Products division.

After preliminary market analysis we came to conclusion that what was needed was one market with lots of absorption capacity and that the electronics parts distributors market for light components had a good future and might fit our organization's need for a method of distributing its products.

Here's the outline of the market-planning program:
1. Analyze total U.S. electronics market for next 3-5 years.
3. Inventory and screen all ITT products on basis of:
   a. market compatibility,
   b. adequate gross margins,
   c. rate of inventory turnover,
   d. manufacturing sources,
   e. technical compatibility of products,
   f. supply availability,
   g. growth potential,
   h. standards of quality and
   i. product identification with ITT line.
4. Select initial product lines.
5. Project sales and share of market capture.
6. Program organization and implementation.
7. Project financial results.

Here's what the study unearthed: that the $9.1 billion of electronics factory sales in 1959 comprised $1.6 billion worth of industrial goods, $4.7 billion in military goods and services, $2 billion in consumer goods and that an additional $800 million was sold through distributors, largely replacement parts.

The U.S. electronics market was then broken into product groups.

Turning to the four major segments of electronics sales, ITT market investigators found that rate of growth of sales by distributors (12 to 15 percent per year) was far greater than that of other sales channels.

THE ELECTRONIC DISTRIBUTOR MARKET
By Product Groups—Year 1959
(In Millions of Dollars at Factory Sales Prices)

<table>
<thead>
<tr>
<th>Product Group</th>
<th>Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennas, Wire,</td>
<td>$102.4</td>
</tr>
<tr>
<td>Tools, Hardware</td>
<td></td>
</tr>
<tr>
<td>Batteries</td>
<td>18.4</td>
</tr>
<tr>
<td>Capacitors</td>
<td>47.2</td>
</tr>
<tr>
<td>Coils, Filters &amp; Transformers</td>
<td>62.4</td>
</tr>
<tr>
<td>Diodes</td>
<td>2.3</td>
</tr>
<tr>
<td>Relays and Solenoids</td>
<td>12.8</td>
</tr>
<tr>
<td>Resistors and Volume Controls</td>
<td>38.4</td>
</tr>
<tr>
<td>Loudspeakers</td>
<td>$18.4</td>
</tr>
<tr>
<td>Transistors</td>
<td>11.3</td>
</tr>
<tr>
<td>Picture Tubes</td>
<td>81.6</td>
</tr>
<tr>
<td>Power Tubes</td>
<td>32.8</td>
</tr>
<tr>
<td>Receiving Tubes</td>
<td>204.0</td>
</tr>
<tr>
<td>Hi Fi, Radio, Tv &amp; Sound Equipment</td>
<td>94.4</td>
</tr>
<tr>
<td>Technical</td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>10.4</td>
</tr>
</tbody>
</table>

Source: International Telephone & Telegraph Corporation

The electronic distributor market was tabulated as a product breakdown by type of product and of annual sales per product.

Next step was to inventory and screen all ITT products according to criteria listed above.

From this screening seven product lines were selected: semiconductor products; capacitor products; consumer products including tape recorders and radios; communications products; sound products; wire and cable; and tube products.

We projected sales for each of the product lines along with projections of the portion of the market which we could capture.

The main elements of the implementation program were:
1. A separate integrated organization was required.
2. Specialized market knowledge had to be developed.
3. System of selling through sales representatives was needed.
4. Field warehousing was required.
5. Heavy concentration on advertising and sales promotion was required at the beginning to get the ball rolling. Advertising and promotion was so important that I (Viles) temporally took on the job of advertising and sales promotion manager in addition to my other duties.

Finally, we projected financial results including: profit before taxes, inventory turnover, receivables turnover and return on assets employed.

We found the expected return of assets employed in the business compared favorable with return on assets employed in other parts of the ITT system.
INTERNATIONAL TRADE—
A VITAL CONCERN

Economic and Political Climate

Trend among free world countries is toward free trade and lessening of trade restrictions. Both large and small electronics firms need to become internationally oriented in their thinking.

There are rapidly developing trends in international trade. We must recognize if we are to compete effectively at home or abroad, say the top international marketing executives of several United States electronics manufacturing companies with extensive interests in overseas trade.

All major product markets are becoming international markets. Generally speaking, no longer can a few large companies completely dominate an important market. There is a rapidly closing gap between the productive and technical skills of the industrialized countries of the world. Add to this the fact that the trend in the free world is to lower tariff barriers and trade restrictions. Thus it behooves every company to start thinking internationally.

Even the small company committed to catering to a regional domestic market can be seriously affected by neglect of international business developments. The small or large manufacturer who does not prepare for these trends will find himself in difficult circumstances.

Foreign Trade Facts—In the international trade world of tomorrow any electronics or other manufacturer can compete if he recognizes certain basic facts.

1. All international trade must be recognized; not only between your country and the country or countries you are selling to, but also trade between third parties. For instance trade developments in Europe or Japan could have an effect on our sales in Latin America.

2. This type of situation could be reversed to the advantage of the domestic company. For instance, suppose for a certain type of equipment we were a high-cost producer. But, if facilities were set up in a country like India, one of the last free-world reservoirs of low-cost labor, for production of inexpensive components and sub-assemblies, the price disadvantage could be wiped out.

3. International trade requires special knowledge and skills. In Europe and some other areas the people are so close to international trade that they absorb knowledge and skills as part of the process of growing up in business.

In the United States we face the problem of having to train our people in the field of international trading.

U.S. companies have to give their executives more exposure to international problems and situations. Not only is this needed for our executives but for our key government workers and labor leaders also.

4. Business should recognize that there are many roads to effective international trading and that simple exporting is not the only way.

In some cases, like the European Common Market or the Outer Seven countries, where tariff preferences for members may limit competition from other countries the answer may be licensing, joint ventures or a subsidiary with local management. A subsidiary with local management may be the answer.

5. Different countries require different types of marketing. For instance countries like Great Britain with well-developed communications are interested in means of adjusting the systems they have to meet modern needs. On the other hand countries like Brazil that are opening up jungle tracts for the first time may wish to leap-frog from no communications to the latest and most complete systems almost over night.

Export Overseas trade can be profitable for U.S. manufacturers

By STANLEY C. ALLYN

The outlook for exports of U.S. electronic products has been clouded by a bewildering conflict of opinions—ranging from extreme pessimism to unqualified optimism.
OF EVERY ELECTRONICS MANUFACTURER

In my opinion, the outlook for most manufacturers lies somewhere between these extremes in points of view.

NEGATIVE ASPECTS of the export picture, such as preferential tariffs and lower labor rates abroad, have recently been the subject of much concern and discussion within the industry. However, without underestimating the seriousness of these problems, it is important to remember that obstacles of various kinds are an integral part of any business venture.

We should not let the problems we face blind us to the fact that successful overseas trade can be highly profitable and often more so than comparable business obtained in the United States.

ELECTRONIC BUSINESS MACHINES—This portion of our industry is entering an era of increasing competition abroad with an outstanding advantage of greater technical maturity.

Large-scale solid-state electronic data processing systems were being produced by several U. S. manufacturers many months before a mere trickle of comparable systems began to appear elsewhere in the world. With a few exceptions this has been the case on down the electronics product line—not only other electronic business machines such as posting and sorting equipment but a wide variety of military electronics and many other electronics industry products.

OUR HOME MARKETS—They are the largest, wealthiest and most diverse in the world. The greater volume made possible by this huge domestic market is capable of sustaining massive expenditures for research and development. This is perhaps the chief reason for our technological lead.

TECHNOLOGICAL DIVIDENDS—We shall continue to enjoy countless technological dividends as a byproduct of the nation's gigantic defense effort, a substantial part of which is devoted to electronics.

OTHER STIMULI—The fact that the American consumer demands the most sophisticated products which can be brought to the market helps us. Our efforts to meet this demand will continue to produce numerous by-products with overseas applications.

Although not uniquely U. S., other assets also tend to strengthen our position. These include our nation's skills in marketing, our willingness to undertake risks in seeking business around the world, our storehouse of know-how and the reputation for high quality of the U. S.-made product.

FOREIGN MARKET GROWTH—Finally, although competition abroad is growing, so is the overall foreign market. Recent Commerce Department studies showed that the two best customers for exported U. S. business machines, for example, are the United Kingdom and West Germany, even though these countries are the leading producers of business machines in the Outer Seven and Common Market blocs. Shipments to these countries have risen steadily, with electronic computer exports up 45 percent over last year.

FLEXIBLE APPROACH NEEDED—How can we best ensure continued popularity of the Made in USA label? I believe that first of all we must approach today's and tomorrow's problems positively. At the same time, we must bring to these problems maximum flexibility.

The overseas market, like the domestic market, demands and will obtain from one source or another the product it wants. Our job is to continue to offer a superior product from a price-performance standpoint. In some cases we shall find it necessary to concentrate in areas like edp and office automation where overseas manufacturers have left opportunities for us, or to depend on those products in which our technological lead is most significant.

MANY ROADS TO SUCCESS—Achievement of these objectives will vary greatly among companies, depending upon their products, resources and skills. For some:

1. Expansion of overseas sales, service, and manufacturing facilities will be called for.
2. Others will take the roads of licensing agreements, joint investment in foreign facilities, cross-production or cross-marketing arrangements.
3. Many will use combinations of these plans.
Imports

Imports from low-wage countries is one important problem the electronics industry faces today

By ROBERT C. SPRAGUE

TODAY and for the foreseeable future, imports from low-wage foreign producers confront the U.S. electronics industry with one of the most critical problems in its history. Heart of that problem is Japan.

JAPANESE EXPORTS—Between 1958 and 1959, the Japanese achieved a 244 percent increase in dollar value of shipments to this country of radio and television apparatus and parts. U.S. imports of these products in 1959, amounted to more than $74 million—nearly $44.5 million over 1958—and the Japanese had almost 75 percent of business. In 1959 the Japanese captured 50 percent of the American market for transistor portable radios, in one month Japan’s portion of the market rose to 70 percent.

EXPORT GROWTH—Speed of Japanese electronics penetration of the U.S. has few parallels in the annals of world trade. As recently as 1955, shipments to U.S. of radio and tv apparatus and parts were valued at a little more than $230,000. In 1959, shipments were over $55 million. Shipment of radio and tv apparatus and parts are cited because these are one of the few product categories, where comparable annual figures are available from U.S. government sources. However, radio and tv equipment represents a major portion of total U.S. electronic imports.

QUOTA SYSTEM—Imports of Japanese electronics are expected to show a slight decline from 1959 levels this year because of temporary suspension of transistor radio shipments to the U.S. last May, preliminary to establishment of a quota by the Japanese Ministry of Inter-
national Trade and Industry (MITI). But this should be regarded realistically—as no more than a brief ebbing of the flood.

Japanese transistor radio imports are expected to account for 52 percent of the $79.7 million worth of merchandise in the radio-tv categories estimated to be shipped to the U.S. during 1960. They may level off because of MITI’s restriction. But, it is our (EIA’s) conviction that the recent flood from Japan represents only the first wave of a general assault on the entire U.S. electronics market. Eventually it will be felt by every sector in the industry.

JAPANESE PRODUCTION—Japanese output rose 46 percent over 1959 in the first half of this year according to an ultra-conservative projection for 1960. Current Japanese electronics production has risen more than 350 percent since 1956, industry sources estimate. The electronics division of the Business and Defense Services Administration recently reported that the Japanese MITI is now projecting by 1964 an 82 percent increase over 1959 in electronics production. As recently as last May, MITI tentatively estimated the five-year increase at only 32 percent. Up to now, much of the Japanese expansion has been in the consumer products field. But substantial gains also have been registered by the industrial-commercial and components segments of the industry.

The Japanese industry is in the strongest conceivable position for assault on American markets. Its production facilities are as modern as any in the world. U.S. producers have little or no technological advantage. But this circumstance would be no cause for concern were it not for the fact that Japanese wage rates are about one-fifth of those in the American electronics industry. No amount of technological improvement could possibly equalize a wage differential of this magnitude.

HOME MARKETS—Home market problems are expected to spur the Japanese to attempting new assaults on the American market. The Japanese market for home radios is near the saturation point. Also, the Japanese are having difficulty in pricing tv receivers within the reach of their wage earners.

Export of tv sets to this country already is under way, offering the Japanese their most immediate hope of escape from domestic marketing problems. Portable and color television sets are expected to be merchandised in the U.S. in the most aggressive manner. Moreover, the Japanese are preparing for a buildup of U.S. business in electronic components and in test and measuring equipment.

EFFECTS HERE—A considerable number of member-companies of the Electronic Industries Association, most of them small, have lost business to Japanese producers. Employment in portions of the industry also has suffered. Foreign imports had been the primary cause of a 20 percent decline in employment among 14 Chicago electronics manufacturing companies, according to a Chicago labor union’s statement.

EIA, to date, has not sought government relief directly on behalf of its members. Instead, the association has chosen to focus attention upon the implications for the nation’s defense potential of a surge in Japanese transistor imports to about 25 percent of the U.S. market.
in about four years. Last year EIA petitioned the Office of Civil and Defense Mobilization to make an investigation, to determine if Japanese transistor imports represent a threat to U.S. security.

MILITARY PROBLEMS—EIA pointed out that military requirements for transistors, representing a substantial portion of total U.S. output, will expand ten-fold in the next five years. Therefore we reasoned that all domestic transistor capacity, whether of military or consumer types, has to be regarded as a basic defense capability, unless reliance is to be placed upon overseas suppliers. And that transistor imports of the magnitude of those from Japan could slow the buildup of capacity essential to defense. Transistor imports also could reduce industry outlays for research and development.

PROPOSED SOLUTION—We do not urge drastic remedies. We would not suggest following the example of Japan where certain electronic products are subject to import licensing.

But we do believe the time has come for federal authorities seriously to consider reasonable import control, such as establishing reasonable quotas on imports from countries where labor rates are low and transportation costs are not a limiting factor.

Financing Export Sales

Selling abroad is complicated by the fact that after the buyer is sold the sale may be only half made. The big problem may be financing the sale.

Second half of the sales chore, whether the buyer be a private individual or a government, is often that of finding ways and means of financing the sale, with many foreign buyers chronically short of cash, particularly hard currencies.

The eight institutions listed below are of special interest to the businessman seeking financial assistance in an overseas venture. Three are United States government agencies. The others are of a public international character. A brief description of each of these financial assistance agencies follows:

EXPORT-IMPORT BANK—makes dollar loans to foreign governments and private firms, both American and foreign, for the purchase of U.S. goods and services in connection with foreign development projects. It also provides exporter credits. In addition, it possesses foreign currency resources out of which loans can be made to U.S. firms including their subsidiaries and subsidiaries abroad, and to either U.S. or local private companies abroad for expanding markets for U.S. agricultural goods. In connection with project loans—that is, those relating to a foreign development project, or export credit, the Bank may give full or partial guarantees of loans made by private lenders. Foreign currency loans may not be so guaranteed.

DEVELOPMENT LOAN FUND—offers loans to foreign governments and loans or investments to private enterprise—U.S. or foreign—for projects or programs contributing to economic development. It will also give full or partial repayment guarantees of loans by private lenders for such purposes. The Fund has both dollar and foreign currency resources. On occasions, dollar loans may be repaid in a foreign currency.

INTERNATIONAL COOPERATION ADMINISTRATION—provides loans and grants to countries cooperating in the U.S. economic assistance program. It also has foreign currency resources that may be loaned to gov-

World Electronics Production

THE UNITED STATES accounted for almost two-thirds of the free world electronics production total last year with factory sales of about $9.3 billion. Total free world production amounted to $14.5 billion.

Two other leading countries were Japan and West Germany both of which accounted for more than six percent of total production with sales in the neighborhood of $900 million.

However, England and France were not far behind with factory sales of $600 and $700 million respectively.

International electronics experts expect that total free-world sales will grow at about the same rate as U.S. sales in the next decade with world sales rising to about $30 million and preserving about the same U.S. ratio to the total.
ernments of those countries receiving U.S. surplus agricultural commodities for development projects. The ICA investment guarantees program offers to U.S. firms investing assets abroad or entering into foreign licensing arrangements, guarantees against inability to convert foreign currency earnings or capital into dollars and losses arising from confiscation or war. The cost is 1/2 percent a year of ICA liability for each risk covered.

INTERNATIONAL MONETARY FUND—does not do business directly with private groups. Its primary function is to encourage international financial stability by providing resources with which member countries may meet short-term balance-of-payment problems. Such assistance takes the form of a member's purchase from the Fund of currencies of other members for an equivalent amount of the member's own currency. Such a purchase of currency must be repaid by repurchases.

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT—another international agency, makes loans to member governments, and to other public or private entities if a member government undertakes a guarantee. Loans must be for the development of productive facilities and resources in member countries. The Bank will also give full or partial guarantees of loans by private lenders for these purposes, providing that the loans are guaranteed by a member government.

INTERNATIONAL FINANCE CORPORATION—is of special interest. It is authorized to invest only in productive private enterprises abroad, but may not subscribe to their capital stock other than in the form of convertible debentures. No government guarantee or approval is required. The IFC is not supposed to become involved where private capital is available on reasonable terms.

INTERNATIONAL DEVELOPMENT ASSOCIATION—was constituted to provide finance for economic development in member countries on terms not possible under the International Bank or the IFC. Not yet operating, the Association is designed to make loans to member governments, or political subdivisions thereof, or to public or private enterprises in territories of members. It will also offer full or partial guarantees of securities in which IDA has invested, and, in special cases, of loans from other sources.

INTER-AMERICAN DEVELOPMENT BANK—is authorized to make, or participate in, direct loans to member government and private entities in those countries. It may guarantee in whole or in part loans by private investors. The general criteria for loans are their contribution to the economic development of member countries and the inability of the applicant to find other sources of financing.

In respect to the three U.S. institutions, there is a general policy that the dollar funds provided be used to purchase goods and services from the United States. In the case of the international agencies, as well as U.S., some evidence is generally required that other sources of financing are not possible and that the proposed enterprise relates to the economic development of the host country.

Gene K. Beare, President
General Telephone & Electronics International

Investments Abroad

U. S. firms may invest $32 billion this year. Joint ventures are popular

By Gene K. Beare

Direct investments abroad by U.S. companies will increase $2 billion this year, reaching a total of $32 billion, according to the best estimates I have seen.

More than half of this increase will represent capital spending for new overseas plant and equipment by U.S. manufacturing companies. Some 44 percent of this new investment will be in Western Europe, where investments by U.S. companies are increasing at a faster rate than in any other part of the world.

Because of this investment trend, both U.S. and European businessmen are thinking more and more in terms of pooling their skills and facilities and creating joint-venture organizations to participate in Europe's rapid economic growth and expanding operations. Moreover, in contrast to the economic pattern existing before World War II, the world is becoming one enormous market place—with unprecedented opportunities to expand existing markets and to create entirely new trade areas.

Businessmen by Joint Ventures—In the score of countries I visited in recent months, I was impressed by the enthusiastic response of businessmen to joint ventures. This is particularly true in Western Europe where joint ventures are playing an increasingly important role in the rapid expansion of industry.

The joint-venture concept had its origins in the Middle Ages, but fell into disuse in modern times—until the end of World War II. This type of venture is exciting unusual interest at present in Western Europe because it provides an excellent vehicle for the pooling of resources of two companies.

Advantages of Joint Ventures—They are many and include:
(1) Gains realized through merging the experience and talents of personnel. The domestic firm (U.S.) may have production knowhow and advanced technical knowledge, while the foreign firm has supplemental technical resources plus established marketing and distributing organizations.

(2) A two-way exchange of scientific, engineering and production knowledge and techniques.

(3) Aid that the domestic (U.S.) company's knowledge of current and long-term economic conditions can bring. The intimate knowledge of the foreign company of local political and economic considerations also can be tapped.

(4) The European Economic Community, the European Free Trade Area and similar movements in Latin America provide another major impetus for joint-venture operations. International trade among the members of these groups is increasing each day because of the lowering of tariffs and regulatory trade barriers between member nations.

Tremendous changes are occurring as a result of the formation of the new trade groups. Manufacturers within them are thinking along wider patterns—how to meet new competition within their home markets and how to take advantage of the markets newly opened.

The joint venture is a means of meeting this competition in world markets, enabling U.S. firms to compete on equal terms with foreign competitors who are members of the trading groups through establishment of jointly-owned operations located within the EEC, EFTA or other trades areas.

JOINT VENTURES, NOT ALWAYS A BED OF ROSES—These benefits and advantages are not automatic. Some alliances turn out to be one-way streets with research never conducted to its full potential. Sometimes the foreign company concentrates on merely expanding the existing markets of the domestic company; and the domestic company merely imitates the methods of the foreign company.

Joint Ventures—A Lawyer's View

Ventures must be tailored to fit legal and tax problems a company faces

By LAWRENCE J. ECKSTROM Partner Baker, McKenzie & Hightower

DEFINITION—The term 'joint venture,' in overseas operations, generally means commercial arrangements for the pooling of resources between United States nationals and foreign nationals.

Basically, it is an equity partnership, with shared ownership interests, under which American and foreign investors invest capital, knowhow, patents, trademarks, and managerial and technical skills.

Joint ventures are used in many industries. But, today the dominant interest is in electronic-industry joint ventures because of profitable opportunities.

In setting up electronics-based joint ventures, the following points should be considered:

(1) So-called basic patents are rare because most of the 'art' is old.

(2) A substantial number of patents can be circumvented by technicians abroad.

(3) Knowhow and technical data, which rarely can be retrieved from an overseas licensee, is of comparatively great importance.

(4) While the art may be old, the incidence of new applications is rapid and growing at an increasing tempo.

(5) The United States by no means has a monopoly on knowhow and inventions.

ROLE OF THE LOCAL GOVERNMENT—The role of the local government varies considerably by countries and is comparatively more important in joint ventures than in other methods of foreign commercial operations. This role includes:

(1) Government incentives and concessions such as tax relief.

(2) Import advantages like reductions on duties or quotas.

(3) Assistance in obtaining local financing.

(4) Arrangements whereby governments may furnish land or buildings and lease-back opportunities to the prospective investor, or may purchase buildings from the joint venturer and lease them back.

(5) Guarantees against currency controls or expropriation.

(6) Other special assistance for 'productive enterprises,' such as training programs, housing or medical services.

LEGAL RESTRICTIONS ON JOINT VENTURES—The following are some of the major considerations which suggest the advisability of competent legal counsel.

(1) Restrictions by law on foreign investments. In general, special foreign investment laws and regulations may be considered the rule rather than the exception in the so-called capital importing countries.

(2) General regulations of commercial activity, such as those contained in Commercial Codes.

(3) Limitations on the nationality of shareholders, management, and executive and technical personnel.

(4) Limitations on the travel and residence of foreign personnel.

(5) National or regional (for example, Common Market and 'Outer Seven') restrictive business practice laws (antitrust).

