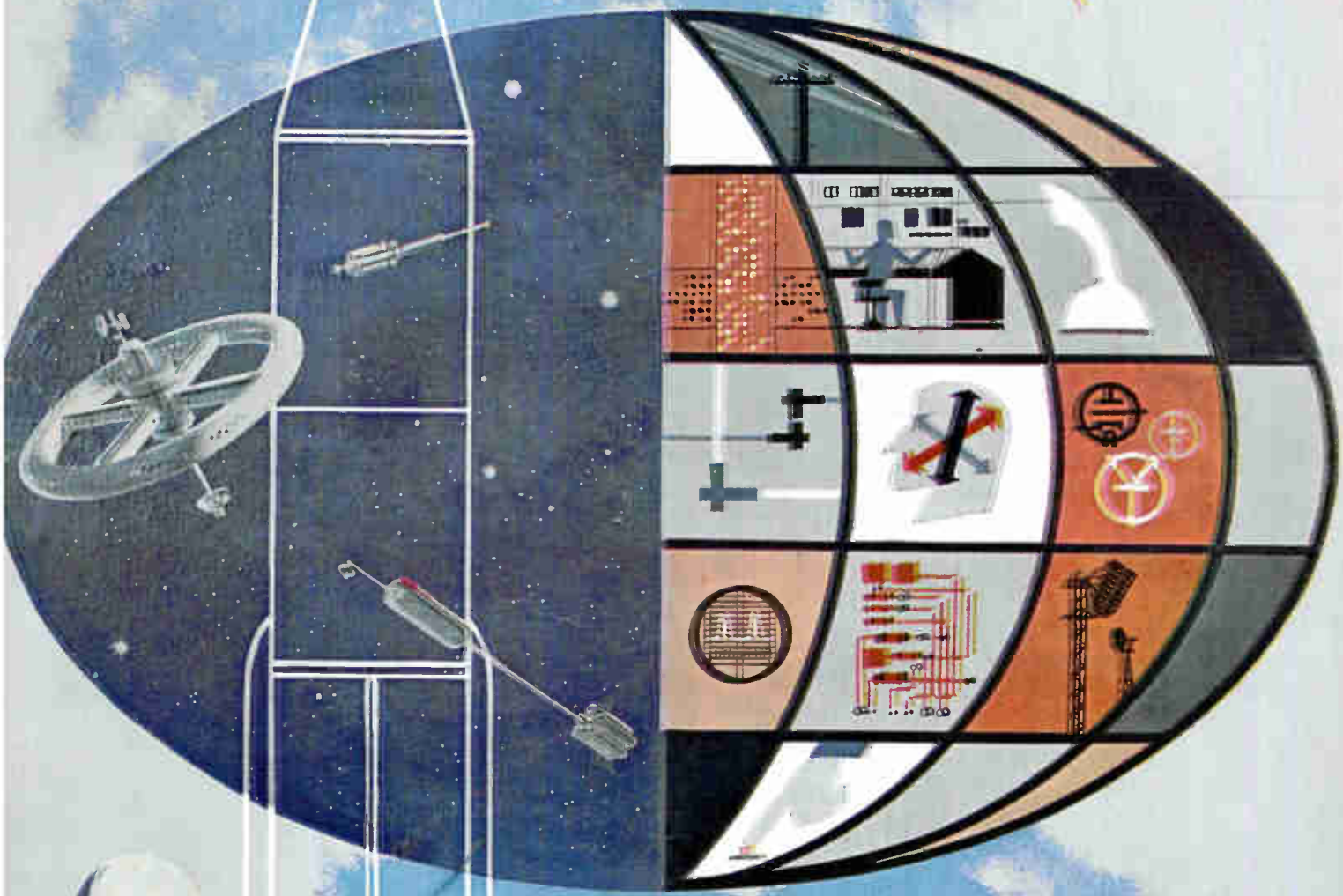
January 6, 1961

electronics

A McGraw-Hill Publication 75 Cents

SPECIAL REPORT *Production will double in the next ten years*



OUR INDUSTRY
Today and Tomorrow

FILTERS FOR ALL APPLICATIONS FROM STOCK

HERMETICALLY SEALED TO MIL-T-27A & MIL-F-18327 SPECS.