Also, it is necessary to become familiar with the basic system of law in each foreign country under consideration. Most U.S. companies are relatively familiar with 'common law' and 'civil law' systems, but Oriental and Mohammedan law systems present to employees problems of land holding, property holding and responsibility unfamiliar to American investors.

MANAGEMENT, LABOR AND OTHER LOCAL PROBLEMS—Most problems of this type are comparable to similar business problems in the U.S. However, in a 50-50 situation in which the foreign investor does not retain voting control the following are of special importance:

(1) Competition with existing domestic enterprises.

(2) Labor laws governing the hiring and discharging
of employees, (often far more severe than in the U.S.).

(3) Local laws and customs on division of profits particularly important in considering dividend and reinvestment policies.

(4) Knowhow and technical data made available to the local party. As the foreign joint venturer usually obtains more knowhow and technical data than the domestic licensee, short and long-term objectives as well as possible future conflicts of interests should be considered.

**COMPANY FORMS AVAILABLE TO JOINT VENTURES OVERSEAS**—Among the more common forms of doing business in the Civil Law countries are the limited company without transferable stock certificates, (GmbH) and the various forms of partnership and limited partnership (for example, the Societe en Commandite) which may or may not have independent legal personality, depending on the local law.

Form used is especially important in computing United States taxes. Foreign tax credit is applicable only to income from a foreign corporation and dividends paid by a foreign 'limited partnership,' for example, might not qualify for the tax credit.

**TAX FACTORS FOR OVERSEAS JOINT VENTURES**—Study of the expected overall tax load of a joint venture operation should be made in all cases. The United States investor would be indeed wise to consider the following factors:

(1) The normal tax rates applicable in the foreign country, plans for repatriation of funds, the United States tax rate, the foreign tax credit against it and special tax incentives.

(2) He should also look at special taxes such as transfer or turnover taxes and various excises, which can be of considerable importance.

(3) Other features, such as depreciation rates, taxes on accumulated earnings, deductions for dividends paid, and availability of loss carryovers and double taxation treaties. For instance, the United States has double taxation treaties with twenty-six countries. Other countries have entered into double taxation treaties among themselves.

**ANTITRUST FOREIGN OPERATIONS**—An international joint venture operation may come up against laws on restrictive business practices in more than one country, often with different standards. The following general points should be borne in mind:

(1) International joint ventures are not as such violations of the United States antitrust laws. The test is usually based on the determining motives back of the joint venture.

(2) Although in some countries cartels are not only approved but even encouraged by local governments, the fact that an act is legal in a foreign country may prove to be a poor defense for a United States national charged with violating United States law.

(3) Under the antitrust laws of certain countries (for example, United Kingdom), the registering of certain contracts may be required. Also several countries have laws whereby a patent is deemed abandoned if not actually put to use within a relatively short time after its issue.

**Licensing**

Licensing agreements with foreign manufacturers strengthen market positions abroad and confer other advantages

By PIERRE F. SIMON

In the electronics industry, the practice by U. S. companies to give European and other foreign manufacturers the right or license to manufacture their products abroad came into prominence at the end of World War II.

Today, almost 15 years after the termination of World War II, interest in licensing agreements among electronics firms on both sides of the Atlantic is at near fever pitch.

Because of establishment of the European Economic Community (Common Market) and the ratification of the European Free Trade Association (EFTA or Outer Seven), products manufactured in these countries under license have a decided economic advantage in selling to countries within the Common Market or Outer Seven group because of tariff preferences. These preferences can be substantial forces of change.

**ADVANTAGES TO THE LICENSOR**—Primary advantage to the licensor who enters into a licensing agreement is that he staves off competition in foreign markets by his domestic competitors.

For example, the European market is so much less extensive than the U. S. market that once a quality product appears on the market and is available in sufficient quantity, the bulk of the demands of the market are quickly satisfied. A second licensee, following in the pioneer's wake, may well find himself superfluous.

Conversely, if a U. S. firm has a product that meets the needs of the European market and does not enter into an agreement with a European company, chances are one of his competitors will do so.

Furthermore, in overlooking the possibilities opened by licensing, and continuing to sell abroad in relatively small quantities, the U. S. originator is often circulating his product among potential competitors. After a few
months or a year of this inadvertent sampling, a European-made product, inspired by the U. S. version, may emerge on the market and take precedence at once.

MORE ADVANTAGES—Other advantages to the prospective U. S. licensor accrue to the prestige and professional reputation of his company.

There is a valuable intangible asset in the fact that a product is made at home and abroad. Aside from this, the practical demands of overseas military contracts, or such projects as the building of the F-104 aircraft in West Germany, make it almost mandatory for U. S. suppliers to have licensees whose facilities, services and products are readily accessible to the contractors for such projects.

The contractors will not seek to replace a U. S. part, which may be included in the original design of the plane, missile, or system being built abroad, with a counterpart of European origin, for they will be able to obtain the U. S. type as quickly as any other.

Thanks to license arrangements, the U. S. company has an agent on the European market, on duty 24 hours a day, to see to it that the original patents are protected from infringement, and to keep abreast of the products and activities of potential competitors abroad.

In addition, there are professional advantages in seeing an item reproduced at a distance of several thousand miles. In that process, problems of application and design may arise that have not been encountered at the originator's own plants; the licensee, distant from the regular production at home, will often arrive at ways to improve the product, for the ultimate benefit of customers both in European countries and in the United States. Likewise, the new producer, in meeting the specific demands of his market, will find new and important applications for the product, beyond its original scope.

For example, an American company may have designed a relay for exclusive use in missiles; the European reproducer will have less use for the relay in missiles, but may successfully place it in a commercial system, thus opening up a new and lucrative market for that relay, in the United States too.

Finally, by taking an active part in the European market the American producer, through his European associate, will be represented at trade shows on the Continent; at such expositions his products will be displayed to visitors not only from Europe, but from South America, Asia and Africa, and sales potential will grow with each new introduction.

ADVANTAGES TO THE LICENSEE—Primary advantage of a license agreement to the European company accepting it is the immediate power to manufacture a product that is of good quality, and with good sales potential.

A European company, which is working in the same field as the U. S. licensor, may have been aiming to develop just such a product. Through license agreement, the licensee is spared the cost inherent in such developments. Furthermore, by getting into production when demand is most evident, it is spared the danger of early obsolescence of the item.

Many electronic parts are covered by patents, which may be referred intact to the licensee by the licensor. We find, however, that sound knowhow is as important as the patent itself, and is of greater ultimate assistance to the licensee than the formal patent.

In accepting a license agreement, the European company gains not only specific advantages that are part of the new production, such as valuable technical assistance, production information, and the like, but also the general advantage of increased awareness of the latest U. S. production techniques in the industry, which are of great help in the manufacture and exploitation of the licensee's other products as well.

This new awareness extends to the latest in raw materials, which the European firm may never have used, the latest developments and refinements in machine tools, which may be unknown in Europe, and the latest factory procedures.

MORE ADVANTAGES—As a corollary to the above benefits, I want to point out that the licensee will learn new testing and checking techniques for the new product that will comply not only with the standards of the originator, but also with the prevailing requirements of U. S. military and government agencies.

The prestige advantage works two ways: we mentioned its effects on the reputation of the U. S. licensor; the licensee gains, too, by being able to link his name with that of his U. S. associate. The product itself gains most of all, for it is backed, in effect, by two highly esteemed companies, and its reputation is enhanced accordingly.

The licensee is automatically in a favorable position when an airplane, missile or electronic system is scheduled for production in Europe, if it incorporates the licensed product; in fact, even when such large units are sold to European companies or governments, although originally built in the United States, the licensee can count on orders for spare parts.

RECIPROCAL ADVANTAGES—The primary reciprocal advantage of license agreements lies in the possibilities for cross-licensing and reverse knowhow, both of which terms mean that the European company may license the U. S. company for the production of some European developments. This process helps to balance the flow of funds between Europe and the United States, as royalties become payable by each party to the other under separate agreements.

MECHANICS OF LICENSING—Following mutual expressions of interest in the idea of licensing, agreements are usually initiated by the submission of samples and all relevant technical data to the prospective licensee by the prospective licensor.

When the former has investigated the market, and is convinced that the demand is there, he will seek a tentative agreement giving him the representation of the U. S. company, so that he can sell small quantities of the U. S. version, and gain acceptance of the product in European equipment prototypes.

Then, the license agreement itself is drafted and consummated.

To get production underway at the European plant, some of the more intricate parts may initially be supplied by the licensor to the licensee, with the licensee doing partial manufacture, assembly and finishing. As soon as possible, however, the licensee will assume full
production. This procedure allows for business as usual with the customers, in the transition between importation of the product and its manufacture in Europe. While the licensee is assimilating all production techniques and establishing his raw material suppliers.

Under the terms of most license agreements, the licensee pays a certain cash sum to the licensor, in compensation for the expenses in transferring vital production information, drawings, procedures, bills of materials and all other forms of knowhow; in addition to this sum, and for the duration of the contract, the licensee pays a royalty to the licensor; usually 5 percent on sales.

What is important to the success of the agreement is that the licensee obtains all technical material and information for a reasonable investment and royalty, at the outset, and that he receives in the contract the rights not only to existing knowhow, but to all improvements and developments that the licensor may bring to the U.S. version of the product during the length of the contract.

**EXCLUSIVE AGREEMENT**—What is also important is that all such agreements be exclusive, so that the licensee need not fear other sources for the same product on his home front. Only through exclusivity, which would bring a steady influx of orders from the market, can the licensee’s sales volume become big enough to allow him to profitably amortize the costs he assumed for tooling and marketing.

Getting back to the implementation of the agreement, we would point out that most of the time, when the European company is accustomed to working with an U.S. firm, based on its experience as customer and representative, the licensee will be able to go into production after receiving the manufacturing files, and after having sent an engineer to spend a little time at the licensor’s plant, becoming thoroughly familiar with the latter’s production techniques. From then on, occasional reciprocal visits, and exchanges of correspondence between the two companies, are usually adequate to keep both parties fully informed of mutual progress.

Royalties on good products will develop into sizable amounts; such funds are frequently used by the licensor for his own research and development projects, with benefits to licensor, licensee and customer.

As the relationship between licensor and licensee solidifies, and the spirit of cooperation intensifies, the U.S. company may wish to have the European company produce various new developments in its behalf, as tools can be made in Europe at lower cost than in the U.S.

It should be stressed, too, that the licensor automatically receives the rights to all improvements and developments which the licensee may bring to the licensed product, at no cost to the licensor; the contract generally grants to the licensor all such rights on its own patents. It often happens that the licensee will develop a complementary product, which can expand the applications of the licensed product; such an item can be readily licensed to the U.S. company.

The first European country to gain licensing orientation has been France. With a substantial proportion of licensed products, mostly U.S. in origin, incorporated into its output, France has become a leader in European electronics.

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**Commodity Description**

- Radio broadcast transmitting equipment and parts
- Television broadcast equipment and parts
- Radio and television audio equipment and parts
- Television broadcast-studio equipment and parts
- Radio beacon (beam) transmitters and parts
- Automobile radio receivers
- Radio-phonograph combinations not incorporating tv
- Radios, home-type, not incorporating tv
- Radio receiver chassis, home-type, not incorporating tv
- Television receivers
- Television receiver chassis
- Electron tubes, receiving type
- Television camera tubes
- Television picture tubes
- Cathode-ray tubes, not elsewhere classified
- Parts and accessories for electron tubes
- Crystal diodes and transistors
- Capacitors
- Resistors
- Inductors (including transformers & coils)
- Loudspeakers
- Carrier-current equipment and parts
- Audio amplifiers and amplifier systems
- Amplifiers (except audio frequency) and parts
- Recorders (disk, tape, wire) and parts
- Electronic equipment not elsewhere classified, and parts
- Coin-operated phonographs, new
- Coin-operated phonographs, used or rebuilt
- Phonographs, except coin-operated
- Phonograph parts
- Phonograph records and blanks
- Signal generators
- Test instruments
- Test instrument parts
- Electronic computers
- Parts and accessories for electronic computers

**Subtotal**

**Special category items:**
- Radio communications equipment
- Electron tubes not elsewhere classified
- Electronic detection & navigation apparatus not elsewhere classified

**Total**
### EXPORTS OF SELECTED ELECTRONIC PRODUCTS BY DESTINATION

**Calender Year 1959**

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**January-June, 1960**

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<th>Japan</th>
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<td>66,142</td>
<td>29,772</td>
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<td>90,691</td>
<td>44,560</td>
<td>9,533</td>
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<td>44,316</td>
<td>22,018</td>
<td>400,725</td>
<td>211,374</td>
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1 European Free Trade Area. Includes Austria, Denmark, Norway, Portugal, Sweden, Switzerland, and the United Kingdom.
2 European Economic Community (Common Market). Includes Belgium-Luxembourg, France, West Germany, Italy, and the Netherlands.
3 Export statistics for these categories are published in totals only without information concerning countries of destination.

United States Imports of Selected Electronic Products, 1959 and 9 mo. 1960
(Value in thousands of dollars)

<table>
<thead>
<tr>
<th>COMMODITY DESCRIPTION</th>
<th>12 Mo. 1959</th>
<th>9 Mo. 1959</th>
<th>9 Mo. 1960*</th>
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<tbody>
<tr>
<td>Television cameras and parts</td>
<td>227</td>
<td>79</td>
<td>750</td>
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<tr>
<td>Television tubes and parts</td>
<td>387</td>
<td>208</td>
<td>323</td>
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<tr>
<td>Television apparatus and parts, other</td>
<td>688</td>
<td>469</td>
<td>1,112</td>
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<td>Radio apparatus and parts</td>
<td>72,724</td>
<td>43,261</td>
<td>61,639</td>
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<tr>
<td>Photocells and other electron tubes and parts (except tv, X-ray and radio)</td>
<td>1,358</td>
<td>956</td>
<td>1,892</td>
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<td>Phonographs, etc., n.s.p.</td>
<td>1,813</td>
<td>772</td>
<td>993</td>
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<td>Phonograph needles</td>
<td>13</td>
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<td>14</td>
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<tr>
<td>Phonograph parts, n.e.s.</td>
<td>950</td>
<td>476</td>
<td>650</td>
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<tr>
<td><strong>Sub-total</strong></td>
<td><strong>78,160</strong></td>
<td><strong>46,233</strong></td>
<td><strong>67,373</strong></td>
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<tr>
<td>Phonograph records</td>
<td>3,551</td>
<td>2,568</td>
<td>2,755</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>81,711</strong></td>
<td><strong>48,801</strong></td>
<td><strong>70,128</strong></td>
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New classes established
January 1, 1960* 

| Grand total in 1960                     | 95,132      |

* Preliminary.
** Includes imports of electronic testing, recording, instruments and apparatus; radar equipment; microphones and parts; loudspeakers; radio-phon combinations; record players and parts; and other electronic sound devices and parts utilizing an electronic transducer device.

Not shown separately in 1939.


United States Domestic Exports of Selected Electronic Products 9 mo. 1960
(Value in thousands of dollars)

<table>
<thead>
<tr>
<th>COMMODITY DESCRIPTION</th>
<th>1959</th>
<th>1960</th>
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<tr>
<td>Radio broadcast transmitters &amp; parts</td>
<td>2,938</td>
<td>1,558</td>
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<tr>
<td>Tv broadcast transmitters &amp; parts</td>
<td>3,058</td>
<td>2,413</td>
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<tr>
<td>Radio and tv audio equip &amp; parts</td>
<td>1,163</td>
<td>1,125</td>
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<tr>
<td>Tv studio equipment &amp; parts</td>
<td>7,413</td>
<td>9,297</td>
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<tr>
<td>Beacon transmitters and parts</td>
<td>1,312</td>
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<tr>
<td>Automobile radio receivers</td>
<td>1,171</td>
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<td>Radio-phono combinations (no tv)</td>
<td>694</td>
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<tr>
<td>Radios, home-type (no tv)</td>
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<td>Radio chassis, home-type (no tv)</td>
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<td>Television receivers</td>
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<td>Television receiver chassis</td>
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<td>Electron tubes, receiving type</td>
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<td>Television picture tubes</td>
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<td>Cathode-ray tubes (n. e. c.)</td>
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<td>Parts for electron tubes</td>
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<td>Crystal diodes and transistors</td>
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<td>Capacitors</td>
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<td>Inductors (including transformers)</td>
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<td>Loudspeakers</td>
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<td>Carrier-current equipment and parts</td>
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<td>Audio amplifiers and systems</td>
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<td>Amplifiers (except audio) and parts</td>
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<td>Recorders (disk, tape, wire) &amp; parts</td>
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<td>Electronic equipment n. e. &amp; c. parts</td>
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<tr>
<td>Coin-operated phonographs, used</td>
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<td>Phonograph parts</td>
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<td>Phonograph records and blanks</td>
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<td><strong>Signal generators</strong></td>
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<td>Test instruments</td>
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<td>8,776</td>
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<td>Electronic computers</td>
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<tr>
<td>Parts for electronic computers</td>
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<td><strong>Subtotal</strong></td>
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<td><strong>208,663</strong></td>
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Special category items:
Radio communications equipment                | 69,882| 70,752|
Electron tubes not elsewhere classified       | 9,333| 14,088|
Detection and navigation equip (n. e. c.)      | 35,030| 36,341|

**Total**                                      | **308,900**| **329,844**

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January 6, 1961

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IN TO-18 PACKAGE

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Strip Alloying Process

<table>
<thead>
<tr>
<th>TYPE NO.</th>
<th>( V_{CEO} )</th>
<th>( P_{Diss} )</th>
<th>( I_{CEO} ) (10V) MAX.</th>
<th>( h_{fe} ) (6V, 1ma) MIN.</th>
<th>( f_1 ) (6V, 1ma) MIN.</th>
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<td>0.1 ( \mu )A</td>
<td>15</td>
<td>5 mc</td>
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<td>0.1</td>
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<td>100</td>
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</table>

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Constructing working model to investigate design problems for proposed control circuits

Electronic Traffic Control

Philosophy of guided evolution is needed to make traffic aids now being developed compatible with those of the future. Proposed electronic control system that embodies this concept is outlined.

By EDWARD K. DAMON and ROBERT L. COSGRIFF
Dept. of Electrical Engineering, Ohio State University, Columbus, Ohio

A NEW DEGREE of freedom in highway design that will yield safer, more convenient driving while increasing highway capacity has been developed using electronic equipment. Every highway design is a compromise between cost, safety, allowable traffic density and convenience to the motoring public. Proper electronic systems will meet these criteria in a realistic manner and such systems are essential for adequate highways in the future.

In analyzing safety and convenience, an individual vehicle and its relationship to local traffic density must be considered. The possible peak traffic density or highway capacity is a group phenomenon, although related to the performance of the individual vehicles in the traffic stream. Data show that above a certain speed average vehicle headway increases more rapidly than speed, consequently decreasing the highway capacity. Random variations in driver performance in dense traffic may also...
have pronounced effects on capacity and safety. Automated control of each individual vehicle in the traffic stream should do much to alleviate these crippling effects on highway systems.

Past experience with automation indicates that because of the importance of individual as well as group considerations, it is desirable to break the electronic system into two major sections—localized and centralized. The localized section will perform tasks associated with the individual vehicle and its immediate environment, while the centralized section will be responsible for the gross nature of highway traffic and its regulation. Some degree of human supervisory control is frequently desirable in such centralized operations. Division into localized and centralized sections may appear somewhat artificial or arbitrary, but it can be justified on the basis of economics and on the type of equipment most suitable.

The localized system would perform tasks associated with adjusting vehicle speed, avoiding rear-end collisions, changing traffic lanes safely, entering or leaving the traffic stream at intersections and automatic steering along a single lane. It must be capable of accepting supervisory control instructions from the centralized system and conforming to these instructions. It will be responsible for supplying the centralized system with local traffic data and communicating information from both the localized and the centralized sections of the individual vehicles.

The centralized system must take into account weather, highway conditions and traffic throughout the rest of the highway system. Operationally it must determine the desired speeds for the traffic stream, alter localized system parameters to operate under these desired speed and headway characteristics, set routine and special traffic signal timing and highway signing, dispatch emergency vehicles and furnish authorities with continuous, reduced information on traffic conditions and performance.

Further duties will probably be assigned to both systems. Special situations may arise justifying a transferral of duties, and intermediate communication links may be advisable.

Various studies have established the technical feasibility of using electronic traffic aids; however, technical feasibility, in itself, is not sufficient reason for their use. Any rational study of highway automation must consider the social and economic factors that will be encountered in implementing the scientific results. Any problem may have several technical solutions, but cost or public acceptance must dominate the choice of solution.

Both cost and public acceptance rule out the probability of a revolutionary electronic highway materializing as a complete usable unit in the near future. The present evolutionary system, however, is producing a complex web of non-related gadgets that are frequently obsoleted when their capabilities need to be expanded. What is needed is a method of guided evolution.

Guided evolution implies that any system outlined be capable of meeting the final goals, and that the requirements and technical feasibility of each section of the system be established early. Development, installation and use of individual portions may then proceed with assurance that they will be compatible with the final system. Thus initial goals were established and feasibility studies instituted. These studies showed that a reasonable attainment of these goals depended

FIG. 1—Action of proposed guidance system is indicated by examples of headway (A to D) and lane changing (E)
heavily upon the techniques for making localized decisions, thus research was concentrated here.

First, the vehicle's position on the highway must be located. This will be referred to as detection. Next, if the logic capability is to be sufficiently flexible to improve rather than seriously curtail highway capacity, the vehicle's speed must be determined. This information must be stored while the logical decisions are made. Logic circuits may now determine the safety and desirability of the vehicle's present course and that of possible alternative courses, considering the placement and speeds of vehicles in its immediate neighborhood and the standards set by the centralized system. This information must be communicated to the vehicle or the driver. With the driver's judgment reinforced, aided or replaced by automatic equipment, automatic steering may be added.

Investigation of techniques to sense a vehicle's presence and determine its position led to the choice of inductive loops as detectors. (See ELECTRONICS, p 73, Nov. 21, 1958 and p 40, June 17, 1960.) Magnetic or conductive objects placed in the field of such a loop change the circuit inductance, creating an output signal. Such a device has been tested in the highway, and is currently being marketed for detection of aircraft and vehicles in airport taxi and parking zones.

Measurement of vehicle speed may be made by determining the time necessary to reach successive highway locations. Dependence on vehicle-contained equipment to transmit this information presents reliability problems with privately maintained equipment and would make the system ineffective during the gradual transition when many vehicles will be unequipped with any special devices.

Problems associated with unequipped vehicles may require some duplication of communication functions in the initial stages of automation. Induction radio will allow personalized communication — personalized meaning that a vehicle, or driver, receives only information of immediate concern, rather than a continuous barrage of instructions for others. Semipersonalized signing and signaling may be necessary for unequipped vehicles, particularly in the early stages. If the rest of the system really benefits the driver, he will invest the reasonable sum necessary to bring him the additional advantages of personalized communication.

Storage, logic and automatic steering should be considered in more detail, as here is where the most serious deficiencies exist in previously proposed systems. Occasional stretches of dream highways scattered among conventional roads have little likelihood of convincing the public of the need for equipping their cars with elaborate instrumentation for such infrequent use. The concept of guided evolution requires instead that the dream highway will be planned, but only the most needed components shall be installed in the near future with assurance of compatibility with eventual complete automation. The highway-contained localized guidance system seems most useful, and is visualized as using detection and logic blocks at intersections and in regions of poor visibility first.

Initial operation would be confined to advisory information or guidance supplementing the driver's judgment as to speed, headway and safety of lane changes. Complete control of the vehicle would be left with the driver while the public gains confidence in the system. More complete local traffic data would be simultaneously available for integration into centralized traffic control functions as desired. Replacement of the driver's judgment in routine driving decisions by automatic steering and speed-control devices could follow when the public is ready to accept them.

Review of existing and proposed guidance techniques did not reveal any system or combination of systems which would lead to a satisfactory solution of all the requirements. An alternative guidance system has been developed, which is believed to overcome these objections. This guidance system uses a spatial array of memory and logic elements along the highway, with one logic block for each detection block. A vehicle's position is stored in a memory element, and its velocity is stored as a zone of influence occupying selected adjacent positions in the memory plane. Guidance decisions based on the relative locations of these zones of influence may then be made.

All storage and logic is performed with OFF-ON devices corresponding to the setting of switches or relays for reliable, adjustment-free operation. To assure the feasibility of such a system, the memory and logic elements, in transistorized

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**FIG. 2**—Direct-coupled logic is used in circuits for tailzone (A), headzone (B), guidance (C) and personalized warning logic (D)

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form, were successfully designed and constructed, although insufficient time and traffic dynamics data has not yet allowed optimization.

The action of such a system may be seen with the aid of Fig. 1 where the ON state of a switch or transistor is shown by a circle, and the OFF state by a dot. In the memory plane, consider a vehicle's position. For convenience, the active areas ahead of the position will be referred to as headzones and those behind as tailzones. The actual number of such zones depends upon future research in traffic dynamics, but it is not essential in understanding the mode of operation. Consider the total zone of influence as occupying only five blocks.

When a vehicle enters a detection block, a series of pulses flows from a central supply, each pulse activating one tailzone. Thus, the longer the vehicle takes to enter the next detection block, the greater will be the zone of influence to the rear of the position. The headzones are turned ON when the vehicle enters the detection block, and are turned OFF individually as the tailzones are activated since less stopping distance is needed at the lower speeds.

Logical operations may now be performed on this memory plane. Examples of headway are shown in Fig. 1. Figure 1A shows two vehicles traveling at the same speed and separated by five blocks, assumed to be the proper distance. In Fig. 1B the leading vehicle has slowed down slightly, causing its zone of influence to shift to the rear. The zones of the two vehicles now overlap, as indicated, and a caution signal is relayed to the following vehicle. If this signal is ignored, a double overlap soon occurs, as shown in Fig. 1C. The new signal may be relayed as a danger signal. A vehicle approaching a stationary obstacle (Fig. 1D) is detected at a greater distance and warned.

Lane-changing opportunities are demonstrated in Fig. 1E. Zones of influence are here compared in adjacent lanes, with logic identical to the headway logic. In the case shown a lane change is unsafe for all three vehicles. If neither vehicle in the upper row were present or if vehicle spacing were greater, a safe lane change signal would be given.

A more detailed explanation of how such a system might be implemented can be obtained by designating each physical highway block by an integer \( i \). Each highway block contains headzone, tailzone, and interpretive logic, as well as sensing equipment which generates a signal \( L_i \) as a vehicle moves into the \( i \)th block. Signal \( L_i \), together with a series of independent clock pulses \( P \), sets up a zone of influence representing the vehicle, and consisting of headzones ahead of the location \( L_i \) and tailzones to the rear of \( L_i \). It will be shown later that the position of this zone of influence with respect to \( L_i \) is a function of the vehicle velocity. Whenever the zone of influence of one vehicle overlaps that of a second vehicle, an unsafe situation exists, and a warning is relayed to the rear vehicle.

The memory and logic elements used to set up these zones may be seen in Fig. 2. While there are several methods that can be used to set up these zones, only one is considered.

Where d-c logic circuits are used, as in Fig. 2A, tailzone \( T_i \) is turned ON by a signal of the form

\[ T_i = (L_{i+1}L_{i+2}T_{i+1}) + (L_{i+3}L_{i+4}T_{i+2}) + (P_T D_{i+4}) + (T_i T_{i+2}) \]  (1)

where the primes indicate the negation or inversion of the particular signal, the superscript \( D \) denotes a delayed signal, and \( P \) is the clock pulse.

As the automobile is moving into a new physical zone \( i + 1 \), (Fig. 3A) from zone \( i \), the \( L_{i+1} \) signal is turned ON and all the tailzones that have been previously activated by the vehicle are turned OFF in a manner analogous to clearing a register. With \( T_i \) OFF, conditions \( L_{i+1} = 1, L_{i+2} = 1, T_{i+1} = 1 \) yield a 1 for the first product term of Eq. 1 and \( T_i \) will turn ON as shown in Fig. 3B. Once \( T_i \) is activated, \( T_i = 1 \) and the second product term of Eq. 1 yields a 1. This corresponds to a self-latching or self-holding action of \( T_i \) to the ON condition as long as the vehicle occupies zone \( i + 1 \) but does not occupy zone \( i + 2 \).

Rewriting Eq. 1 for \( T_{i+1} \) gives

\[ T_{i+1} = (L_{i+1}L_{i+2}T_{i+3}) + (L_{i+3}L_{i+4}T_{i+2}) + (P_T D_{i+4}) + (T_{i+1} T_{i+2}) \]  (2)

where the last two terms are of interest. A short time \( D \) after \( T_i \) is turned ON, a clock pulse \( P \) will create a 1 in the third term of Eq. 2 and \( T_{i+1} \), will turn ON. The fourth product term acts as a latch for \( T_{i+1} \) as long as \( T_{i+2} \), is present. The action corresponds to Fig. 3C. A similar action activates the following tailzones as shown in Fig. 3D, so that the last two terms of Eq. 2 are responsible for the propagation of the \( T_i \)'s to the rear of the vehicle position. Delay \( D \) used in the third and fourth product terms should be longer than a clock pulse, but may be short compared to the clock period.

At some subsequent time, the vehicle will reach zone \( i + 2 \) and \( L_{i+2} \) will then be zero. All product terms of Eq. 1 are zero and \( T_i \), will turn OFF. After a short delay, all product terms of Eq. 2 will be zero, \( T_{i+1} \), will turn OFF and the clearing mode will propagate to the rear of the vehicle. The situation will now be as shown in Fig. 3E, which differs from Fig. 3A only in the vehicle position, so that the cycle can be repeated.

Headzone \( H_i \) in coincidence with the above tailzone conditions is controlled by the circuit in Fig. 2B and is given by

\[ H_i = T_{i+1}(L_{i+4} + L_{i+5} + \ldots + L_{i+3}) \]  (3)

This indicates that the headzones will be ON if there is a vehicle between \( L_i \) and \( L_{i+4} \), unless \( T_{i+1} \) is ON. Thus, each tailzone activated turns OFF the headzone \( n \) spaces in front of it.

The circuits have not been optimized; circuit and possibly logic equation revisions may be desirable, but it is a valid application of the type of operation possible. Application of present research in the integrated electronics approach to semiconductor circuits may offer great simplification in circuits and in the number of circuit elements. Rearrangement for fail-safe operation should also be considered.

Headzones and tailzones are now developed and may be used for collision prevention. If the headzone of one vehicle overlaps the tailzone of a second vehicle, the following vehicle is too close. This overlap is detected by the AND guidance circuit of Fig. 2C, where an output caution signal \( C \) is present if and only if both \( H_i \) and \( T_i \), are ON. The presence of two consecutive overlaps \( C_i \) and \( C_{i+1} \) could be selected to give a more imperative danger sig-
nal $D_i$. The use of an $n$ input OR (Fig. 2D) can relay this signal to, and only to, the following vehicle at location $L_i$. Either signal could also be used to control highway-installed devices to warn unequipped vehicles. Figure 4 shows a breadboard of the circuits in Fig. 2.

Cross-coupling collision prevention logic to adjacent lanes will similarly warn of unsafe situations before the driver starts a passing maneuver or aid him in merging at an intersection acceleration lane.

A change in the pulse rate setting up the zone of influence could change speed and headway characteristics, or electronic obstacles setting up an artificial zone of influence could be remotely inserted to close a lane or automatically stepped along the highway to bunch traffic approaching an intersection. Memory and logic similar to that shown could permit blind passing on hills and curves and blind cross-trafﬁc warnings or provide driver alertness indicators.

Having the capability of controlling speed, headway and lane changes, and assuming public education and acceptance of such devices, automatic steering can be discussed. Recent tests have shown that such automatic steering is now possible. However, in following the concept of guided evolution, automatic steering should be one of the last localized installations. Once automatic steering is used, the driver will not be as attentive to highway conditions. Automatic braking and speed control is therefore an essential forerunner of automatic steering to prevent rear-end collisions.

Some years ago, two types of automatic steering techniques for various types of ground vehicles were investigated for the armed services. The first was a system in which radar would sense the position of the highway relative to the vehicle at a distance ahead proportional to the velocity of the vehicle. This particular system has good characteristics, analogous to the techniques used by the human driver. However, it is not workable for automobiles because it would be virtually impossible to isolate the information collected by one radar from that generated by other nearby radars. Essentially, one vehicle would jam its neighbors. Public resistance would also be encountered since the cost of such a system would have to be borne by the owner of the automobile, and maintenance would be difficult and expensive.

The second system consisted of some type of track in the highway or roadway. This track would be electronically sensed and followed by the vehicle. With this system it would not be possible to anticipate the position of the highway ahead. As a result it is necessary to have a tight control system, responding rapidly to any indication of an off-course signal.

This electronic steering system may be viewed as corresponding to a roadway with a cross section in the shape of a V. As a result of any turning, the forces upon the automobile will move the vehicle from the neutral position of this V. The major problem involved from
the dynamic standpoint is that of lateral accelerations. Consider this V trough when for some reason the trough consists of two sectors slightly displaced from one another. When the automobile strikes this offset, serious lateral accelerations or sidesway will occur.

After completing this study it was felt that the techniques available did not allow for a reasonable solution. During the past few years, by the improvement of a sophisticated control system, it has been possible to minimize the sidesway problem. Even with this advance, such a solution is satisfactory only if the guide line is laid down with greatest precision and if this precision is maintained throughout the life of the highway.

In the summer of 1950 when investigating electronic highway systems, it became important to determine the possibilities that might be used for automatic steering so that the principle of guided evolution would be formalized. As a consequence, the automobile steering problem was reconsidered. It was found that most of the problems of both the guide line and the radar could be eliminated, and the advantages of both systems realized by using two guideline signals.

The first guideline would be the same as that considered in the previous studies. The second guide line signal would be proportional to the radius of curvature of the highway. By using this second signal, the servo system could be loosened, causing the analogous V trough to become flat. Thus small displacements of the guide line corresponding to similar displacements of the V trough will not cause serious lateral accelerations.

The human driver and the automobile are ideally matched to one another. From the servo point of view, this combination of man and automobile cannot be improved. Furthermore, the nature of the automobile dynamics relative to the steering system turns out to be an ideal system for the human. This was determined by engineers and psychologists only after months of study during World War II and such a system was subsequently employed in gun directors.

Finally observe the automobile track relative to the roadway for the three systems. Figure 5A is for the single track cable. In traveling around a curve, the vehicle tends to follow a line of slightly larger radius. Compensation for a single speed is made by displacing the cable slightly to the inside of the curve. If the cable has a small sideways step in it, the tight control system corrects for this rapidly, resulting in high lateral accelerations.

The radar system, looking a distance ahead, tends to follow inside the curved highway (Fig. 5B). A slight jog in the roadway does not affect the radar greatly, and the automobile passes without serious sidesway. With its limited visibility, however, the system would have more trouble than a human at sharp corners and on hills. The dual signal track, where a curve of constant radius can be compensated for at all speeds, is shown in Fig. 5C. An accidental jog in the track would not have curvature information and the system would therefore correct more slowly with no serious sidesway.

Vehicle detection and localized communication have been demonstrated on the highway. A guidance system and automatic steering equipment that can make the automated highway a fact has been described. Enough is known about the problems to permit initiation of a concerted program to develop hardware and test it on the highway. Such a program should be undertaken immediately. The combination of the guidance and steering systems, and the use of centralized functions to control traffic most effectively will depend upon a more thorough analysis of highway dynamics. The detection and guidance systems described may be the best means of gathering such data and of studying the effectiveness of the rest of the system.

The use of all, or portions, of the automated highway system would allow for the personalized guidance or control of speed, headway and lane selection for individual vehicles, and the optimization of these for desired gross traffic behavior. It is well suited for either supplementing or replacing the driver's judgement. With virtually unlimited sight distance, the guidance will permit passing on hills and curves, and more selective merging at intersections.

Until this is done, the highway engineer will still be forced to design future highways and do long-term planning with insufficient information on the electronic aids that will be available. Money cannot be saved by adding electronics to existing highways unless by so doing it adds capacity and saves the expense of expanding or rebuilding the highways. Major changes may be possible in the original highway design with installation of electronic traffic aids when conditions warrant their use.

The work reported here was a cooperative effort of the Ohio Department of Highways and the Engineering Experiment Station and the Antenna Laboratory of Ohio State University.
INTRODUCTION

Multifunction tubes and increasing use of transistors in radio and TV sets for the home entertainment market has resulted in some interesting design trends in this area of the industry. These were aired recently at the Radio Fall Meeting in Syracuse.

The 10-pin miniatures of Sylvania and the 12-pin Compactrons of GE are two approaches to the problem of reducing the number of components in radio and TV sets. Both approaches require new tube sockets in future designs.

The 10-pin arrangement tube requires the same size tube socket as a 9-pin tube and only minor changes in component layout should be necessary. The 12-pin tubes afford designing flexibility since they have more pins, cool bulb temperature, high voltage ratings because of pin spacing, and low overall height at the expense of increased diameter. Total circuit volume is likely to be about the same with either tube complement but is certain to be a little less than before introduction of the tubes.

A result of the larger envelope of the Compactrons is a decrease in bulb temperature in comparison with the hottest of similar conventional tubes. In the range of interest the larger envelope runs up to 30 C cooler, as indicated in Fig. 1E. A study of tube failure rate as a function of bulb temperature shows that cutting temperature from 180 to 140 C cuts the failure rate approximately in half. A reliability study of the Compactrons indicates that replacement rate of the tubes should be less and also that average replacement cost should be slightly less than with present tubes; the conclusion is based on estimated higher unit cost (not yet firmly established) but fewer replacements.

Features of a rectifier tube type,
3DG4, introduced by GE were described. The tube is designed for full-wave operation with a 25-v drop at 350 mA and has a total dissipation of 30 watts (compared with 55 w for a 5V3).

High-strength cathode material reduces the problems of cathode bowing and microphonics and allows close spacing, while plates constructed of a copper-iron-aluminum sandwich help to eliminate hot spots and to reduce cathode input power.

In transistorized tv sets, heater power for the crt is a major drain on batteries and it is desirable to use for this purpose power that would otherwise be wasted in conventional circuits. Special low-power CRT's are being developed for these sets and a Philco design for a 14-inch tube requires approximately 1/2 watt of heater power. Circuits investigated for supplying the heater include the vertical output stage, horizontal output stage, power-supply section, and horizontal output transformer core. Circuit details for the CRT in the vertical output stage are shown in Fig. 2. Since removal of the vertical drive signal increases heater current by about 20 percent, a protection circuit is necessary, perhaps a series fuse or a shunt Zener diode. Power from the horizontal output transformer core was obtained by several closely coupled turns giving essentially constant voltage and causing only about 5-percent heater current variation for out-of-sync conditions.

While the circuit best suited for each design will vary, the horizontal output transformer appears to be the most versatile choice.

Except for portable radios, transistors have been little used in entertainment electronics, primarily because of the cost differential in favor of tubes. But transistor prices have been going down steadily so the number of hybrid and fully transistorized sets can be expected to increase.

Entertainment transistors are being made on Philco's automatic production line, with parameters of the Madt units optimized for a particular use. Besides having a high degree of interchangeability—a necessity in this area—Madt units can be optimized for use as amplifiers, converters, reflex amplifiers, oscillators and mixers in home radio and tv sets.

An advantage claimed for the

![Figure 2 - Low-power heater of special CRT's can be supplied from various sources, saving battery power](image)

![Figure 3 - Transistors optimized for entertainment functions can be held to specs (A), show good life expectancy (B). Functional test circuit for rf amplifier transistor (C) and mixer transistor (D)](image)
automatic production line is its ability to control parameters by transistor geometry. Control factors include the resistivity of the blank, diffusion gradient, how far the emitter electrode extends into the diffusion region, diameter and flatness of the etched collector and emitter pits and the diameters of the electrodes. Typical parameter spreads are shown in Fig. 3A.

For most entertainment applications it is sufficient to set limits on power gain, bandwidth and noise figure. Fig. 3C shows a functional test circuit for optimizing parameters of a transistor in a specific application.

The circuit of Fig. 3C is fixed-matched, fixed-neutralized and fixed-biased and is similar to actual r-f amplifiers in tv or vhf applications. Specifications with the 2N1742 in the circuit are 14 to 19-db power gain, 10 to 16-Mc bandwidth and maximum noise of 5.5 db at 200 Mc. Bandwidth and noise are measured at maximum circuit gain, giving results reproducible in typical applications. A similar, standardized test circuit for a mixer transistor is shown in Fig. 3D.

Results of life tests on 18 units are shown in Fig. 4. Of particular interest is one unit which exceeded spec limits within the first 500 hours of testing. As testing continued, however, \( I_{cm} \), decreased—contrary to the usual sequence—and the figures of merit approached the specific limits. The scale of the graphs is such that the magnitude of the charge is exaggerated and the unit would have functioned without noticeable indication in many applications.

In a transistorized, battery operated tv, the video amplifier is a large power drain. Other requirements of the circuit, particularly the 80 v peak-to-peak output, make a one-transistor stage difficult to design: the two-transistor phase-splitter circuit' of Fig. 5 was proposed as an alternative. The circuit uses a high frequency npn unit in the common-emitter mode and a medium frequency npn unit connected common base. With stage impedance a little higher than a conventional common-emitter stage for the same purpose, a low impedance video driver is still required. Characteristics of video output stages are compared in Fig. 6.

REFERENCES
All papers presented at Electronic Industries Association’s 1960 Radio Fall Meeting at Syracuse.
(1) W. J. Sember and L. R. Maquire, Ten-Pin Miniature Receiving Tubes.
(4) B. Soloff and C. Tyson, Power Sources for Low Heater Power Tubes in Transistorized Receivers.
(6) C. D. Simmons and C. R. Gray, Variations of Transistor HF Noise Figure and Gain with Life.
(7) Z. Wienczek, Phase Splitter Video Amplifier for Transistor TV.
THE DIELECTRIC MATERIAL requirements (radomes for example) of hypersonic vehicles have placed increased emphasis on the need for dielectric measurements at elevated temperatures. Many refractory dielectrics are capable of continuous exposure to temperatures of 1,500°F and higher without serious electrical degradation. Most of these materials, however, exhibit changes in their dielectric behavior with increasing temperature. The accuracy to which these changes can be measured becomes a direct factor in the overall accuracy of any system using these dielectrics. With this in mind, a program was initiated to develop an X-band dielectrometer capable of measuring dielectric constant and loss tangent to 2,700°F with an accuracy of ±1 percent in the dielectric constant measurement.

During the early design stage of the dielectrometer, it was agreed that to approach the desired measurement accuracy, the $\varepsilon_r$ resonant cavity method would be required. Further, a method of storing several preheated samples, and the transfer of these samples to and from the cavity without disassembly would be necessary, while the heating system would have to maintain the cavity and preheater at 2,700°F for one hour a run.

A cutaway view shows the major components of the dielectrometer. The outer case is made from 0.25 inch steel plate. Copper cooling tubes are attached to the case and can maintain the outer surface at 100°F when the interior is at 2,700°F. The insulating jacket, a castable refractory material, is cast directly into a removable steel inner liner. The liner-jacket assembly is split lengthwise to allow access to the cavity and sample-holder heater assemblies and the sample transfer chute. Removable insulating plugs above each heater unit permit access to the sample holder and cavity without removing the complete liner-jacket assembly.

The heater units for the cavity and sample holder are identical in size and power rating, each being designed to dissipate a maximum of three kilowatts continuously. Each heater unit has a radial slot in the side wall for the sample chute. A saturable-core reactor control system provides the power input to the molybdenum heater. It is controlled by a platinum-rhodium thermocouple near the upper shorting plate of the cavity. Since molybdenum oxidizes readily above 800°F, it is necessary to maintain a constant argon purge to protect the heater elements.

As may be seen from the diagram, the cavity is within the cavity heater assembly. A 180 degree radial slot mates with the slot in the heater side wall and permits entry and exit of the sample. Electrically, the cavity operates in the $\varepsilon_r$ mode and is tunable between the $\varepsilon_r$ and $\varepsilon_{r\infty}$ modes. Physically, it is 2.180 inches in diameter and 4.45 inches long. Two 4-inch barrel extensions above and below the cavity enhance its thermal stability. The cavity is driven at the fixed shorting plate by two slots with their long dimension parallel to the cavity radius. These slots are 180 electrical degrees apart and are centered about the circumference of the $\varepsilon_r$ mode.

The slots are driven by two aluminum oxide filled platinum rectangular waveguides. Electrically, the guides operate in the $\varepsilon_r$ mode and have the same cutoff wavelength as air filled RG-52/U waveguide. Physically, they are smaller than RG-52/U by a factor of three in both the broad and narrow dimensions.

The upper ends of the two guides extend into a transition-phase splitter assembly. This device provides a transition from dielectric-filled guide to air-filled guide, and a method of driving the two ceramic filled guides 180 degrees apart in phase from a single source.

The cavity output is taken from a rectangular slot in the upper shorting plate. The slot is cut on the same radius as the input slots and is oriented at a 45-degree angle to one of them. A platinum, ceramic-filled guide similar to the input guides couples the output to the transition assembly. Power level of the cavity is monitored by a crystal detector on the output transition.

A sample holder in the storage heater unit, holds 12 samples preheated to the same temperature as the cavity. The holder is made from aluminum oxide parts held together with platinum rods. An aluminum oxide sample transfer chute connects the cavity slot to the slot in the sample-storage heater unit. To transfer a sample from holder to cavity, the sample is first positioned opposite the slot. A platinum rod pushes the sample through the chute into the cavity. After the sample has been measured, it is returned to holder by reverse process.