Write For NEW Catalog

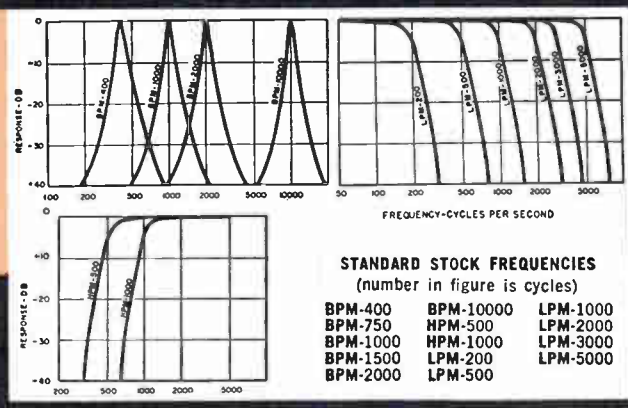
MINIFILTERS

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; attenuation 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; attenuation of 30 db at 1.5 cut-off frequency, 40 db at 1.65 cut-off frequency. Input and output 10K.



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

BPM-400	BPM-10000	LPM-1000
BPM-750	HPM-500	LPM-2000
BPM-1000	HPM-1000	LPM-3000
BPM-1500	LPM-200	LPM-5000
BPM-2000	LPM-500	

BPM case (MIL AF)
¾ x ¾ x 1⅛"
Weight....1 oz.

HPM and LPM case (MIL AG)
1 x 1 x 1⅜"
Weight....2¼ oz.

INTERSTAGE & LINE

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

BMI 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.

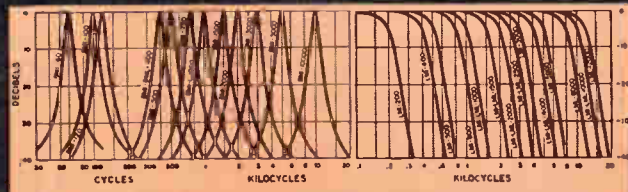
HMI high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

LMI 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 same as HMI but 500/600 ohms in and out.

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

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



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

BMI-60, 100, 120, 400, 500, 750, 1000, 1500, 2000, 3000, 4000, 5000, 10000
BTI-60, 100, 120
HMI-200, 400, 500, 800, 1000, 2000, 3000
LMI-200, 400, 500, 800, 1000, 1500, 2000, 2500, 3000, 4000, 5000, 10000
BML-400, 1000
HML-200, 300, 500, 1000
LML-1000, 1500, 2000, 2500, 4000, 8000, 10000, 12000

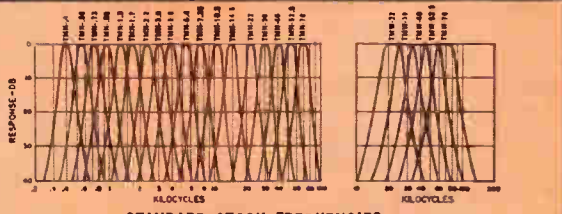
Base ..... 1¾ x 1¹¹⁄₁₆"
Height, BMI, LMI, BML..... 1⅜"
Height, HMI, HML, LML ..... 2½"
Weight ..... 6 oz. and 9 oz.

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.



STANDARD STOCK FREQUENCIES
(number in figure is KC)

TMN- .4	TMN-1.7	TMN- 5.4	TMN-30	TMW-22
TMN- .56	TMN-2.3	TMN- 7.35	TMN-40	TMW-30
TMN- .73	TMN-3.0	TMN-10.5	TMN-52.5	TMW-40
TMN- .96	TMN-3.9	TMN-14.5	TMN-70	TMW-52.5
TMN-1.3		TMN-22		TMW-70

TMN-2.3 thru TMW-70
2⅜ x 2⅜ x 1¾"
Weight....1.2 oz.