To calculate the dielectric constant of a sample in the cavity, these expressions must be solved for $\beta$,

$$\tan \beta d / \beta d = \tan \beta_i (M - M_0 - d) / \beta d$$

where $\beta_i$ is the phase constant in the sample, $d$ is the sample thickness, $\beta$ is the phase constant in the empty portion of the cavity, $M$ is the micrometer reading at resonance in the $\varepsilon_r$ mode with the sample inserted and $M_0$ is the micrometer reading at resonance in the $\varepsilon_r$ mode with the cavity empty.
Dielectrometer

By ROBERT W. SUTTON,
NESTOR GRECHNY JR.,
Physics Technology Department
Boeing Airplane Co., Seattle, Wash.

Then for medium and low-loss samples

\[ \epsilon = \frac{(\beta^2 + K^2)}{(\alpha^2 + K^2)} \]  \tag{2}

where \( \epsilon \) is the dielectric constant of the sample, \( K = 3.832/a \) for the \( \text{TE}_{\infty} \) mode, and \( a \) is the cavity radius. Solution of Eq. 1 and 2 requires this data

\[ M^+ \text{ and } M^- \] are the micrometer reading at the upper and lower half-power points, \( \text{TE}_{\infty} \) mode, sample inserted

\[ M^* \text{ and } M^e \] are the micrometer reading at the upper and lower half-power points, \( \text{TE}_{\infty} \) mode, cavity empty

\[ M^* \text{ and } M^e \] are the micrometer reading at the upper and lower half-power points, \( \text{TE}_{\infty} \) mode, cavity empty

\[ d = \text{sample thickness} \]

\[ \lambda_0 = \text{free space wavelength of the microwave signal.} \]

These data are then used to find \( M^*, M_n, \beta, \) and \( a = M^e - M^* \) where

\[ \alpha = \left( \lambda_1 \times \lambda_2 \right) / \left[ 2.6896 \left( \lambda_1^2 - \lambda_2^2 \right) \right] \]

where \( \lambda = 2 \left( M^* - M^e \right) \). With the exception of \( \lambda \), all data are micrometer readings, consequently, accuracy depends upon the ability of an operator to repeat a reading.

Errors may occur in determining the half-power points of the resonance curve. For the empty cavity resonant in the \( \text{TE}_{\infty} \) mode, the slope of the resonance curve is approximately 0.0002 inch per db. The accuracy of the attenuator used to measure the half-power points is ±0.05 db at 3 db, so the ambiguity in measuring the half-power points for the empty cavity is ±0.00001 inch. However, with a sample inserted, the width of the resonance curve broadens. For a typical aluminum oxide sample at 2,500-F, the slope of the resonance curve is approximately 0.0030 inch per db. Hence, using the attenuator, an ambiguity of ±0.00015 inch exists in determining half-power points.

Long-term stability of the microwave generator used to excite the cavity is ±1 Mc. The change in the resonant length of the cavity produced by a generator shift of 1 Mc is of the order of 0.0001 inch. An error may be introduced by variations in sample thickness. The surfaces of samples to be measured are ground flat and parallel to ±0.0002 inch. At elevated temperatures, the sample expands and a new thickness must be calculated. This is usually based on average linear coefficients of expansion taken from manufacturer's data.

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By DONALD H. BRESLOW,  

Power transistor parameters may be divided into two principal groups: parameters associated with operating the transistor in the active region and parameters associated with operating in the cutoff region. Power transistors are usually specified by their d-c parameters. The power consumed in measuring cutoff parameters is normally small compared with the dissipation ratings as long as there is no breakdown. However, measurement of parameters in the active region may present problems because of the relatively high power that may be required to bias the transistor at the operating point.

Manufacturers usually rate maximum power dissipation using an infinite heat sink; that is, the transistor case is maintained at normal ambient (25°C) during application of power. Maximum allowable dissipation is then determined by measuring the power that will cause the junction to reach its highest allowable temperature. The thermal resistance of a power transistor case to ambient is usually high and an external dissipating media is required if the transistor is required to dissipate even a relatively small fraction of its maximum allowable power. These heat-sink requirements become more stringent as appreciable fractions of maximum power are dissipated.

Pulse or sweep-type methods have been developed to reduce the input power when testing high-power transistors. The basic method of pulse testing is to apply biases to the test transistor such that power is drawn in pulses of high peak value, but of sufficiently low duty cycle that the average power and resulting heating is small. Detections of the transistor's response signals are made and the d-c parameters obtained. These measurements are equivalent to those made by conventional d-c.

Pulse-type testing has several purposes. First, the requirements for heat sinks may be minimized and, in some cases, eliminated completely. Second, less stress is put on the test transistor. Third, the transistors may be tested in areas not possible with d-c, for example testing at instantaneous power levels many times greater than rated dissipation. Also, the device is evaluated under switching conditions, so the capabilities of the transistor as a switch are obtained simultaneously.

To appreciate the merits of pulse tests, consider the problem of measuring the d-c current gain, $H_{re}$, at point X of the transistor characteristics shown in Fig. 1A. Biasing the transistor with d-c will require a heat-dissipating media capable of continuously dissipating a steady power $V_c I_c$. It is assumed that the power in the emitter junction is small compared with that in the collector junction.

Suppose that instead of well-filtered d-c, half-wave rectified, unfiltered d-c is applied. The collector voltage has a peak value $V_c$; the base and collector currents, which are also half-wave rectified and unfiltered, are of peak values $I_c$ and $I_b$. If these signals are observed on a peak-reading meter, then the ratio $I_c/I_b$ would have the same value as would be measured by an average-reading meter with steady d-c. However, the average input power is $P_r = \frac{1}{T} \int E(t) I(t) dt$ 0 and for this example $P_r = V_c I_c/4$. This is $\frac{1}{4}$ the power that would be required by d-c. Now consider the use of rectangular base drive current pulses, with a steady collector voltage. The waveforms are shown in Fig. 1B. As in the case of the half-wave signals, by peak detecting the signals, $H_{re}$ may be calculated as $I_c/I_b$. The average power is $P_r = V_c I_c \frac{\tau}{T}$ where $\tau$ is the pulse width and $T$ is the period. By making $\tau/T$ small, the average power can also be kept small, typically one to two percent of peak.

The values of $\tau$ and $T$ to obtain the duty cycle must be selected with care if optimum results are to be obtained. The minimum value of $\tau$ is determined by the electrical response of the test transistor. In measuring current gain, the ratio of two amplitudes is compared. The comparison is made by peak detecting and comparing the amplitude of two current pulses. Both pulses must have the same shape if the measurement is to be a unique function of amplitude. Consider the examples of Fig. 1C and 1D. In Fig. 1C the collector current response is too slow, and the collector and base current pulses are not the same shape. Since the collector current pulse does not reach its peak, the measured current gain would appear too low. In Fig. 1D, the wider base drive pulse permits the collector current to reach its maximum, thus enabling a true d-c measurement.

Actually, if simultaneous evaluation of current gain and switching
Power Transistor Pulse Techniques

When excitation is applied, the junction temperature will rise exponentially, the rate of rise being determined by the transistor's thermal time constant. With pulses of maximum collector dissipation, the junction will reach maximum temperature in about four time constants. Hence, \( r \) should at most be equal to four thermal time constants if thermal advantage is to be gained from the pulse method. After excitation, the junction cools exponentially. The junction will cool in about four thermal time constants, so that the minimum pulse spacing from trailing edge to leading edge should be a minimum of four thermal time constants.

The poorest electrical response time of available transistors is about 100 \( \mu \)sec. Thermal time constants are typically on the order of one to ten \( \mu \)sec. Therefore, a range of rectangular pulse widths from 100 to 1,000 \( \mu \)sec will be electrically and thermally compatible with most available transistors. Repetition periods of several thousand \( \mu \)sec, that is, pulse repetition rates of 10 to 100 a second, are satisfactory. The common power-line frequency is 60 cps and is compatible with thermal requirements. This frequency lends itself to a number of engineering advantages. With 60-cps pulses, ranging in width from 100 to 1,000 \( \mu \)sec, the duty cycle \( r/T \) is variable from 0.006 to 0.06. Thus, in the most favorable case 98.4 percent of the average power for a conventional d-c test is eliminated.

If power greater than maximum

Flexible instrumentation has been designed to permit power-transistor evaluation by pulse methods. (See Fig. 2A.) All tests in the active region are done in the common-emitter configuration. The components are a constant-current base-drive generator, collector supply, ammeter and voltmeter. Resistors are placed in series with each power supply so that a current sampling pulse may be obtained. The current pulse to be measured
is routed to an amplifier and peak detector that conditions the pulse for display on a d-c meter. Similarly, a voltmeter and selector display either collector or base voltage. A power supply reversing switch changes polarities for pnp or npn transistors.

The collector supply must furnish appreciable peak power with reasonable cost and size. For flexibility, a continuously adjustable supply is desirable; this is done with an a-c operated supply using a variable autotransformer. The supply must have a low internal impedance and be able to supply current pulses to 50 amp at voltages up to 15 v and lesser amounts of current up to 250 v.

Key to the acceptability of this power source is the phasing of the current pulse relative to the peak of the a-c input signal. (See Fig. 2B.) The rectangular collector current pulse is centered about the peak of the rectified wave. The longest pulse is 1,000 μsec wide, which has a voltage variation of about three percent during the pulse, adequate for most applications. Hence, by using a 60-cps repetition frequency and proper phasing, large economies can be achieved in the collector power supply. The drop that occurs during current conduction is due to the internal impedance of the supply. The transformers must have magnetic circuits capable of supplying the peak powers to avoid core saturation. There is not too much saving in size over transformers designed to continuously supply power equal to the peaks in this application. However, since copper losses are smaller than for a transformer rated for continuous duty, winding size is governed mainly by regulation requirements. An input filter capacitor suppresses ringing caused by shock excitation of the leakage inductance of the transformer at the leading and trailing edges of the current pulse. Unlike conventional capacitor input supplies, there is little energy storage in the capacitor. Virtually all the energy delivered to the test transistor is supplied from the a-c line at the peak of each cycle.

The base drive supply (Fig. 3A) is of the constant-current type. An a-c signal in phase with the collector supply is applied to a phase shift bridge and advanced about 88 degrees. This signal is sharpened and fires a one-shot multivibrator of width variable from 100 to 1,000 μsec. The 88 degrees of advance centers the multivibrator pulse about the a-c collector supply peak. The pulse operates the current generator, which has ranges of 0 to 100 ma, 100 ma to 1 amp, and from 1 amp to 5 amp.

Measurement techniques are different than those used in conventional d-c equipment. The ammeter circuit, shown for the collector supply in Fig. 2A, operates as follows. Collector current flows through a sampling resistor that is tapped for the various ammeter scales. Voltage pulses developed across the resistor are amplified by a stable feedback amplifier, which is followed by a peak detector. Peak detector output is then displayed on a d-c meter. Both ammeter and peak detector float across the whole sampling resistor, not just across the portion passing current. The smallest sampling resistor used, on the 50-amp range, is two millihms, which could easily be swamped by the contact resistance of the ammeter range selector. Floating the ammeter across the whole sampling string keeps all switch contacts out of the sampling resistance. Ammeter input signals of 0.1-v peak (full scale) are amplified to 50 v and then peak detected. Peak detector diode losses are small compared with 50 v, minimizing error.

Voltage measurements are also unusual. A graph of collector voltage against time is shown in Fig. 2B. It is desired to measure the voltage from the baseline to the bottom of the dip since this is the actual voltage across the transistor when current is drawn. The collector voltage is measured with a sampling gate, shown in Fig. 3B. The same pulse that drives the base current generator opens the saturated amplifier. The output of this gate is a series of pulses whose amplitude is equal to the voltage across the transistor when current is drawn. The pulses are amplified and peak detected for display on a d-c meter.

This instrument also measures Icv, Icv, and other leakage parameters. Since these tests are conducted at low power levels, conventional d-c is used. A function-switcher switch automatically supplies biases to the test transistor for the desired mode of operation.

The author acknowledges the contributions of H. Aronson and P. Watson, who provided the basic concept for this equipment.

REFERENCES
(1) K. E. Mortensen, Junction Transistor Temperature as a Function of Time, Proc IRE, 45, No. 4, April 1957.
Sensitive Amplifier Helps Locate Tumors

By EDWIN GORDY, M.D. and GEORGE SIEBER,
Roswell Park Memorial Institute, Buffalo, N. Y.

One method for localizing tumors in clinically inaccessible areas within the human body takes advantage of the fact that there is usually a detectable difference between normal and tumor tissue in their uptake of certain radioactive compounds. In this technique, a radiation-detecting probe positioned over the anatomical region under study is used to sense the local tissue radiation level following the administration of a radioactive compound. The uptake of radioisotope varies from tissue to tissue and depends to a large extent upon the radioactive compound. It is known, for example, that functioning thyroid tissue has a great affinity for iodine in iodide compounds, whether these are radioactive or not. In brain tumors, using I\textsuperscript{131} iodinated albumin, the difference in detected count rate between normal and tumor tissue is only about 10 percent.\textsuperscript{2, 3}

Working with this information,\textsuperscript{3} an instrument was developed that mechanically scans a body region, using a scintillation counter fitted with a lead focusing-collimator.\textsuperscript{4} The instrument presents the tissue radiation level data or detected count rate as variations in the blackening of a sheet of photographic film, similar to an X-ray picture. The film is kept in a light-tight box in a plane parallel to the plane of scanning, and is exposed to only a small focused spot of varying intensity from a small light bulb mechanically linked to the scintillation probe. The bulb traces out a scanning pattern over the film parallel to the pattern that the probe is scanning over the patient. An increase in count rate causes an increase in bulb brightness.

In the drawing, (A) is a functional diagram of the apparatus used to translate counts per minute into varying bulb brightness. The present design uses a transistor d-c amplifier to drive the light bulb, in place of the servomotor-rheostat control used in the original apparatus.\textsuperscript{5} Pulses from the scintillation detector are passed through a pulse-height-analyzer that is adjusted to pass only those pulses corresponding to a specific gamma peak of the nuclide being used. This improves the signal-to-noise ratio by rejecting pulses due to scatter and background. The selected pulses from the pulse-height-analyzer are averaged by a count-rate-meter whose output serves as the input signal to a d-c amplifier that supplies power to the light bulb scanning the photographic film.

The scanning speed is dictated by the permissible isotope dosage and the statistics of counting nuclear disintegrations. With the present probe geometry, the usable scanning speed is about 10 cm per minute. At this scanning speed, the maximum desirable lamp voltage is 6.5 v, which corresponds to a film optical density of 3.5, while the...
minimum or lamp idle voltage is about 2.3 v, which corresponds to a just-perceptible increase over the 0.3 background film optical density. The minimum idle voltage preheats the lamp filament, thereby reducing the thermal lag prevailing with a cold filament. Lamp voltage above 6.5 v serves only to enlarge the apparent focused spot size due to lateral light scatter in the sheet of film.

It has been shown empirically that the exponential relationship between detected count rate and film optical density illustrated in (B) is clinically useful. The present circuit design provides separate controls for zero suppression (length along the abscissa to the foot of a curve) and contrast adjustment (slope of the curve).

The exponential expansion of optical density as a function of detected count rate is provided by the exponential relationship between light emission and the voltage applied to the filament of a tungsten lamp. According to Walah’s, the light output of an incandescent lamp obeys the relationship \( B = kV^n \), where \( B \) is light output, \( V \) is applied voltage and \( n \) has a value of about 3.5 for a tungsten lamp.

The circuit (C) is used in the d-c amplifier. The upper part is a difference amplifier having controls for zero suppression \( R_z \) and \( R_e \) and scale expansion \( R_s \) which are needed to magnify the small detected count rate difference between normal and tumor tissue into large differences in optical density on the photographic film. The balanced amplifier was chosen because it affords independent adjustment of gain and zero suppression. The output emitter-followers \( Q_1 \) and \( Q_2 \) drive meter \( M \), as well as the lamp power stage shown in the lower part of the diagram. The meter adjusts the range and span of the instrument to the absolute detected counting rate prevailing at the patient at the time a scan is to be taken. The lamp power stage is stabilized by negative voltage feedback from the lamp to \( Q_s \) through \( R_s \). Transistor \( Q_s \) is a voltage clamp to prevent the lamp voltage from exceeding 6.5 v. About 0.5 v at the input will produce full lamp drive power. Separate power supplies are used because the lamp power stage floats at the voltage level of the emitters of \( Q_1 \) and \( Q_s \).

An example of a positive brain tumor picture recorded by this apparatus is shown in the photo. The instrument is flexible, being adaptable to many types of clinical studies using the scanning of tissue radiation level technique for tumor localization. It is simple to operate and its transfer characteristics are stable over an indefinite period of time. This instrument has been in continuous trouble-free daily operation for the past eighteen months in the tumor scanning apparatus of the Department of Nuclear Medicine of this institute.

We wish to thank Drs. Bender and Blau for permission to use the tumor scan shown in the photo.

REFERENCES

1. T. Planiol, Therapie, 12, 747, 1957.
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KELSEY-HAYES COMPANY, UTICA 4, N.Y.
Thyratron Monitors Line-Voltage Dips

By T. D. KORANYE, IBM Development Lab., Endicott, N. Y.

SHORT, SUDDEN VOLTAGE dips in the power line can cause errors in computer operation. Because it is awkward to monitor the voltage with an oscilloscope or recording voltmeter, a simple line-voltage dip monitor was developed. It senses and counts sudden dips but not slow voltage variations.

Whenever the line voltage drops below an adjustable threshold level, the grid of thyratron 2D21, see circuit diagram (A), becomes more positive than the cathode. The thyratron fires and operates an electromagnetic counter. Tube current is self-extinguished by an R-C combination in the plate circuit.

The input voltage is rectified and filtered in a circuit with a time constant of about 0.025 second, and reaches the grid as a d-c sawtooth wave. The cathode filter has a time constant of about 1 second; this produces an almost smooth voltage at the cathode.

Potentiometers in the cathode circuit allow for adjustment of cathode voltage level. When the control potentiometer is at zero, cathode voltage and sawtooth peak are equal; numbers on its dial, from 0 to 30, refer to the rms voltage difference between rated line voltage and threshold voltage. If the dial is set at 15, then the sawtooth peak exceeds the cathode level during any cycle in which the line voltage dips more than 15 volts below rated value. The thyratron fires and actuates the counter coil. Voltage waveforms (B) illustrate this.

Component values in the plate and cathode filters determine the repetition rate; using the values shown, the monitor can record about one voltage dip a second. Dips of even one cycle duration are counted. Because of stable cut-off characteristics, the 2D21 thyratron will fire with a ten-microsecond pulse. By changing the component values in the three R-C circuits, response can readily be varied; moreover the circuit could, if desired, be adapted to register only positive voltage surges.

Work on the monitor also produced a low line-voltage indicator, which indicates only one dip in line voltage, and then has to be reset. Two neon lamps with different striking voltages are in parallel and are the indicators of this device, forming a neon latch. The circuit is shown in (C).

When this device is operated as a voltage dip monitor, the threshold voltage is set by the control potentiometer. Normally, the low-firing voltage lamp L will ignite first. Opening the momentary reset switch in series with L extinguishes L and forces current through lamp H. The next line voltage dip below the preset level re-ignites lamp L, and this indicates that a dip has taken place. The circuit is now disabled until the reset button is again operated.

REFERENCES

Circuit diagram (A) shows that monitor requires no auxiliary power source; it uses same source as voltage being measured. Waveforms (B) illustrate circuit operation. 4x5x3 in. box houses monitor. In the neon latch (C) lamp H is ignited by opening switch S, thus preventing lower voltage lamp L igniting until a dip in voltage turns H off. Lamp L then lights on restoration of input indicating that a dip has occurred.
Several years ago, when AMPEREX announced the new 6922 and 6688 frame grid tubes for military and industrial applications, they were received with immediate and overwhelming acceptance. However, our applications work in these areas subsequently revealed that there was still room for improvement — as, for example, in the case of video amplifiers which must carry signals from DC to UHF... without microphonics, under extreme shock and vibration conditions. Today, with the new 7737 and 7308 AMPEREX Ampliframes (now in mass production in our Hicksville, Long Island plant), we believe that we have arrived at the ultimate in tube reliability.

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Heavy, square mica supports — eliminate mica chipping and flaking as well as loosening of mount when subjected to shock and vibration.

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Solar-Radio Event Not Explained by Theories

SEVERE communications blackout not accompanied by a hydrogen-alpha solar flare may cause revision of techniques for observing such events as well as conclusions based on them. The unusual occurrence, reported in IGY Bulletin, Oct. 1960, took place at 1630 UT on June 16, 1959.

A solar flare was not observed until almost 1½ hours after the start of bursts of radio noise on a number of wavelengths. Also, the subsequent major geomagnetic and ionospheric storms usually associated with such disturbances were absent. Only on June 11 did a sudden onset of magnetic disturbance appear followed by moderate disturbances.

These and other observations of the unusual event have caused the National Bureau of Standards to make a critical reappraisal of past observation techniques and to review the conclusions drawn from them. The solar research group is seeking a better understanding of the relationships between solar events, ionospheric disturbance and geomagnetic storms. These associations have played an important part in the Bureau’s radio disturbance network. This service bases its predictions partly on analysis and evaluation of solar-radio data from many sources.

The unusual solar event does not conform to previously assumed relationships and is considered a major anamoly. As severity of the blackout became apparent, radio and optical observations were intensified. The position on the sun of a solar flare that would cause such a disturbance was calculated to be on the eastern edge of the disk. However, in the light of the hydrogen-alpha line, only jets (spikes from chromosphere) and bright loops (rare type gaseous prominence generated by large active sunspot groups) were observed. The expected hydrogen-alpha flare was not observed at the calculated position until almost 13 hours later.

Complete blackout of WWV was experienced at a number of receiving locations. Outstanding cosmic noise absorption (3+) was evidenced by the significant drop in received signal strength and the unusually slow onset of the absorption. These observations in the absence of a major solar flare were difficult to explain.

Another unusual feature was the exceptionally low velocity of the source of radio emission. This velocity deduced at two separate low frequencies was about 250 kilometers per second, compared with the usual 1,000 kilometers per second.

The hydrogen-alpha jet ejections appeared to be based near the sun’s eastern limb on the side facing away from the earth. This fact and the late appearance of a flare led to speculation that an early stage of the flare also occurred on the other side of the sun at a time more closely associated with the terrestrial radio blackout.

Even if this assumption is made, no explanation is provided for the way in which the solar radio emission and the ionizing emission reached the earth. Both these emissions usually travel in straight lines. It then becomes necessary to assume a different trajectory for each type emission, which is at variance with many prior observations.

It can be inferred, however, that the flare originated at a lower level in the atmosphere of the sun than the source of emissions. This assumption would help explain ionizing emission reaching the earth while a flare was not observed.

Getting More Data
From Weather Data

ENHANCED usefulness of airborne weather radar may result from study of high-level thunderstorms. An attempt will be made to establish a relationship between radar echoes and turbulence patterns.

The program was announced by the Air Force Office of Scientific Research and will be carried out by the Air Research and Development
End-of-line clipper
Clipper tube is connected across the far end of the pulse-forming network in series with a resistive load whose value approximates the network impedance. When the clipper tube is triggered, the pulse-forming network terminates in its characteristic impedance thereby reducing the inverse voltage to zero.

Positive protection against destructive voltages with Tung-Sol Clipper Thyratrons

Line-type radar modulators require clipper protection against excess inverse voltages, which can destroy costly components and increase equipment downtime. Clippers also perform valuable circuit service by regulating pulse amplitudes and reducing switch tube loading.

But until Tung-Sol developed these high-reliability hydrogen-filled clipper triodes previously used clipping devices brought some serious disadvantages to the job.

Now, however, you can be sure of perfect clipping action when you design Tung-Sol clippers into your equipment. More rugged and less costly than solid state devices, more efficient with a much lower dynamic impedance than vacuum clippers, and faster acting and more resistant to arc-back than gas diodes, the new Tung-Sol thyatron clipppers are designed and built to deliver uncompromised performance.

The low “firing” voltage and the ability to carry large peak currents make these hydrogen clipper thyratrons ideal for this application. These tubes also feature hydrogen reservoirs which promote long life by providing an automatic mechanism for replenishing hydrogen lost by “cleanup”.

Circuit requirements are simple whether the Tung-Sol thyratrons are used as “end of the line” clippers, “across switch” clipppers or “tail biters”.

NEW KEARFOTT DIGISTROBE* DISPLAY

Kearfott's new, highly compact Digistrobe digital display utilizes the stroboscopic principle to produce an exceptionally high-definition readout in the actual size shown here. Through the use of a unique shutter arrangement, a single diode-encoding matrix is shared by all columns (5 in the standard model), resulting in substantial savings in electronic components and circuitry. The fast response time of the Digistrobe (56 milliseconds transition from one five-digit quantity to a totally different one) permits a single unit to sample several different inputs on command through an input selector switch. Up to 15 individual displays of existing types can thus be replaced by a single Kearfott Digistrobe!

Incorporating only two moving parts and exclusively solid-state switching circuitry, the Digistrobe has extremely long life expectancy and requires minimum maintenance and service. Operation is directly from the output register of a computer, counter or allied equipment, eliminating the cost of intervening circuitry. Two years of extensive laboratory tests assure compliance with Kearfott's rigid standards of quality. For complete data and specifications, write for Digistrobe bulletin.

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KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

Command for the Strategic Air Command. The Aerophysics Laboratory, the Geophysics Research Directorate, Air Force Cambridge Research Laboratories, will furnish meteorological support.

Airborne weather radars can pinpoint areas of liquid water concentration. However, they do not indicate turbulence and drafts to enable aircraft to safely penetrate high-level thunderstorms. The problem is further aggravated because higher aircraft speeds are required to stay aloft at high altitudes. At subsonic speeds, the aircraft is subject to stall-out at speeds slightly below cruising speed. Above cruising speed, severe buffeting adds to the problem of turbulence.

An Aerophysics Laboratory team will operate a cumulus cloud observation site. Equipped with stereographic, panoramic and time-lapse cameras, it will measure and record growth rate of cumulus towers over San Francisco peak as thunderstorms form.

As aircraft are directed to the building towers by visual and radar guidance from the ground, Aerophysics personnel will make meteorological measurements in the air from a C-130 cloud-physics aircraft and with ground radar.

The proper time and place for a T-33 and an F-106 to penetrate through the storm will be determined. This information will be established from visually observed rates of cloud top rise, height and rise rate of ground-based radar echoes, turbulence measured in echoes of ground-based radar and meteorological information relayed from the C-130.

During penetrations observers in a B-47 will view the storm from a safe distance with standard weather radar and photograph the progress of the storm from the radar display. The echo pattern will subsequently be related to turbulence experienced by the T-33 and F-106 and to observations made by the ground and C-130 teams.

Results will form the basis of a manual for SAC crews. It will include photographs of typical weather radar patterns and their relationship to high-level thunderstorm turbulence distribution. The Aerophysics Laboratory will be assisted in research aspects of the project by personnel from the Uni-
Instruments, January

High-Speed Radiography For Metals Industry

LINAC, an eight-million-electron-volt linear accelerator is designed to produce 6,000 roentgens per minute to permit the x-ray examination of very thick metals. At full power and at a distance of nine feet, a five-millimeter focal spot will x-ray an 11-inch thickness of steel in about one minute. With a one-millimeter focal spot source and an output of 1,500 roentgens per minute, eight inches of steel can be radiographed in one minute with greater clarity.

Main power tubes can produce the maximum amount of roentgens while operating at one-third of their rated capacity.

Built by the High Voltage Engineering Corporation of Burlington, Mass., Linac will be installed at the A. O. Smith plant in Milwaukee next Spring. The machine is needed to assure reliability of products handling nuclear matter or operating at extremely high pressure such as core barrels for nuclear reactors and high pressure vessels for the petrochemical industry.

Blood Changes Measured

Changes in blood pH as small as ± 0.003 pH have been measured by Dr. W. S. Yamamoto of the University of Pennsylvania Medical College. Such blood changes, Dr. Yamamoto believes, are messages to the brain that determine how bodies regulate breathing to suit physiological demands.

Decoding of the messages is obtained by studying the electropotential between the blood stream and the brain. This requires the accurate measurement of pH changes, and this is being continuously refined because future studies must attempt to record changes within the time of a single heart-beat (0.8 second).

The sensitive instrument used to detect these changes is called the Vibron Electrometer, and was designed and developed by Electronic Instruments, Ltd., Surrey, England.

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Write for Bulletin 3450D

That "quality look" of Electro-Pulse modular instrumentation goes deeper than front panels...inside the 3450D it's very apparent...from its clearly marked, neatly packaged printed circuits to its fully regulated power supply, de-rated components, dual cooling fans...and more.

It looks and is versatile. Substitution or addition of physically and functionally interchangeable modules economically extends instrument performance to meet your expanding requirements...and those plug-in modules are really accessible and easy to maintain.

It's a better design to begin with...and coupled with advanced pulse techniques and field-proven circuitry the result is solidly reliable, remarkably flexible instrumentation. The 3450D GENERAL PURPOSE PULSE GENERATOR IS A TYPICAL EXAMPLE. Electro-Pulse, Inc. offers a broad line of modularized pulse and digital instrumentation.

SEE FOR YOURSELF

Check its (superior) performance, check its (built-in) reliability and how easily it may be adapted to a wide range of applications and requirements—including yours.

STANDARD MODIFICATIONS AVAILABLE expand your instrument-dollar:

Y = simultaneous complementary output ± 45v from 470 ohms with durations to 1 second
X = twin pulse and pulse train capability
T = 0.5—5,000 cps rep. rate
I = 1 volt input trigger sensitivity
G = ON-OFF gate control of output

Electro-Pulse, Inc.
A SUBSIDIARY of SERVO CORPORATION of AMERICA
6711 SOUTH SEPULVEDA BOULEVARD, LOS ANGELES 45, CALIF.—Oregon B-2244
CIRCLE 131 ON READER SERVICE CARD
Has Shakeout In Components Already Begun?

NESTLED IN A CORNER of General Electric's vast Schenectady plant is a small group of carefully selected specialists assigned a special task.

Their mission, for planning activities of the company's Electronic Components Division, is to materially increase their company's growth rate in new business in the next five years. And by their own assessment, the period will coincide with a challenging shakeout in the electronic components business that they believe has already begun.

The key to this philosophy, which recognizes opportunity commensurate with the challenge, is that the business demands a customer-oriented approach that both fills the needs of current technology and anticipates what future products ingenuity will demand.

The Advanced Product Planning Operation applies the "blue-sky" thinking of its engineers—with a healthy assist from professionals in five product departments and two laboratories—to the premise that the shakeout period in component areas is under way.

Typical of the broad experience shared by the APPO group is that of its manager, M. A. Edwards, who holds 93 patents and is a three-time winner of General Electric's Coffin Award for scientific and technical achievement. Edwards formerly was engineering manager of the company's X-Ray Department and also served in that position at the General Engineering Laboratory. He is a fellow of the American Institute of Electrical Engineers and the Institute of Radio Engineers.

James E. Keister, Manager—Advanced Engineering who joined APPO after 25 years' experience with electronics-oriented General Electric departments, describes the shakeout as the result of "innovations in material selection." Keister pins it down further:

"We feel the electronics industry is at the stage where it cannot support itself on natural materials, because today we can envision applications beyond reach due to the restrictions imposed by the limitations of existing materials."

To meet these requirements, the APPO group feels, will demand the development of either ultra-refined or tailored materials; in other words, materials-development will get a large share of research- and-development attention and dollars.

The shakeout theory further progresses with the realization that heavy R & D support possibly can be brought to bear by a large corporation, with broad-based products.

The challenge becomes increasingly complex, for example, in the area of vacuum melting. Here the objective is 100-percent purity of materials, but once that goal is reached it becomes necessary to maintain absolute purity in operation. Thus, the advantages of operating in a vacuum become apparent.

Then there is the principle of integrating electronics, of combining a cross-section of functions into one unit. Here high-purity vacuum melting can create the materials, but it may become necessary to evacuate the entire package—tubes, resistors, capacitors, etc.—to assure satisfactory operation.

A typical example of that approach is the GE TIMM circuit (for thermionic integrated micromodules), an evacuated package containing tube functions with resistors and capacitors.

TIMM units have been shown to be highly resistant to radiation effects, and with their small size they make possible futuristic designs for computers, missile-control circuitry, and a broad spectrum of Space Age electronic applications. Another aspect of the challenge to product research and development, in Keister's forecast, is the soaring need to develop materials capable of operating under severe temperatures. These higher temperatures, he adds, are a natural
Born to live a short life,
this missile guidance component
must perform as if it had to last forever?
CDF molded this part under high
pressure from glass fabric epoxy
laminate to meet rigid military
electro/mechanical requirements.
Result: a panel with excellent
electrical insulating properties and
high mechanical strength that provides
significant savings in space and weight,
helps minimize vibration.
Install Coaxial Cable Faster and for Less Cost!

HICKORY BRAND®
I. M.
Coaxial Cable
needs no separate messenger!

When you install Hickory Brand I. M. Coaxial Cable, the need for spinning or supporting the cable to a separate messenger is completely eliminated! The high-strength, galvanized solid steel messenger is an integral part of the cable jacket and can be gripped, pulled and tensioned using standard techniques without breaking!

Conductor insulation and dielectric material is polyethylene for maximum operation efficiency making these cables especially adaptable to applications requiring high, very high and ultra-high frequencies.

If Hickory Brand Supported Coaxial Cables spark an idea for you, write us for advice and complete information today!

For FREE SAMPLE, send request on your letterhead to

HICKORY BRAND®
Electronic Wires and Cables
Manufactured by
SUPERIOR CABLE CORPORATION, Hickory, North Carolina
direction projects will take:

"A very general survey of electronics businesses was completed to determine the most fruitful areas for division expansion."

Because of the aspects of materials innovation mentioned previously, specialty materials already are getting a large degree of attention with APO. The operation is currently quarterbacking an integration of effort that previously had been spread among the product departments of the division—a method that created islands of activity.

Also receiving a share of attention is the nuclear radiation problem, as it affects component reliability (TIM circuits again), and a new corporation-wide concentration in the area of microelectronics.

Possible future areas of activity by the operation include investigations into opportunities in superpower microwave components for communications, extension of microwave channels into the micron spectrum range, solid-state phenomena, and energy generation and conversion.

Thus the "shakeout" theory is shared by Quill, who calls it an "opportunity as well as a challenge."

"The successful competitors," he adds, "will be those with the aggressiveness, competence and mobility to change with the requirements of the business. It is a very opportune time to be on the lookout for opportunities to expand."

Silicone Price Decreases

FURTHER REDUCTIONS in the price of Silicone antifoam compounds and antifoam emulsions was recently announced by General Electric's Silicone Products Department in Waterford, N. Y. (see Progress Report on Silicones, p 98 ELECTRONICS, Dec. 18, 1960). Reductions decrease the price of Silicone antifoam compounds by 20 cents per pound, and antifoam-60 emulsion by 10 cents per pound.

This is the second reduction in Silicone prices to be made by GE in five months. A four percent reduction in the price of Silicone fluids and emulsions was made last June. A previous cut, also of four percent, occurred in September of 1959.
Strip Terminals: Assembly Common Denominator

By RICHARD YOUNG,

TERMINALS STAMPED in a continuous strip and mounted on prepunched boards are the basis of a strip packaging method designed to simplify design, production and testing of circuit modules. Many of the hand assembly steps usually needed for wired circuitry are avoided.

The assembly equipment is simple and versatile, allowing different assemblies to be made on an assembly line with the advantages of large volume continuous production. Terminals come in reels and boards are stocked in six standard sizes, carrying up to 30 terminal pairs in five-pair increments. The equipment will also accept boards with non-standard dimensions.

Primary operations, shown in Fig. 1, are inserting the terminal strips in the boards (A), cutting out unwanted connections between terminals (B) and placing components in a row between terminal pairs (C). The assembly is then machine-soldered.

Terminal strip is fed upside-down into the die of the insertion press. The operator starts the terminal lugs into the prepunched board holes and operates the press with palm switches. A rod driven by an air cylinder pushes the terminal strip into the die. The number of terminals is controlled by the length of the rod's stroke, determined by a parallel rod carrying an adjustable stop which trips a limit switch. The strip is cut off after insertion by a blade on the edge of the die, which moves back and forth.

Cutouts between terminals are...
New voltage reference battery demonstrates mercury battery stability

Another Mallory 'First'

Mallory Voltage Reference Battery has 8 outputs, 0-10.8 volts in 1.35 volt increments; accuracy ±1/2%; internal impedance 1/2 to 1 ohm. Can be calibrated for accuracy up to 1 part per million for short periods. Price $39.50. Write for name of nearest distributor.

If you’re interested in lab tests and calibration, investigate a new kind of voltage standard ... the Mallory Mercury Reference Battery. This rugged, multi-output voltage reference gives precision approaching that of glassware-type laboratory standard cells ... is free from damage by overloads or mechanical shock.

If you’re designing circuits, you’ll find endless uses for Mallory Mercury Batteries as a reference source in tachometers, bias circuits, bridges, potentiometers, telemetering and control systems. Many voltages and physical sizes are available. Write today for application engineering service.

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

In Canada, Mallory Battery Company of Canada Limited, Toronto 1, Ontario
In Europe, Mallory Batteries Ltd., Dagenham, England

January 6, 1961
EYE TEST FOR RADAR

B&L optical-electronic-mechanical capabilities assure accuracy in missile tracking system

The strength of our missile defense program depends in part on extreme accuracy of radar tracking.

Bausch & Lomb has developed a camera lens for boresighting a radar antenna—in essence, this lens checks the performance of radar just as one's vision is checked in an eye examination.

Accuracy of this lens system easily meets the most extreme requirements.

The same skills that made possible this missile track radar camera lens are available to assist on your project. Write us for full details. Bausch & Lomb Incorporated, Military Products Division, 61413 Bausch St., Rochester 2, N. Y.

made on another press by cam-operated blades lined up on either side of a nest. The board is placed in the nest so that the terminal strips are between the blades and a backing plate. An adjustable stop in the rear of the nest aligns the blades and terminals.

The blades slide in tracks so that each blade can be in neutral, operating or cutting position. In Fig. 2, three of the left-hand blades are in operating position. As the cam, driven by the press, comes down vertically into the operate slot, it drives the blades to the right, cutting the tab. The blades retract as the cam rises again.

FIG. 2—Cam drives cutters in operating position

If a blade is retracted to the programming plate, the cam will go down into the neutral slot with vertical sides and the blade will not operate. Holes in the programming plate are numbered to correspond to tab positions. To set up the sequence of cutouts, the blades are pushed to operating position by a rod inserted in the plate holes.

A press has been equipped for punched card programming. Miniature air cylinders, mounted on a manifold, substitute for the programming plate. The air lines go to individual holes in a platen mounted in the main air supply line. The card, placed on the platen, acts as a gasket, allowing the air to reach
only the selected air cylinders.

Boards are now ready for component assembly. The boards can be mounted in advance on a plug-in module’s frame or assembled individually for attachment to a chassis. In most cases, the assemblers use a fixture which lines up the boards in parallel rows (Fig. 1).

Wiring is added first and wire ends are crimped to terminals at connection points. Wire is generally pre-cut and stripped by machine. Component leads are also pre-cut. Leads are merely dropped into the terminal slots. When all components are in place, the rubber-backed clamp bar is added so the fixture can be turned over without the components falling off.

The assembly fixture is also the soldering fixture, fitting on the conveyor of a stream-soldering machine. The machine in which Elgin uses was designed to allow flux and solder to touch only the terminal strips. Flux is pumped through small tubes spaced the distance of the terminal strips. As with other flowing solder methods, solder is delivered free of dross and tailing is minimized. There is little heating of the assembly, since only a small amount of molten solder touches it, for about 1.5 seconds at 475 F. A soldering iron might be in contact for five seconds at 700 F.

Typical assemblies. Wiring is used for interconnection.

Final tests are made with a test set programmed by punched tape (Robotester, Lavoie Laboratories). The test fixtures look like large vases. In one, the jaws are lined with 200 spring-loaded bar contacts positioned so they will press against the terminals of a unit placed in the fixture. The fixture has another 24 contacts on the base and five test plugs for tube sockets. A bank of 50 miniature switches in the base allows the number of points checked to exceed the 240-point capacity of the tester.

DIRECTIONAL COUPLERS • RF LOAD RESISTORS
COAXIAL TUNERS • RF WATTMETERS • VSWR METERS

MicroMatch

RF Power and VSWR measuring instruments are rugged and accurate in both field and laboratory use. The patented circuit produces an output essentially independent of frequency. Over 3800 models of coupler units available. MICRO-MATCH instruments meet highest government and commercial standards, combine highest quality with low cost.

**RF POWER and VSWR Instruments**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Frequency Range (mcs.)</th>
<th>Power Range Incident &amp; Reflected (watts)</th>
<th>RF Connectors and Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>263</td>
<td>0.5 - 225</td>
<td>0 - 10, 100, 1000</td>
<td>Type N* 52 ohms</td>
</tr>
<tr>
<td>200N</td>
<td>28 - 2000</td>
<td>0 - 400</td>
<td>Type N* 52 ohms</td>
</tr>
<tr>
<td>711N</td>
<td>25 - 1000</td>
<td>0 - 30, 75, 300</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>721N</td>
<td>25 - 1000</td>
<td>0 - 2.5, 10</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>722N</td>
<td>1000 - 3000</td>
<td>0 - 12</td>
<td>Type M 52 ohms</td>
</tr>
<tr>
<td>723N</td>
<td>1000 - 3000</td>
<td>0 - 12</td>
<td>1% Flange 50.0 ohms</td>
</tr>
<tr>
<td>40588</td>
<td>28 - 2000</td>
<td>0 - 4000</td>
<td>3½ Flange 50.0 ohms</td>
</tr>
<tr>
<td>445A10</td>
<td>20 - 2000</td>
<td>0 - 40,000</td>
<td>3½ Flange 50.0 ohms</td>
</tr>
</tbody>
</table>

**DC OUTPUT DIRECTIONAL COUPLERS**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Frequency Range (mcs.)</th>
<th>Power Range Incident &amp; Reflected (watts)</th>
<th>RF Connectors and Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>576N1</td>
<td>42 - 2000</td>
<td>1.2</td>
<td>Type N* 52 ohms</td>
</tr>
<tr>
<td>576N6</td>
<td>28 - 2000</td>
<td>0 - 400</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>596N2</td>
<td>1000 - 3000</td>
<td>0 - 4</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>596N3</td>
<td>1000 - 3000</td>
<td>0 - 4</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>40288</td>
<td>28 - 2000</td>
<td>0 - 12</td>
<td>1% Flange 51.5 ohms</td>
</tr>
<tr>
<td>442A9</td>
<td>28 - 2000</td>
<td>0 - 12,000</td>
<td>3½ Flange 50.0 ohms</td>
</tr>
</tbody>
</table>

**RF OUTPUT DIRECTIONAL COUPLERS**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Frequency Range (mcs.)</th>
<th>Coupling Attenuation (db)</th>
<th>RF Connectors and Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>313N3</td>
<td>300 - 2000</td>
<td>30</td>
<td>Type N* 52 ohms</td>
</tr>
<tr>
<td>313N5</td>
<td>60 - 2000</td>
<td>50</td>
<td>Type M 50 ohms</td>
</tr>
<tr>
<td>442A40</td>
<td>200 - 1000</td>
<td>40</td>
<td>3½ Flange 50.0 ohms</td>
</tr>
</tbody>
</table>

**ABSORPTION TYPE RF WATTMETERS**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Frequency Range (mcs.)</th>
<th>Power Range (watts)</th>
<th>RF Connectors and Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>621N</td>
<td>1 to over 1000</td>
<td>0 - 120 milliwatts</td>
<td>Type N* 52 ohms</td>
</tr>
<tr>
<td>625C5</td>
<td>50 - 1000</td>
<td>0 - 120</td>
<td>Type C 50 ohms</td>
</tr>
<tr>
<td>651N</td>
<td>25 - 1000</td>
<td>0 - 25, 100, 500</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>611A7</td>
<td>50 - 1000</td>
<td>0 - 1200</td>
<td>3½ Flange 50.0 ohms</td>
</tr>
<tr>
<td>612A</td>
<td>44 - 1000</td>
<td>0 - 6000</td>
<td>3½ Flange 50.0 ohms</td>
</tr>
</tbody>
</table>

**RF LOAD RESISTORS**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Frequency Range (mcs.)</th>
<th>RF Power Dissipation (watts)</th>
<th>RF Connectors and Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>603N</td>
<td>3000</td>
<td>20 (air cooled)</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>633N</td>
<td>3000</td>
<td>50 (air cooled)</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>636N</td>
<td>3000</td>
<td>600 (air cooled)</td>
<td>Type N 52 ohms</td>
</tr>
<tr>
<td>638A</td>
<td>2000</td>
<td>6000 (water cooled)</td>
<td>3½ Flange 50.0 ohms</td>
</tr>
</tbody>
</table>

**CALORIMETRIC TYPE Primary Standard of RF Power**

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Frequency Range (mcs.)</th>
<th>Power Range</th>
<th>Range of Correction</th>
<th>RF Connectors and Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>151N</td>
<td>100 - 1000</td>
<td>0 - 3; 10; 30; 100; 300</td>
<td>Type N 50 ohms</td>
<td></td>
</tr>
<tr>
<td>152N</td>
<td>200 - 4000</td>
<td></td>
<td></td>
<td>Type N 50 ohms</td>
</tr>
</tbody>
</table>

For more information, write:

M. C. JONES ELECTRONICS CO., INC.
185 N. MAIN STREET, BRISTOL, CONN.

CIRCLE 139 ON READER SERVICE CARD 139
New On The Market

Parametric Amplifiers

**75 Mc BANDWIDTHS**

BROADBAND, Mil Spec parametric amplifiers for applications at L, S, C and X bands are now available from Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Tex. Included is an S-band nondegenerate model that gives bandwidths to 75 Mc at 15 db gain. The increased bandwidth can improve radar detection, target tracking, and communications systems.

Extra wide bandwidth has been achieved by double tuning the amplifier idler circuits. Noise figure, including circulator loss, for the S-band model, is no greater than 3 db from -40 to 50 C. The unit also meets vibration requirements of MIL-E-5400D. Operation under these environmental conditions is possible because the amplifier's passband is considerably larger than that required by an incoming signal. Within the range of characteristics available in the design, noise figures degrade slightly at the upper temperature limits and are dependent on the bandwidth required.

The amplifiers are designed with TI's SC-500 series of gallium arsenide Varactor diodes. Associated devices, such as miniaturized three-port ferrite circulator, pump frequency and power monitor, level set attenuator, and transistorized pump power supply are also available. For some models, solid-state pump sources can be supplied.

Precision Recorder

**THREE CHANNEL**

A 3-CHANNEL instrumentation quality magnetic tape recorder; 2 by 4 by 5 inches, weighing 31 ounces (including 7 ounces of tape), has been introduced by Precision Instrument Co., 1101 Commercial St., San Carlos, Calif. Designed for direct recording from 100 to 5,000 cps, the recorder can operate in any environment where man can live.

The Model PS-303M can be attached to an animal, worn with a flight suit, or carried in a coat pocket; accuracy is unaffected by position or motion. It is also suited for applications where weight and power are critical.

The recorder can also be used with standard IRIG telemetry subcarrier oscillator equipment for multiplexing up to 30 channels of data in the range from d-c to approximately 100 cps.

Power required is 1/2 watt, sup-
Now you can cut precious inches and ounces from your assemblies with space-saving, weight-saving MAX-C Sealcaps.

The surprising increase in range of the Max C trimmer capacitor is obtained by embedding the electrode band in the glass cylinder. This design provides the thin dielectric required for a large capacitance range while retaining the ruggedness and mechanical strength of a heavy wall glass tube.

Included in the Max C design is the Sealcap construction which provides the additional stability safeguard of a completely sealed interior.

### MINIATURE PANEL MOUNT MAX-C SEALCAP SERIES

<table>
<thead>
<tr>
<th>Model</th>
<th>Min. (PF)</th>
<th>Max. (PF)</th>
<th>Distance Beyond Panel</th>
<th>Maximum Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC601</td>
<td>1.0</td>
<td>14.0</td>
<td>29/64&quot;</td>
<td>5/16&quot;</td>
</tr>
<tr>
<td>MC603</td>
<td>1.0</td>
<td>28.0</td>
<td>11/16&quot;</td>
<td>5/16&quot;</td>
</tr>
<tr>
<td>MC604</td>
<td>1.0</td>
<td>42.0</td>
<td>29/32&quot;</td>
<td>5/16&quot;</td>
</tr>
<tr>
<td>MC606</td>
<td>1.0</td>
<td>60.0</td>
<td>1 3/32&quot;</td>
<td>5/16&quot;</td>
</tr>
<tr>
<td>MC609</td>
<td>1.0</td>
<td>90.0</td>
<td>1 3/4&quot;</td>
<td>5/16&quot;</td>
</tr>
</tbody>
</table>

The Max C retains all the advantages of glass tubular trimmers: Working voltage of 1000 VDC, Insulation Resistance of $10^6$ megohms, Q of 500 at 1MC, operating temperature range of $-55°C$ to $+125°C$, and high stability. It meets or exceeds the applicable performance and environmental requirements of Mil-C-14409A.

Escape from the design limitations of conventional trimmers by specifying JFD MAX-C Sealcaps for your current and projected circuitry. Write today for the complete catalog describing MAX-C Sealcaps and other JFD precision electronic components. Other JFD components are...

**FOR PANEL MOUNTS AND PRINTED CIRCUIT MOUNTING**

**SEAL CAP TRIMMER CAPACITORS**

- Glass or Quartz Dielectric
- Distributed Constant Delay Lines
- Filters
- LC Tuners
- Lumped Constant Delay Lines
- Pulse Forming Networks
- Metalized Inductors

Detailed data sheets on any of these components selected from the extensive J.F.D. line are yours for the asking. Our engineering staff is at your service for consultation on your particular application.

### JFD ELECTRONICS CORPORATION

6101 Sixteenth Avenue, Brooklyn 4, New York

**WESTERN REGIONAL DIVISION**

JFD CANADA LTD

51 McCormack Street, Toronto, Ontario, Canada

JFD INTERNATIONAL

15 Moore Street, New York, N.Y.
plied by mercury cells or other low-impedance source. Recording time is one hour at 1½ ips; frequency response is 3 db from 100 to 5,000 cps, with negligible flutter and wow, and signal-to-noise ratio better than 30 db.

CIRCLE 303 ON READER SERVICE CARD

Long Life TWT
6,000-HOUR GUARANTEE

GUARANTEED for a minimum life of 6,000 hours, and operating as a broad band amplifier in the 4,400 to 5,000 Mc range, twt is suitable for unattended microwave stations.

Ease of maintenance is a feature of the tube. Mount and tube are so designed that input and output circuits remain matched when a new tube is inserted in the mount. Operating voltages need no adjustment when new tubes are inserted; for more than 80 percent of the tubes, no focus adjustment will be needed.

CIRCLE 305 ON READER SERVICE CARD

Three-Beam CRT

ELECTROSTATIC DEFLECTION

TRIPLE BEAM 4 x 6-inch rectangular cathode-ray tube, registered as type TBFP, is announced by the Electronic Tube Div., Allen B. Du Mont Laboratories, Clifton, N. J., Div. of Fairchild Camera and Instrument Corp. The tube is electrostatically focused and deflected, and each beam is independently controllable with common accelerator and heater connections. A linear post accelerator together with an advanced gun design gives high deflection sensitivity and brightness. Each beam scans a separate screen area permitting simultaneous displays. All connections, with the exception of the post accelerator, are brought out through base pins for ease of connection, and the screens are metallized for maximum in brightness and stability.

Some operating conditions are: post accelerator voltage of 9,000 v d-c, accelerator voltage of 3,000 v d-c, focusing voltage of 300 to 575 v d-c, grid No. 1 voltage of -70 to -130 v d-c; deflection factors: D1D2, 53 to 73 v d-c per inch; D3D4, 40 to 54 v d-c per inch.

CIRCLE 306 ON READER SERVICE CARD

Insulation Tester
0 TO 5,000 V RMS

PORTABLE nondestructive high voltage insulation tester, continuously adjustable from zero to 5,000 v rms, has been introduced by the Opad Electric Co., 43 Walker Street, New York 12, N. Y. The Model HV53 has a calibrated transistorized high voltage circuit breaker with a continuously settable trip point between 10 and 3,000 μA. Leakage current in excess of the present value immediately disconnects the high voltage, lights a pilot light and sounds an audible alarm.

The unit is arranged for manual, foot switch, or remote control operation, with automatic or manual resetting after tripping. A selector switch provides for guarded or unguarded testing. The tester has a high resistance case and panel; dimensions are 7½ by 3½ by 8½ inches; weight is 8½ lb. The unit is furnished with a standard six-foot 3-wire detachable line cord, two six-foot detachable test leads with locking type panel connectors and an operating manual. Price is $250.

CIRCLE 304 ON READER SERVICE CARD

Electrostatic Printer

10" CHARACTERS/SEC

EXTREMELY high resolution in electrostatic printing tube results from a direct-wiring crt designed by Litton Industries Electron Tube Div., 960 Industrial Rd., San Carlos, Calif.

The screen is a target mosaic
IS AN OUTSTANDING CHARACTERISTIC OF

**AlSiMag Ceramics**

AlSiMag Ceramics offer exceptional resistance to heat and erosion. They have marked electrical and physical stability at elevated temperatures and in varying environments. Chemically inert. Good strength. Can be accurately fabricated in micro-miniatures.

AlSiMag Ceramics include many special purpose ceramics, some especially adapted to hermetic sealing. Widest choice of materials, more than half a century of specialized experience. Send blue print and operating conditions.

ReLIABILITY
IS AN OUTSTANDING CHARACTERISTIC OF

**AlSiMag Ceramics**

AlSiMag pioneered micro-miniature ceramics... some as thin as 0.005". Relatively high strength, superior performance at high temperatures, high frequencies. Excellent record for withstanding fatigue, heat, shock, vibration.

The AlSiMag Ceramics in these multiple pin headers may be safely used up to 2800°F. The metal components are the limiting factors. These tantalum pins with nickel braze alloy operate around 1000°F. All materials are rugged. Strong hermetic seal. Low vapor pressure. High temperature bake-out is practical.

A Subsidiary of
Minnesota Mining and Manufacturing Company

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston, Newton Center, Mass. • Chicago, Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Calif. • New York, Ridgefield, N.J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Calif. • Seattle, Wash. All other exports: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N.Y.
NEW! “TRU-DODO” TIME DELAY RELAYS
Precise electronic time delay with all power removed!
Announcing a new addition to Tempo’s growing product line of high precision electronic timing devices...“TRU-DODO” Time Delay Relays, with fixed time delay periods from .050 to 100 seconds, featuring an advanced circuit design which provides true Delay-On-Drop-Out logic. With this circuit, no power is required during the timing cycle.

SOLID STATE DESIGN
Similar in basic design to Tempo’s service-proved Time Delay Relays with Delay-On-Pull-In action (DOP), these new units include Tempo’s exclusive no-moving-parts solid state timing module plus an output relay to achieve the true Delay-On-Drop-Out logic.

TYPICAL SPECIFICATIONS
Timing Accuracy: ±0.1% of nominal time delay, guaranteed under any combination of rated conditions.
Temperature: -55° to +71°C
Vibration: 20 g’s, 2000 cps.
Shock: 50 g’s, 11 milliseconds.
Acceleration: 20 g’s, steady state, any axis.
Relay Contacts: 2PDT-2 amp resistive.
Input Voltage: 24 to 31 vdc
Current Drain: 60 milliamps max.
Size: 7 cu. in. (for 100 sec. unit)

WRITE FOR BULLETIN 5903-3
Complete technical description and specifications of standard models plus special type variations available.

Mechanical Filters
FOR F-M MOBILE RADIO
Two mechanical filters especially designed for f-m mobile radio equipment have been developed by Collins Radio Company, Western Division, 2700 W. Olive Ave., Burbank, California.

One filter, the F455YA-120, has a 455 Kc center frequency and a passband of 12 Kc. With this filter f-m mobile receivers can be designed to match the ±5 Kc transmitter deviation specified under the FCC split-channel ruling. Because of its sharp cut-off characteristics, the filter keeps interference from adjacent channels to a minimum.

The small size of the filter (approx. 2 inches long and ½ inch in diameter) makes it suitable for compact mobile equipment.

The other filter, F455YA-320, has a 32 Kc bandpass and is especially suited for wideband mobile equipment.

Power Supplies
MICROWAVE TUBE TYPE
MICROWAVE DYNAMICS CORP., Plainview, L. I., N. Y., offers a new concept in microwave tube power supplies in the range 0-2.2 Kt at 0-200 ma max, for use in automatic missile checkout systems and for making exacting microwave measurements in the lab. All potentials, including the d-c heater supply, being very well regulated, increased versatility is achieved by features such as plug-in modulators including a precision 1,000.0 cps square-wave modulator with internal synchronization voltage derived from a tuning fork. A built-in cro for visual observation of the detected signal permits complete integration of the power supply into a microwave system.

Heat Sinks
FOR POWER TRANSISTORS
INVAR ELECTRONICS CORP., 323 W. Washington Blvd., Pasadena, Calif., has available heat sinks for power transistors and diodes especially designed for ease of mounting and stacking. Offering 25 sq. in. of surface area for each in. of length, the
heat sinks provide a large heat dissipating surface while maintaining a minimum overall size. The units were specifically designed to be used singly or in multiple arrays and are furnished with holes for mounting the power transistor, for mounting or “stacking” the heat sinks in a compact array, and for attaching a terminal or resistor board to the heat sink. The finish is electrically conductive and meets MIL-C-5541. Special hole patterns and finishes can be furnished.

**CIRCLE 310 ON READER SERVICE CARD**

Cartridge-Rectifiers
HIGH-VOLTAGE

COLUMBUS ELECTRONICS CORP., 1000 Saw Mill River Road, Yonkers, N.Y., has available a series of high voltage cartridge rectifiers with these specifications: piv from 1,000 v to 6,000 v; d-c current from 100 ma to 200 ma at 25 C ambient; reverse current of 10 μa at fully rated piv at 25 C ambient. Construction of the cartridge units is of nonmetallic material with high dielectric strength, making them ideal for high altitude applications. Other features include lightweight, easy to mount configurations and full check-out to the most rugged military environmental tests.

**CIRCLE 311 ON READER SERVICE CARD**

Centrifugal Blowers
MIL-SPEC LINE

MCLean ENGINEERING LABORATORIES, Princeton, N. J., announces a complete line of Mil-Spec rack-mounted centrifugal blowers. Models are available in panel heights ranging from 3½ to 10½ in. Airflow ranges from 150 cfm to 800 cfm. Motors are 50-60 cycle and 400 cycle a-c single and three-phase, 115-230 v and 440 v. Performance character-

Another in a series of thoughtful observations on the topic of Time goes, you say? Ah no! Alas, Time stays, we go.”

AUSTIN DOBSON, English Essayist, 1840-1921
TWO DIFFERENT TIPS GIVE 2 SOLDERING TEMPERATURES

Merely interchange high and low heat tips for the soldering temperature best suited for the job. Low heat for heat-sensitive soldering...higher heat for regular work. Available with Magnastat Soldering Iron model TC-552.

Magnetron VOLTAGE TUNABLE

EITEL-MCCULLOUGH, INC., San Carlos, Calif. The X-747 magnetron, shown with its magnet and cavity can be electronically tuned over the range of 400-1,200 Mc with a nominal output power of 100 mw. The tube is easy to use. No complicated regulation of heater voltage is needed; and heater power supply can be either a-c or d-c. Back heating is eliminated through Eimac's indirectly-heated matrix cathode and through the advanced electron injection design of the X-747. In addition, the extremely linear tuning characteristics of the X-747 greatly simplify circuit design.

Phase Meter & PHASE SHIFTER

DYTRONICS CO., 5485 N. High St., Columbus 14, Ohio. Model 341 phase meter and phase shifter was designed especially for high accuracy phase measurements between fundamental components in the presence of severe harmonic distortion. For example, it will measure the phase difference between two signals with an absolute accuracy of 0.1 deg in the presence of 200 percent 3rd harmonic content. All harmonics are rejected by more than 80 db. The instrument characteristics of all units are thoroughly checked and tested in the company's air-flow test chamber.

Weller MAGNASTAT®
CONTROLLED TEMPERATURE SOLDERING IRONS

- Automatically maintain correct soldering temperature
- Weigh only half as much as uncontrolled irons
- Give greater heat efficiency with lower wattage

Plus these advanced features for greater efficiency:
- Various tip types now available
- New tip retaining nut minimizes freezing
- New rubber shock absorber prevents sliding
- New, rugged, non-arcing snap switch
- Handle stays cool
- New cord connection locks cord securely in place, yet permits easy replacement
- 2 or 3-wire cords available.

3 MAGNASTAT SOLDERING IRONS ARE AVAILABLE

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Wattage</th>
<th>For Heat-Sensitive Soldering</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC-552</td>
<td>55 watts</td>
<td></td>
<td>$900</td>
</tr>
<tr>
<td>TC-602</td>
<td>60 watts</td>
<td>Light to medium soldering</td>
<td>$1000</td>
</tr>
<tr>
<td>TC-1202</td>
<td>120 watts</td>
<td>Medium to heavy soldering</td>
<td>$1150</td>
</tr>
</tbody>
</table>

Prices shown are for Magnastat Iron with tip and 2 wire cord.

Send for NEW literature on Weller MAGNASTAT Soldering Irons.

performs with full accuracy and resolution at signal levels as low as 10 mv with useful operation at 1.0 mv. The null meter sensitivity may be set for 1 deg, 10 deg, or 100 deg for full scale indication. Other features include a 10 megohm input impedance, direct reading of phase angle in degrees, and continuous 0 to 360 deg phase coverage. Price is $850.

CIRCLE 318 ON READER SERVICE CARD

Preamplifiers

TRANSISTORIZED

RADIATION ELECTRONICS CO., division of Comptometer Corp., 5600 Jarvis Ave., Chicago 48, Ill. Compensated from -5 F to 125 F, a new series of transistorized preamplifiers have a noise figure of less than 2 db, operate from self-contained batteries, and are provided with battery condition indicator. Model TA-4 is designed for use with source impedances ranging from 5 to 24 ohms or 25 to 100 ohms and provides a maximum gain of 50,000 over a bandwidth of 10 cps to 1 Mc. Model TA-5 is used with source impedances of 100,000 ohms or less and provides a maximum gain of 1,000 over a bandwidth of 5 cps to 1 Mc. Use of the TA-4 and TA-5 will extend the sensitivity of oscilloscopes, vtm's and noise measuring instruments and will permit realization of near-ultimate performance of low and high impedance transducers.

CIRCLE 319 ON READER SERVICE CARD

Traveling-Wave Tube

SOLENOID FOCUSED

HUGGINS LABORATORIES, INC., 999 East Arques Ave., Sunnyvale, Calif., announces a Ku-band, solenoid-focused twt amplifier with broadband performance. The HA-82 has a frequency range of 10,000 to 20,000 Mc with a small-signal
Whether you're working with solar energy in space, ground test check-out equipment or anything in between... if your problem is power and the environments are extreme, ITT provides compact, efficient system solutions in the areas of:

- Conversion
- Regulation
- Inversion
- Control

This total power capability has been proved in such customized designs as unique airborne multiple-output primary DC power supplies... complete power conversion packages for test vehicle check-out systems... aircraft missile launcher power supplies... and in many other weapons systems and space exploration projects.

To accomplish these lightweight, ruggedized packages, ITT takes your power problem at the design inception, carefully analyzes the load and draws upon a vast inventory of design and application data to develop fast, economical solutions.

ITT's total power capability is readily available to solve your toughest power problems. Contact your ITT Power representative or write for Data File E-1284-1.

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Overspeed Governor
MINIATURIZED

PITOMETER LOG CORP., 237 Lafayette St., New York, N. Y., has developed a miniaturized electronic overspeed governor for aircraft and other high-speed engines. Completely transistorized and designed to withstand extreme military environments, the new governors are available as both on-off and servo control types. Provision has been made to allow the engine that the units are meant to control to run at half speed for testing, eliminating the need to over speed the engine when testing the governors. The units are available with accuracy as high as 0.5 percent.

CIRCLE 321 ON READER SERVICE CARD

Microwave Absorber
THIN, FLEXIBLE

MC MILAN INDUSTRIAL CORP., Brownville Ave., Ipswich, Mass., now offers a new, tougher version of the type T microwave absorber. With the same high electrical performance as before, it covers the usual radar frequencies as well as...
special frequencies. The metal foil back of the absorber has been covered with a rubberized cloth which meets MIL-C-20696 and prevents accidental tearing of the foil. Improved physical characteristics include: (1) about 30 percent lighter than before; (2) standard temperature range now — 70 to 270 F, wider ranges on special order; (3) greater physical integrity and easier handling. Standard 18 in. by 36 in. sheets from stock—preforms and special dimensions on short notice.

**CIRCLE 322 ON READER SERVICE CARD**

**Wheatstone Bridge**
**HAS DIGITAL ACCURACY**

**MILLIVAC INSTRUMENTS**, division of Cohu Electronics, Inc., Box 997, Schenectady, N. Y., announces its new MV-276A electronic Wheatstone bridge, possessing digital accuracy (0.05 percent) and an exceptionally wide measuring range—1 ohm to 1,000 megohms. It has a "calibrated unbalance" which makes it possible to read many similar resistances directly without balancing each time. A compact, rugged, portable 12 in. by 8 in. by 9 in. housing contains the complete bridge, electronic null detector and power source.

**CIRCLE 323 ON READER SERVICE CARD**

**Right Angle Probe**
**MEASURES COATINGS**

**UNIT PROCESS ASSEMBLIES, INC.,** 61 E. 4th St., New York 3, N.Y. announces a right angle probe for use with the Dermitron nondestructive coating thickness tester. Each coating thickness reading takes

**CIRCLE 149 ON READER SERVICE CARD**
THE MOST RELIABLE SOLUTION TO MANY ELECTRONIC PROBLEMS CAN BE FOUND IN THE PALM OF YOUR HAND WHEN YOU USE...

VECO THERMISTORS AND VARISTORS

What better way to prove to yourself the reliability of VECO Thermistors and Varistors than by testing them under the actual environmental conditions in which they are to be used? VECO Thermistor and Varistor Circuit Design Kits give you the opportunity of doing this to your complete satisfaction. In kit form they cost so much less — and each kit presents a full range of resistance values of the various bead, disc, rod, and washer type Thermistors or a wide assortment of standard Varistors. Here's your opportunity to put stock Thermistors and Varistors through your toughest quality control tests. Once you've tried them you'll agree — VECO is the leader in reliability.

**VECO Products:**
- Thermistors
- Varistors
- Chopperettes
- Combustion Analyzers
- Thermistors, Catheters and Needles
- Matched Thermistors
- Thermal Conductivity Cells
- Hypsometers
- LOX Thermistors
- Any many others.

**VECO Glass Enclosed Thermistors** are not adversely affected by radiation. Our quality control processes are accepted under MIL-Q-3923 standards.

FRE E:
To learn more about VECO Circuit Design Kits write for folder SE102

101 SPRINGFIELD ROAD, UNION, N. J. • MURdock 8-7150

**Mixer Preamplifiers**
FOR UHF, MICROWAVE
ORION ELECTRONIC CORP., 108 Columbus Ave., Tuckahoe, N.Y. With this complete line of matched mixer preamplifier units, featuring symmetrical bandpass, specified gain and noise figure, a designer of a uhf or microwave receiver can obtain optimum performance. Units can be delivered within 90 days. A free catalog is available.

CIRCLE 325 ON READER SERVICE CARD

**Modular Heat Sink**
USES INTEGRATED BLOWER
ASTRO DYNAMICS, INC., 200 Sixth St., Cambridge, 42, Mass., introduces transistor heat sink building blocks which offer outstanding heat dissipation and flexible packaging characteristics. Model 2401 makes use of a light, compact, integrated blower and permits use of power transistors at 2 to 3 times previous achievable ratings. While dissipating almost 60 w at 25 C ambient temperature, this heat sink has a thermal resistance between transistor shelf and air of less than 0.8 C/w. Because of a newly developed...
Variable Resistor

CONTINUOUS ROTATION

CTS Corp., Elkhart, Ind., has designed a new 360 deg continuous rotation composition variable resistor which increases effective rotation from approximately 270 deg to 360 deg. Exact resistance adjustments are easier because of this approximately 20 percent increase in rotation for the same incremental resistance change. After each effective rotation, the contact arm returns from maximum to minimum resistance without opening the circuit. Series CR45 has a 1/4 in. diameter and the same 37 in. depth as the standard series 45. Resistance range is 250 ohms through 10 megohms with linear resistance gradient. Rating is 1/2 to 1/2 w depending on resistance value. Maximum operating voltage from terminals to bushing is 750 v d-c with a high pot test of 1,000 v a-c for 1 minute.

CIRCLE 327 ON READER SERVICE CARD

Converter

DIGITAL-TO-ANALOG

DAXEX CORP., 1307 S. MYRTLE AVE., MONROVIA, CALIF. Digital-to-analog converter generates an analog out-

A Variety

OF WAVEFORMS...

now available to your requirements!

THE
tensor
5846 ARBITRARY
FUNCTION GENERATOR

$49500 F.O.B.
Brooklyn, N.Y.

In addition to producing standard sine, triangular and square waveforms, the Model 5846 can generate arbitrary functions as desired by changing cam shapes.

Specific waveshapes are quickly formed by inserting appropriate cams into the instrument. Cams for desired functions are available from the factory, or can be easily constructed from enclosed instructions.

Tensor's Arbitrary Function Generator comes equipped with two cams... one for sine wave... one for triangle wave. The square wave, at the function frequency, is of adjustable phase and symmetry. It is always available regardless of the function being generated.

APPLICATIONS:

The Tensor Arbitrary Function Generator is extremely flexible because of (1) the infinite variety of waveforms that can be produced, (2) the wide frequency range and (3) provision for suppressed carrier modulations. Listed below are typical applications:

AC or DC servo testing
Vibration machine programming
Medical electronics
Input to analogue devices
Process control testing
Any application where electrical simulation of mechanical, physiological, biological or hydraulic functions is desired.

SPECIFICATIONS:

Frequency Range: .001 to 10 cps in four ranges
Output Voltage: 10 volts peak to peak, adjustable
Load Requirements: 10K or greater
Output Function: Cams supplied for sine and triangle waveforms
Sine Wave Distortion: 3% harmonic
Triangle Wave Distortion: ±3% deviation from a straight line
Power Requirements: 50 watts at
115 VAC 60 cps
put signal proportional to a binary coded decimal input. The DA-102 is designed for dual-channel input, each channel consisting of three decimal digits and signs (+ or −) indication. It has two output ranges, 0-10 v full scale and 0-20 v full scale. These ranges are selected by a mercury relay operated by an external contact. Designed for standard relay rack mounting, the new unit contains 30 mercury relays and two ratio transformers. A front-panel lamp display indicates input data in 8421 BCD form.

**CIRCLE 328 ON READER SERVICE CARD**

**Electronic Timer**
**TRANSISTORIZED**
SYRACUSE ELECTRONICS CORP., P.O. Box 566, Syracuse 1, N.Y. A new rugged subminiature (2 by 2 by 2½ in.) transistorized electronic timer offers a wide range of selection in timing ranges and physical mounting. Standard units are plug-in with 2 pdt 5 ampere resistive contacts. Model TR-302 operates on 115 v a-c, other voltages are available. Repeat accuracy of 0.2 percent can be guaranteed. The unit is unaffected by voltage, temperature, and line transient. List price is $73.60 and discounts to $44.16 in quantities. Samples are available from stock, production quantities in 2 to 4 weeks.

**CIRCLE 329 ON READER SERVICE CARD**

**Tiny Feedthrough**
**EXTRA-LONG PIN**
SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N.Y. Significant feature of the Press-Fit type FT-SM-16L6 feedthrough is the extra-long
pin, permitting extra “reach” combined with a small diameter Teflon body for space-saving on the mounting chassis. Overall length is 0.987 in., while the Teflon body is 0.093 in. diameter through-chassis, and 0.125 in. diameter through mounting shoulder. The unit is designed for use with chassis having a maximum thickness of 0.060 in.

**CIRCLE 330 ON READER SERVICE CARD**

Multiple Power Supply
COMPACT, RUGGED

**HARVEY-WELLS ELECTRONICS, INC.,**
14 Huron Drive, Natick, Mass., has introduced a new low-cost multiple power supply for use in custom digital systems. Model B data power unit is a compact, rugged standard product that will provide all of the voltages required for the operation of most medium-size digital systems. The versatile unit is designed for 19-in. standard relay rack mounting to permit quick installation in custom systems. Price is $598.

**CIRCLE 331 ON READER SERVICE CARD**

Generator-Detector
HIGH PERFORMANCE

**ELECTRO SCIENTIFIC INDUSTRIES, 7524 S.W. Macadam, Portland, Ore.**
Model 800-R generator-detector is a combination of a variable power supply and a sensitive microvoltmeter. The generator provides 6 output ranges to match loads from 1 ohm to 100 kilohms. The output is continuously variable from 0 to 1 W into a matched load. The isolation and guarding make the 800-R particularly applicable to high accuracy bridge measurements. The detector

**CIRCLE 153 ON READER SERVICE CARD**

**ENGINEERING IS PART OF THE RELIABILITY PATTERN AT ELECTRO-TEC**
Highly creative, but infinitely profound engineering is basic to the reliability pattern at Electro-Tec. A product is designed with built-in reliability. It doesn't stop with basic design...all phases of engineering proceed with a comprehension of the natural laws that insure reliability—the spark that extends product capability and performance beyond the expected. **ELECTRO-TEC CORP.,** South Hackensack, N.J.—Blacksburg, Va.—Ormond Beach, Fla.
Headquarters for
INSULATION TESTING

High Voltage Breakdown ... Leakage Current Measurement
of Assemblies, Components and Materials

HYPOT® High Potential Test Sets provide accurate, direct-reading measurement of insulation leakage current for over-potential tests to applicable commercial and military specifications.

10 kv Insulation Testing ... Portable HYPOT® Jr.
Insulation testing at a-c potentials with separate indication of leakage current and insulation breakdown. Optional features including audible "squeaker" leakage current indicator with provision for external control circuits, meet needs of high production and automated test installations. Model 404 HYPOT® Jr. is designed for insulation testing of components, assemblies, and cables. Output variable 0 to 4000 v a-c, read on 4½" meter. Leakage limit adjustable from 0.3 to 3.0 ma. Arcing and corona signalled by separate indicator light. Operates from 110-120 v, 50/60 c outlet. Measures 6" x 9" x 8½". Weight is 20 lbs. Net, complete .............................................. $150.00

Insulation Leakage .02 mma to 10 ma ... Potentials to 30 kv
Bench HYPOT® Test Sets, a-c and d-c models, have outputs to 30 kv. Separate 4½" meters for test voltage and leakage current. Wide selection of models to meet specific applications. Model 424 Bench HYPOT® provides 0-5000 v d-c for testing cables, condensers, coils, transformers, motors and complete assemblies. Measures leakage current from 0.1 microamperes to 100 microamperes for four scale ranges. Rapid testing of capacitors with output of 5 milliamperes under short circuit. Operates from 110-120 v, 50/60 c outlet with long-life selenium high voltage supply. Net complete .............................................. $497.50

Test Potentials 150 kv and up
Mobile HYPOT® Test Sets offer potentials to 150 kv and higher. Power source and metering circuits in a single, mobile cabinet. Write for new HYPOT® Catalog.

Insulation Materials Tester ... ASTMSpecs.
Fixtures for Tape, Film, Liquids and Solids
Dielectric strength of materials determined to laboratory accuracy ... yet speed and simplified operation meet needs for production and quality control applications. Transparent test cage with safety interlocks is optional as well as automatic rate of rise control. Interchangeable fixtures available for varnishes, porcelain, oils, solid filling compounds, paper, tape, acetate sheets, films, tubing and cloth. Prices start at $1175.00. Write for bulletin describing the Model 4501 HYPOT® Materials Tester.

NEW!
Complete Catalog
Write today for new "Manual on Insulation Testing" describing the complete range of HYPOT® Test Sets and VIBROTEST® Resistance Measuring Instruments.

Instruments for measuring
- Insulation Resistance ... the VIBROTEST®
- Ground Resistance ... the VIBROGROUND®
- Earth Resistance ... the VIBROGROUND®
- High Voltage Breakdown, AC-Dc ... the HYPOT®
- Special instrumentation for laboratory, production, and maintenance needs

Microwave Filter
ETCHED CIRCUIT
RS ELECTRONICS CORP., 435 Portage Ave., Palo Alto, Calif. Model 1201 is a four-channel etched circuit microwave filter with built-in video detectors designed to cover an extremely wide input dynamic range. Each channel has a bandpass of 2,600 to 3,200 Mc at a maximum input vswr of 2:1. The video detector in each channel has a tangential sensitivity of -40 dbm (minimum). The dynamic range is obtained by the use of two type IN833 silicon diode detectors in parallel, one operated at full sensitivity, and the second through a 14.5 db coupler. Filter dimensions are 6.15 in. diameter and 0.7 in. thick, excluding connectors.

Subminiature Relay
RUGGED TYPE
FILTORS, INC., Port Washington, N.Y. Series V subminiature relay is designed to meet the most severe environmental requirements of present-day prototype missiles. It
is designed in its entirety using data from Filters' relay motor analyzer—an instrument developed to check all important relay parameters under dynamic conditions. The V relay header has improved bounce characteristics which increase contact life and reliability, and enhance relay performance under severe vibration and shock. There is no increase in relay motor size because the new relay motor has greatly increased efficiency. V-series relays are available with or without arc-inhibiting circuits and with either a-c or d-c relay motors.

CIRCLE 334 ON READER SERVICE CARD

Variable Phase Standard SELF-CONTAINED UNIT

GERTSCH PRODUCTS, INC., 3211 South La Cienega Blvd., Los Angeles 16, Calif. Model VPS-1 variable phase standard permits phase between two self-generated voltages to be shifted to any desired angle, with an accuracy of ±0.05 deg or better. Instrument generates two signals of equal amplitude, differing in phase by any angle from 0 to 360 deg, as determined by front panel controls. The reference signal has a fixed amplitude of 50 v rms. Vector output, which may be displaced in phase, has a maximum amplitude of 50 v rms, and can be attenuated in steps of 50 mv within the range of 0-50 v rms. A front panel selector switch permits operation at any of three frequencies within the range of 150 to 3,000 cps, variable ±5 percent maximum.

CIRCLE 335 ON READER SERVICE CARD

Time Delay Relay SMALL SIZE

LAND-AIR, INC., 16226 S. Broadway, Gardena, Calif. MP-446 series of small time delay relays employ transistorized R-C time constant net-
Airpax presents
the FIRST Miniature, Magnetic, Hermetically Sealed
CIRCUIT BREAKER...

...with an isolated
SPDT INDICATION CIRCUIT

• Trip-free action  • Inverse time delay
• Trip level independent of ambient temperature
• Dual-way indicating circuit

Send for detailed information

CIRCLE 336 ON READER SERVICE CARD

Spectrum Analyzer
0.001 TO 200 CPS

GENERAL APPLIED SCIENCE LABORATORIES, INC. Merrick & Stewart Aves., Westbury, L. I., N. Y., has announced the SA-11 spectrum analyzer system for applications in seismology, underwater acoustics, shock and vibration analysis, heartbeat analysis and speech analysis. Signals may be analyzed in any one of 6 different scales within the range of 0.001 to 200 cps on a real time basis. Selectivity on the lowest scale is 0.0037 cps, while on the 200 cps range selectivity is 0.75 cps. Of particular interest are the applications in data processing of acoustic, seismographic and biological signals.

CIRCLE 337 ON READER SERVICE CARD

Strain Gage Indicator
HIGHLY SENSITIVE

DAYTRONIC CORP., 225 S. Jefferson St., Dayton 2, Ohio. Accurate indication or recording of static and dynamic strain gage measurements is achieved with the model 800
Antenna Systems, Inc., is devoted exclusively to the design, fabrication and installation of antenna systems in the fields of scatter communications, missile tracking, space tracking, radar and surveillance, radio astronomy, and special antenna products. We invite your inquiry, whatever your antenna problem may be. Write for our folder.

CIRCLE 225 ON READER SERVICE CARD

Metal Parts
WIDE VARIETY

THE CLY-DEL MFG. CO., Sharon Road, Waterbury 20, Conn. Production of new parts at this company includes those made from metal which has been blanked to diameters of six inches and drawn into shells as deep as three-and-one-quarter inches. The electronic and missile industries should be particularly interested in this for component parts in a wide range of products. Picture shows some of the typical productions including several of the larger parts.

CIRCLE 339 ON READER SERVICE CARD

Microwave Equipment
BROAD BAND

INDUSTRIAL TELEVISION, 7270 Beverly Blvd., Los Angeles 36, Calif., announces development of a line of broad band microwave equipment. Operating in the 5,900 Mc to 7,600 Mc and 10,500 Mc to 13,200 Mc bands, it can be used for point-to-point f-m transmission of television signals, multiple voice communication channels and high-speed data information. Both systems are capable of NTSC color transmission.

CIRCLE 340 ON READER SERVICE CARD
Amazing NEW Pencil-Type Epoxy offers almost unlimited applications to industry

For the first time . . . a single component epoxy in stable stick form. The New Cetron Epoxy Pencil offers a simple solution for most problems involving bonding, cementing, sealing and insulating. In pencil-stick form, the new epoxy is handy to use. In many instances it offers the only practical means of applying epoxy to minute objects and hard-to-get-at places.

The New Cetron Epoxy Pencil is always ready for use . . . requires no refrigeration or special storage . . . nothing to mix. The New Cetron Epoxy Pencil is simple to apply . . . cures fast to a tough, permanent waterproof bond . . . unaffected by most oils and solvents.

WRITE FOR FURTHER INFORMATION
CETRON ELECTRONIC CORPORATION
Plastics Division
2265 E. Foothill Blvd., Pasadena, California

NEW CURVED brazing washers and shims

The operator no longer needs three hands to put the components together!
Applications on which one tube is radiused or saddled to fit over another are sometimes difficult to preform with a washer or shim. The stiffness of the washer may hold the radiused member away from the other tubes. By curving the washer to the curvature of the tube, the problem is minimized. Curving a shim permits snapping of the shim onto the tube.

LUCAS-MILHAUPT Engineering Co.
5051 South Lake Drive, Cudahy, Wisconsin

NOW! NEW LOWER PRICED COIL FORMS
Interchangeable with industry standards


Waters MANUFACTURING, INC.
WATERTOWN, MASS.

ALSO AVAILABLE IN EXCLUSIVE RIBBED DESIGN
CIRCLE 218 ON READER SERVICE CARD electronics
How to hit the jackpot...

IF YOU HAVE A MOISTURE PROBLEM, Waters APW½ sealed potentiometer is so watertight and heat resistant, it operates reliably even in boiling water. Completely unaffected by humidity and water vapor, two common causes of pot failures in aircraft and missiles. Also available with servo face as Waters WPW½. Write for bulletin APW.

IF YOU REQUIRE A HERMETIC SEAL, Waters APH½, designed for soldering directly to the panel, not only maintains a hermetic seal behind the panel, but is itself tightly sealed against outside atmosphere and salt spray by means of double “O” ring shaft seal. Passes liquid immersion tests per MIL-E-5272A and, excluding the shaft, the Mass Spectrometer Test with leak rate less than $1 \times 10^{-7}$ cc/sec. N.T.P. Write for bulletin APH.

IF YOU WANT TO READ A FUNCTION OF RESISTANCE DIRECTLY, Waters Dialpot® gives you the answers to these questions: Where is the slider? At what angle is the pot set? At what percentage of voltage is the pot set? Dial calibrated with equal graduations from 0 to 10 in the 300° winding angle. Scribe line on base. Plug-in feature is ideal for printed circuitry. Write for bulletin APD.

WATERS MANUFACTURING, INC. • WAYLAND • MASS.

January 6, 1961
for Accuracy
in Precision Test Receivers

THE AIL TYPE 132

This high precision instrument combines a high gain, low noise figure, intermediate frequency receiver with a secondary standard of attenuation to deliver extremely accurate measurements in a variety of applications:

- Convenient and accurate method for the measurement of NOISE FIGURE.
- Ideally suited to high accuracy, quick laboratory calibration of rf attenuators at all frequencies.
- Rapid and accurate in measurement of the selectivity characteristics of rf filters, preselectors and similar devices.
- Valuable for measurement of coupling factors and directivities.

The Type 132 is designed to operate from the i-f output of a wide variety of standard microwave mixers. In combination with these and a suitable local oscillator it becomes a sensitive detector of microwave energy.

Write for descriptive literature.

AIRCUT-URNE INSTRUMENTS LABORATORY
DEER PARK, LONG ISLAND, NEW YORK
A DIVISION OF CUTLER-HAMMER, INC.

new GEN-PRO
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New single row Taper Pin Terminal Board available in 10 or 20 feed-thru type taper receptacles, single and double feed-thru connections. Ideal for computer and data processing programming, multi-channel communications systems, etc.

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Beverly Hills, California

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WRITE FOR BULLETIN V1090.

DIVISION OF DYNAMICS CORPORATION OF AMERICA
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- Accuracy within 3% of full scale; a four-terminal measuring system eliminates errors due to clip and lead resistance.
- 2 microwatts maximum dissipation across sample.
- No calibration or zero adjustments.
- Instantaneous indication of resistance without zero drift or errors due to thermal EMF's.
- Lightweight and portable. Furnished with protective cover and set of four test leads.

Details about the Model 502 Milliohmeter are available in Keithley Engineering Notes, Vol. 6 No. 3. Write for your copy today.

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January 6, 1961
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**electronics sells the engineering team...**

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**McGraw-Hill Publication, 330 West 42nd Street, New York 36, N.Y.**

January 6, 1961
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Mr. J. P. Thatcher, Employment Mgr.
RCA Service Company, Dept. BM-4A
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Electronic Designers’ Handbook by Landers, D. Davis, and A. Alger. Describes practical design data on electronics circuits for all types of equipment.
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System Engineering—An Introduction to the Design of Large-scale Systems. An introduction to solving problems of large-scale systems.
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inter-industry conference on
ORGANIC SEMICONDUCTORS
April 18 and 19, 1961
The Morrison Hotel, Chicago, Illinois
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ARMOUR RESEARCH FOUNDATION
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and electronics
a McGraw-Hill publication

Technical sessions of invited and contributed papers on the
present state and future potential of organic semiconductors
in the electronics, chemical, and semiconductor industries.

Invited papers will cover the following areas:
David Fox, State University of New York
Theoretical Aspects of Electrical Transport
R. G. Kepler, E. I. DuPont de Nemours and Company
Conductivity in Anthracene Single Crystals
Jan Kommandur, National Carbon Research Laboratories
Characteristics of Charge-Transfer Complexes
Oliver Le Blanc, General Electric Research Laboratories
Interpretation of Conductivity in Molecular Crystals
Herbert A. Pohl, Princeton University
Electrical Properties of Pyrolyzed Polymers
Marvin Silver, Office of Ordnance Research
Surfaces and Contacts in Organic Semiconductors

For further information contact James J. Brophy, Co-Chairman,
Physics Division, Armour Research Foundation, Technology Center, Chicago 16, Illinois.

Literature
of the Week

HORIZONTAL-FORCe MOUNT
Barry Controls, division of Barry Wright Corp., 700 Pleasant St., Watertown 72, Mass. Bulletin 60-04.14 contains detailed information on the new horizontal-force mount, series RM.
CIRCLE 341 ON READER SERVICE CARD

SUBMINIATURE RELAYs
Filters, Inc., Port Washington, N. Y. An engineering bulletin on the series "Y" subminiature relay includes features, applications, mounting styles, type designation and detail data.
CIRCLE 342 ON READER SERVICE CARD

VOLTAGE COMPARATORS
Non-Linear Systems, Inc., Del Mar, Calif. A two-color, six-page bulletin on the series 50 transistorized voltage comparators used for critical go/no-go applications is being offered.
CIRCLE 343 ON READER SERVICE CARD

LEADS AND TERMINALS
AMP Inc., Harrisburg, Pa. Complete specifications for a new line of leads and terminals for high-altitude, high-voltage power transmission requirements, are given in a new six-page folder.
CIRCLE 344 ON READER SERVICE CARD

SERVO - ACCELEROMETER
Kistler Instrument Corp., 15 Webster St., North Tonawanda, N. Y. Details of a new, miniature, ruggedized linear servo-accelerometer for missile, aircraft, and other circuitry uses are contained in the illustrated data release 116900.
CIRCLE 345 ON READER SERVICE CARD

D-C POWER SUPPLIES
Rapid Electric Co., Inc., 2881 Middletown Road, Bronx 61, N. Y. Brochure MA-1 presents static-regulated d-c power supplies from 5 amperes 6 v to 1,500 amperes 22-29 v. Regulation, ripple, dimensions, components and general design are detailed.
CIRCLE 346 ON READER SERVICE CARD

SYSTEMS FACILITIES
Monitor Systems Inc., Fort Washington,
Pa., has available a brochure describing its facilities for the engineering and production of advanced high speed monitoring and automatic checkout systems.

CIRCLE 347 ON READER SERVICE CARD

CLUTCHES AND BRAKES Technology Instrument Corp., 531 Main St., Acton, Mass., has available a four-page brochure with performance characteristics graphically illustrated and data describing the fast response of both Electronic magnetic dry particle clutches and brakes.

CIRCLE 348 ON READER SERVICE CARD

TRANSISTOR AMPLIFIER Harco Laboratories, Inc., New Haven, Conn. Bulletin 204 illustrates and describes a new high gain, low power drain, plug-in type transistor amplifier designed especially for thermocouple null device application in environmental temperatures ranging from -100°F to +175°F.

CIRCLE 349 ON READER SERVICE CARD

FERRITE MATERIALS Krystinel Corp., Fox Island Road, Port Chester, N.Y. First of a series of data, stock and price sheets deals with a line of threaded ferrite tuning cores.

CIRCLE 350 ON READER SERVICE CARD

SPECTRUM ANALYZER General Atomics Corp., One Bala Ave., Bala-Cynwyd, Pa., has published a brochure describing its spectrum analyzer, and electronically synthesized filter bank that permits operator control of bandwidth, frequency spacing, and frequency group location.

CIRCLE 351 ON READER SERVICE CARD

ELECTRICAL MEASURING STANDARDS Sensitive Research Instrument Corp., 310 Main St., New Rochelle, N.Y., has available an 8-page brochure and a price list on a line of electrical measuring standards.

CIRCLE 352 ON READER SERVICE CARD


CIRCLE 353 ON READER SERVICE CARD

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RFL Model 1890 Gaussmeter

measures flux densities from 0.1 to 20,000 gauss with 0.1-gauss resolution

Sensitive enough to register half-scale deflection for the earth's magnetic field, the Model 1890 provides a selection of 14 overlapping ranges from 1 gauss full-scale to 20K gauss. Accuracy over all ranges, using standard reference magnet, is better than 3%, with repeatability of meter readings better than 0.5%.

Temperature stable, InAs flat and axial probes are encapsulated in glass reinforced epoxy for durability and safe use around exposed electrical circuits.

The indicating meter is calibrated in gauss, has mirror scale, knife edge pointer and can be adjusted to four positions for most comfortable reading.

Meter has flexible leads, can be removed from cabinet and placed next to magnet structure being measured for most accurate reading. Jacks for external recorder output (1 ma. into 1500 ohm max.) and oscilloscope (2 volts max.) are also provided. Choice of plug-in AC supply or battery pack for portable or field use. Price $430. with flat probe and battery supply.

Performance is rigidly guaranteed.
Prices are f.o.b. Boonton, N.J.
and subject to change without notice.

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January 6, 1961

CIRCLE 171 ON READER SERVICE CARD
Clevite Settles in $4-Million Plant

CLEVITE TRANSISTOR recently moved into a new 164,000-sq-ft plant on a 43-acre plot of land in Waltham, Mass. The acreage provides two large parking areas and ample space for expansion. Total cost of the building, grounds and equipment is approximately $4 million.

The company was organized early in 1952 in Cambridge, Mass., and shortly thereafter moved to Brighton, Mass., where the first products developed were point contact transistors, plastic encapsulated gold bonded diodes and an electronic instrument called the Transtester. The plastic encapsulated gold bonded diodes were the forerunners to Clevite's present diode.

Transistor Products, the original name of the company, was purchased by the Clevite Corp. in 1953. Early in 1954 the company began manufacturing germanium power transistors. With increased production, greater space was needed so the firm moved into the Waltham Watch plant in Waltham, Mass.

By 1959 business had grown at such a rapid rate it became apparent that in a very short time even the Waltham Watch plant would not have adequate floor space. It was decided to build a new semiconductor plant, and wheels were set in motion for Clevite Transistor's present building, a striking example of modern industrial architecture.

Earlier this year Clevite purchased the Shockley Transistor Corp. of Palo Alto, Calif. This major expansion brought to Clevite William Shockley, co-winner of the 1956 Nobel Prize in Physics for his work in the development of the transistor. Acquisition of the Shockley organization has materially increased Clevite's semiconductor research and development capabilities. It has also added new products, such as the four-layer diode. New facilities are already required to satisfy growing demand for this diode, says the company.

Burroughs Promotes D. N. MacDonald

DUNCAN N. MACDONALD has been appointed director of engineering for the ElectroData Division of Burroughs Corp., Pasadena, Calif. He has been associated with this Pasadena facility since 1951.

Schaevitz Hires Louis D'Angelo

APPOINTMENT of Louis D'Angelo, engineering projects administrator, is announced by Schaevitz Engineering, Penasauken, N. J.

The engineering projects administrator, a new position at the company, was created to supervise all aspects of projects administration and cost control functions.

D'Angelo was previously associated with the Philco Corp. and with Vertol Aircraft.

Clary Corp. Names Design Engineer

APPOINTMENT of Hans-Joachim Kunzke as special design engineer for computer and electronic data processing products is announced by Hugh L. Clary, president of Clary Corp., San Gabriel, Calif.

Kunzke has had wide experience in development and design engineering with leading German manu-
Stocked for off-the-shelf delivery! **AUDIO CABLES**

- **UNSHIELDED AUDIO CABLE** Each conductor tinned copper, plastic insulation, color coded, conductors twisted. Available with or without plastic jacket in 2 or 3 conductors. Wire sizes 12-22, solid and stranded.
- **SHIELDED MICROPHONE CABLE** Each conductor stranded tinned copper, color coded, braided tinned copper shield, insulation polyethylene or rubber, with either plastic or rubber jacket overall. Available from 1-6 conductors in wire sizes 18-26 stranded.
- **SHIELDED AUDIO CABLE** Each conductor tinned copper, plastic insulation, color coded, conductors twisted, braided, tinned copper shield overall. Available with or without plastic jacket in wire sizes 12-30.
- **SHIELDED MULTI-CONDUCTOR CABLE** Each conductor stranded tinned copper, rubber insulation, color coded, braided tinned copper shield, cotton wrap, tough black rubber jacket. Available up to 10 conductors in wire sizes 18 and 20.
- **PLASTIC INTERCOM CABLE** Each conductor tinned copper, plastic insulation, conductors color coded, twisted into pairs, gray vinyl plastic jacket overall. Available from one pair to 101 pairs in wire size 22, solid and stranded.
- **UNSHIELDED RUBBER CABLE** Each conductor stranded tinned copper, rubber insulation, color coded, conductors twisted, cushioned with cotton fillers, cotton wrap. Available up to 10 conductors in wire size 22.
- **MULTI-CONDUCTOR AUDIO CABLE** Each conductor tinned copper, shield, insulation, conductors color coded, twisted into pairs, gray vinyl plastic jacket overall, or brown cotton braid. Available up to 20 conductors in wire sizes 20 and 22 stranded.
- **SHIELDED PLASTIC JACKETED CABLE** Each conductor stranded tinned copper, plastic insulation, color coded, conductors twisted, spiral wrapped copper shield, gray vinyl plastic jacket overall. Available from 1-4 conductors in wire sizes 16-22.

**ALPHA WIRE CORPORATION** Subsidiary of **LORAL** Electronics Corporation

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**CIRCLE 227 ON READER SERVICE CARD**

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**JOELIN SPACE-AGE PLASTICS**

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For a confidential discussion, please write: C. E. Fitzgerald

Laboratory For Electronics
1079 Commonwealth Avenue
Boston 15, Massachusetts

LABORATORY FOR ELECTRONICS
John Oster Advances
Melvin Kohner

JOHN OSTER MFG. CO., Racine, Wis., has appointed Melvin Kohner chief engineer of its Avionic Division.

Kohner joined the firm five years ago as project engineer and became a section head two years later.

Richmond To Head
New Laboratories

MARTIN R. RICHMOND, corporate vice president of Sanders Associates, Inc., Nashua, N. H., has been named to head the company’s new advanced systems laboratories in Burlington, Mass. One of the founding group of Sanders Associates, he has directed their R&D activities over the past 9 years.

The Sanders Burlington advanced weapons system laboratory, which presently occupies 30,000 sq ft, will be expanded by 60,000 sq ft of new construction in 1961. Between 300 and 500 engineering and production personnel will be employed within one year.

Datex Corporation
Hires Jack Monroe

APPOINTMENT of Jack C. Monroe as chief engineer at Datex Corp., Monrovia, Calif., is announced.

Formerly with Bendix Computer, where he worked on analog/digital systems, he was also associated

president of the company’s four operating directors.

The new vice presidents are J. C. Brandon, Jr., engineering; Robert W. Omsted, marketing; Charles B. Wakeman, research and development; and Elmer B. Kaelin, manufacturing.

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Melvin Kohner

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LEXINGTON 73, MASSACHUSETTS


Heller Becomes General Manager
RAYMOND H. HELLER was recently appointed general manager of Robertshaw-Fulton's Aeronautical and Instrument Division at Anaheim, Calif. He succeeds Robert L. Wehrli, who is moving to Richmond, Va., as vice president and assistant to the president of the corporation.

Carl Solomon Joins Budd Electronics
CARL SOLOMON has been named manager of product engineering at Budd Electronics, Inc., Long Island City, N. Y.

Prior to joining the Budd Company subsidiary, he was affiliated with the Interline Division of ITT and Hogan Facsimile Labs. He has also worked on microwave test equipment for PRD Electronics.

Harvard Industries Appoints Hurley
THE DIRECTORS of Harvard Industries, Inc., have announced the appointment of William D. Hurley as
general manager of the company's Frequency Standards division, Asbury Park, N. J. He was also elected a vice president of Harvard Industries and member of the board.

Frequency Standards is engaged in the development and manufacture of electronic components in the microwave field and employs more than 100 persons. Current sales volume is above $1 million.

Hurley was formerly assistant to the president of Lockheed Electronics Co., Plainfield, N. J.

Gehlke Heads Up New Program at Babcock

BABCOCK ELECTRONICS CORP., Costa Mesa, Calif., manufacturer of remote guidance and control equipment, has appointed Donald A. Gehlke as vice president, corporate director of advanced development.

Gehlke will head a new company program to expand engineering capabilities into diversified and advanced fields. Prior to his appointment, he was vice president and director of engineering for Babcock.

Shen Takes Over New Position

KUCHEN SHEN, formerly of Vitro Electronics, has joined Communication Electronics, Inc., Bethesda, Md., as chief design engineer.

Branson Corporation Hires Goldberg

THE BRANSON CORP., Whippany, N. J., announces that Stuart Goldberg has joined its engineering staff. He was formerly with Federal Pacific in Newark.

Excellent engineering opportunities in Southern California or Grand Rapids, Mich.

JOIN the Leader

Long range programs, salaries commensurate with ability for:

SENIOR ENGINEERS
BSEE • 5-10 YEARS EXPERIENCE IN:
Analytical and electrical engineering of automatic flight control systems...or:
Transistor and/or controlled rectifier circuit design for servo amplifiers...or:
Airborne communications with design experience of VHF receivers and transmitters, plus background in RF circuitry design and transistors...or:
5 OR MORE YEARS of responsible design experience on:
Gyros and Platforms or Flight Reference Systems. Attitude Indicating Instruments or Systems.

DESIGN AND DEVELOPMENT ENGINEER
With minimum experience of 3 yrs. R & D on:
Indicating Instruments (ball or tape), Gyroscope Instruments, Transistorized Circuits, Optics.

LIAISON ENGINEERS
Experienced in airborne components. Must have worked intimately with production personnel on problems associated with "phase in" of any of the above products. Must have basic knowledge of good design, production and test practices.

RELIABILITY ENGINEERS
To establish new engineering reliability program. Should have 2 to 4 years experience in reliability preferably on gyros, indicators or electronic components or systems.

Send complete resume to:

G. E. Brooks
Technical Employment
110 toria ave., N.W.
Grand Rapids, Mich.

R. H. Rowlin
Technical Employment
3171 S. Bundy
Santa Monica, Calif.
To meet the recent increase to $50 million in contract commitments, Sanders Associates of Nishua, New Hampshire is rapidly expanding its engineering staff in 3 locations: Nashua Headquarters; Burlington, Massachusetts and Plainview, L.I., New York.

This new expansion follows a 9-year growth from 11 engineers to over 1600 employees—a growth soundly based on technical excellence—inventing new concepts instead of using traditional approaches.

Pioneering programs are being continued in phased arrays, radar, pulse doppler radar systems, space radar and communication systems. Advanced concepts and techniques in a variety of areas provide stimulating assignments involving space technology, missiles and radar systems.

Positions available at all locations for:

**SENIOR SYSTEMS ENGINEERS**
To contribute to advanced techniques in the general field of military electronic systems. Applicable experience includes systems analysis, synthesis and integration, with extensive background in circuit design augmented by hardware implementation.

**CIRCUIT DESIGN ENGINEERS**
EE or Physics graduates with 2 to 8 years experience and familiarity with tubes and transistors and their utilization in all types of circuits, as well as the integration of circuits into sub-systems.

**TRANSMITTER DESIGN ENGINEERS**
2 to 8 years experience. For work up to and including microwaves.

**PRODUCT DESIGN ENGINEERS**
ME with heavy experience in feasibility studies coupled with experience in taking developed systems into production, monitoring mechanical design and overall packaging concepts of ECM or other airborne systems.

**Positions in Plainview, L. I.**

**GROUND SUPPORT EQUIPMENT ENGINEERS**
To design and develop system, assembly and sub-assembly electronic test equipment for the military. Should have appreciation for test equipment philosophy, with extensive experience in circuit design and hardware follow-through.

To arrange for a convenient interview at any of the three locations, send resumes to Mr. Richard McCarthy, Employment Manager, in Nashua.

---

**ADVANCED SYSTEMS LABORATORIES**
(on famed "Electronics Row" in suburban Boston)

**NEW ENGINEERING OPERATION**
(on suburban Long Island near New York City)

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**SANDERS ASSOCIATES, INC.**
NASHUA, NEW HAMPSHIRE

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CIRCLE 384 ON READER SERVICE CARD
FOCUS ON RESEARCH
the first step in progress

Few, if any, organizations offer more challenging opportunity for research and new development work than The National Cash Register Company. Encompassing all sciences, the program at National’s Research and Development Center at Dayton, Ohio, is built on the philosophy that Progress is limited only by man’s imagination... that research is the first step in Progress. Perhaps your opportunity rests with us in one of the following areas:

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- SEMI-CONDUCTOR RESEARCH
- LOGICAL and CIRCUIT DESIGN
- MILITARY RESEARCH & DEVELOPMENT

Openings in the above areas of work are at an advanced level and require direct experience and an appropriate degree up to Ph.D. level.

FOR FULL CONSIDERATION, simply send your résumé to Mr. T. F. Wade, Technical Placement Section G-11, The National Cash Register Company, Dayton 9, Ohio. All correspondence will be kept strictly confidential.

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ONE OF THE WORLD’S MOST SUCCESSFUL CORPORATIONS
77 YEARS OF HELPING BUSINESS SAVE MONEY
CIRCLE 385 ON READER SERVICE CARD

January 6, 1961
Choose Your Pursuit From These

FIVE FACETS
OF PHILCO IN CALIFORNIA

A PLACE FOR YOU awaits at rapidly expanding Philco Western Development Laboratories on the San Francisco Peninsula, where new concepts of space communication offer exceptional opportunities to the exceptional engineer... with proportionate rewards. Your experience and your interests determine your assignment at PHILCO in the development of the complete system — from the space communication network of space vehicles to the complex data processing equipment of the ground station complex.

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Immediate openings now exist for graduate engineers with experience in equipment design, systems engineering, analysis and integration. As a first step toward expanding your skills at Philco, send your résumé in strict confidence to Mr. W. E. Daly, Engineering Placement.

PHILCO CORPORATION
Western Development Laboratories
3875 Fabian Way, Dept. E-1
Palo Alto, California
exploring a new method of communication

Although the initial excitement over Echo I has subsided, Collins engineers and scientists still seek additional information vital to the nation’s space effort. So far, they have...

• bounced intelligible signals in north-south direction
• transmitted and received live voice messages
• established a two-way voice circuit
• transmitted and received a teletype signal
• collected valuable propagation and orbit data

One of the most difficult obstacles for Collins to overcome was that of accurately tracking the Echo I satellite, 800 miles, roughly speaking, separate Collins Radio Company in Cedar Rapids, Iowa, and its subsidiary, Alpha Corporation in Dallas, Texas. Both locations were prepared to send and receive radio signals bounced off Echo. Because Echo I was speeding through space at approximately 15,000 miles per hour some 900 miles above the Earth, its time above the horizon of both Collins locations was brief. However, Collins engineers perfected an automatic tracking device which permitted both the sending and receiving units to maintain constant contact from the time Echo I appeared on the horizon until it disappeared some 15 minutes later.

The radio signals actually traveled a minimum of about 2000 miles. Power loss was of staggering proportions...with received signal strength approximately 10^-16 watts.

These contributions to the new world of space communications were completely company sponsored—and represent an investment in the future by Collins Radio Company and its subsidiary, Alpha Corporation. It was worth it...in the warm feeling of accomplishment alone.

Collins provides freedom of activity in basic research for the engineer, physicist and mathematician...and is able to offer unique professional opportunities. Your inquiry is invited.

The Echo project is being coordinated with the National Aeronautics and Space Administration. Data collected by Collins is being submitted to NASA to be used in the evaluation of this communications technique.
An unusual opportunity awaits a qualified engineer who will assume an important area of responsibility in a well established electronic equipment manufacturing firm.

Minimum requirements: Bachelor Degree in Electrical Engineering plus experience in the development of electronic equipment.

Salary to be commensurate with qualifications. G.L.A. is located in a pleasant mid-state New York community.

Send resume or wire: Mr. R. E. Powers

GENERAL LABORATORY ASSOCIATES, INC.

1 Lee Avenue Norwich, New York

CIRCLE 390 ON READER SERVICE CARD

An employment advertisement in this EMPLOYMENT OPPORTUNITIES section will help you find the engineers you need. It's an inexpensive, time-saving method of selecting competent personnel for every engineering job.
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January 6, 1961

Analog to Digital CONVERTERS

IDL Shaft Angle Converters

are fully qualified per MIL-E-5272 A

for Operation:
At temperatures 0°F to 160°F for Paragraph 4.1.1 Procedure 1
From 0.55 to 14.7 p.s.i.a. for Paragraph 4.1.3 Procedure 3
Under vibration 5-5000 cps for Paragraph 4.7.1 Procedure 1

for Exposure:
To Humidity and Temperature per Paragraph 4.4.4 Procedure 1
To Sand and Dust per Paragraph 4.11.1 Procedure 1
To 50 hour Salt Spray per Paragraph 4.6 through 4.6.13
To Shock per Paragraph 4.13.1 Procedure 1 and Paragraph 4.15.1
To 10 G's Sustained Acceleration per Paragraph 4.16.2 Procedure 2

For Linear Motions, Model S00206 provides accuracies of 1 part in 1000 counts.
For Angular Motions, Model S00406 provides accuracies of one tenth degree; Model S00407 provides accuracies of a tenth of a minute.

Each unit provides bidirectional rotation for applications in mechanically geared systems. The Gray BCD coding system is easily translated into other digital format for visual readout or for recording.

For specifications on these components, ask IDL for their data sheet, "Shaft Position to Digital Converters" or price information, use your letterhead.

INSTRUMENT DEVELOPMENT LABORATORIES
INCORPORATED
Subsidiary of Royal McBee

51 MECHANIC STREET, ATTLEBORO, MASS.

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ULTRASONIC CLEANER
SONOGEN® LG-75

Compact, efficient, fully transistorized, 75 Watt generator drives a two-gallon cleaning tank. For extremely difficult jobs, the one-gallon high-intensity tank is recommended. Equipment is backed by a nationwide factory-trained service organization. Bulletin 5-526. Two-gallon system, 5395, FOB Stamford.

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R. S. QUINT, Assistant Advertising Sales Manager and Buyers’ Guide Manager; FRED STEWART, Promotion Manager; RICHARD J. TOMLINSON, Production Manager; GEORGE E. POMEROY, Classified Manager; HUGH J. QUINN, Circulation Manager.


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Advertising Sales Manager

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January 6, 1961

CIRCLE 185 ON READER SERVICE CARD 185
Over four years ago the editorial staff of *Electronics* set out to produce, once a year, for the engineer-subscribers, an annual survey of the economics of our industry—a market forecast, if you will, of the stuff by which we work and live.

The editors are proud of this week's issue. The annual forecast (pages 67 to 104) is more complete this year—predicts in greater depth what is likely to occur—"calls the shots" with a confidence based on continuing and penetrating research.

Coincidently, pages 56 and 57 carry a message titled "How American Industry Points the Way to Sustained Prosperity in 1961".

A table on page 56 lists capital spending plans industry-by-industry. We must suppose that most of the 10.2 billion dollar electronics industry is contained under the heading "Electrical Machinery." It is heartening to note the +10%, highest increase planned for 1961 of any industrial classification.

Electronics as an industry must continue to invest to stay on top. Adequately increased profit margins in the year ahead depend in large part on adequate capital spending now. Nor is capital spending synonymous with mere plant expansion in square feet. While we must have facilities large enough to handle continually expanding volume we must also have equipment modern enough to minimize costs and permit us to meet growing competition.

This is the time to check the quantity and, more particularly, the quality of equipment ranging all the way from instruments needed for research and development, through production, to equipment needed for efficient installation and maintenance of products in the field.

The special report and the editorial beginning on page 56 are interelated. We hope you will read them both.

Should you want an extra copy of the special report for an associate—or for filing—circle number 250 on the reader service card bound elsewhere in this issue. No charge of course. And one further rhetorical question. Why does *Electronics*, an engineering magazine, publish a market forecast report each year? Because engineers, be they engaged in research, development, design production or management, MUST know where the industry is headed if they, in turn, are to get it there. It's that simple.

*Electronics* PUBLISHER
50% lighter . . . 40% Smaller . . .

Daven’s new miniature Egg Crate LC Filters

Now, for airborne and missile applications, Daven offers a miniature version of the popular Egg Crate LC Filter; 50% lighter and 40% smaller than any previous filter!

Frequency range is 0.4 MC to 60.0 megacycles . . . temperature range is —55°C to +125°C . . . different physical configurations are available depending on allowable space.

The new Filter is suitable for pulse-type circuits and those where the phase shift characteristics must be uniform. It can be pre-tuned in the actual circuit, thus eliminating additional adjustment during assembly. With new production facilities, these Filters are available in quantity, and each unit is identical in performance to the prototype.

Utilizing no critical materials, the LC Filter is also excellent for medium and wide band-width filters. It can be used for band-widths down to 0.5%, if under-coupled response is permitted.

Daven's extensive engineering staff, also producing other types of filters extending into the low audio range, is ready to assist you in your filter problems. Just send details of your specific requirement.

THE DAVEN CO. LIVINGSTON, NEW JERSEY

TODAY, MORE THAN EVER, THE DAVEN © STANDS FOR DEPENDABILITY
In recent months, several leading tube manufacturers have issued statements and product notices regarding new large receiving-type tubes having an all-glass base instead of the conventional plastic base.

With great pride, RCA announces its new line of NOVAR receiving tubes. These types, which are now being sampled developmentally to the industry, reflect the careful effort made by our engineers to design a product that has low initial cost and low replacement cost; top quality; and simplicity of installation and conversion.

The new NOVAR tube has a 9-pin base with a pin-circle diameter of .687" and a pin length of .350". Most important, the inner leads used in NOVAR tubes have a diameter of 30 mils. Thus, the NOVAR tube types have a strong cage support and feature high heat-dissipation capability. Relatively cooler operation can therefore be expected from NOVAR types with consequent improvements in tube reliability and life.

Of equal importance is the wide distance between pins in the NOVAR tubes: .212". As a result the new RCA types can withstand high voltage gradients between pins. In other tubes using relatively close spacings, voltage breakdown between pins will occur at much lower values when all pins are used. It is evident, therefore, that certain families of tubes would be very difficult to design using a base with close pin spacings.

There is another factor. NOVAR tubes offer outstanding versatility. There is no function presently served by "octal" tubes that cannot be duplicated by the new RCA NOVAR line. In addition, these tubes will be priced lower than their present "octal" counterparts.

RCA believes that the introduction of NOVAR tubes represents a logical and realistic approach to the design of large glass-based receiving tubes. During 1961, as the new tubes are installed in a variety of home entertainment equipment, we are sure that our approach will be commended: that the development of the NOVAR line will have outstanding significance in the manufacture of finer, more reliable electronics components.

RCA Electron Tube Division, Harrison, N.J.