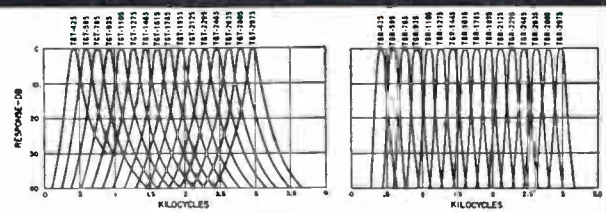
TMN-.4 thru TMN-1.7
1¼ x 1½ x 2"
Weight... 3.5 oz.

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 cross-over.

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 cross-over.



STANDARD STOCK FREQUENCIES
(number in figure is cycles)

TRANSMITTING		RECEIVING	
TGT-425	TGT-1785	TGR-425	TGR-1785
TGT-595	TGT-1955	TGR-595	TGR-1955
TGT-765	TGT-2125	TGR-765	TGR-2125
TGT-935	TGT-2295	TGR-935	TGR-2295
TGT-1105	TGT-2465	TGR-1105	TGR-2465
TGT-1275	TGT-2635	TGR-1275	TGR-2635
TGT-1445	TGT-2805	TGR-1445	TGR-2805
TGT-1615	TGT-2975	TGR-1615	TGR-2975

TGT CASE
1½ x 1½ x 2½"
Weight....8 oz.

TGR CASE
1½ x 1½ x 4¼"
Weight....15 oz.

And Special Units to Your Specifications

UNITED TRANSFORMER CORP.
150 Varick Street, New York 13, N. Y.

PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
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January 6, 1961

electronics

A McGraw-Hill Publication 75 Cents

BUSINESS

ENGINEERING

DEPARTMENTS

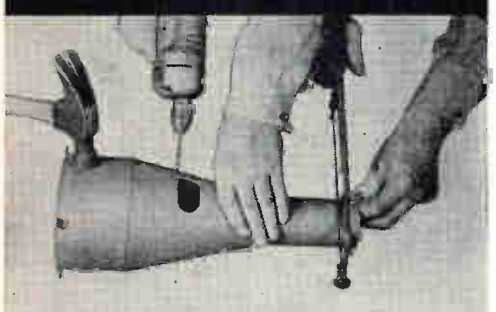
THE RECORDING THAT WASN'T

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

Burton browne advertising

Test factually demonstrates shielding effectiveness of Netic alloy material and enclosure design. Instrumentation used: magnetic field radiating source, AC vacuum tube voltmeter, Variac, pickup probe and Netic Tape Data Preserver. For complete test details and results, request Data Sheet 142.

For safe, distortion-free storage of large quantities of vital magnetic tapes. Designed for Military Establishments, Radio & TV Broadcasters, Automated Plants, Libraries, Laboratories, Gov't. Agencies, etc.



Composite photo demonstrating that magnetic shielding qualities of NETIC alloy material are not affected by vibration, shock (including dropping) etc. Furthermore, NETIC does not retain residual magnetism nor require periodic annealing.

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

GET A-HEAD

think small...

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.

MLP and *MHP* *MICROID*® 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 *MLP* with the *MHP* produces excellent response band pass characteristics.

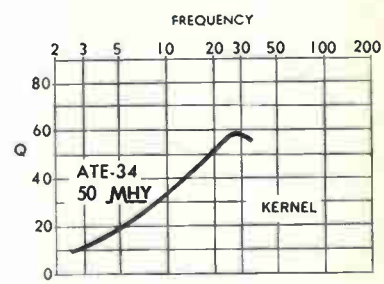
"Cheerio" Toroids — Subminiature high Q coils in a range of frequencies that make them ideal for transistorized equipment.

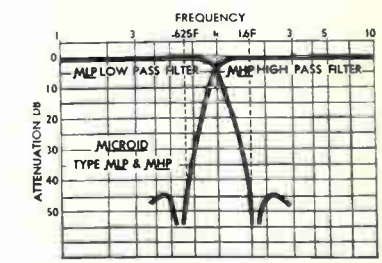
Crystal Filters—Advanced engineering techniques enable Burnell to offer at nominal cost, high selectivity, high attenuation crystal filters covering the extraordinary range of 1 kc to 30 mcs with considerable latitude in impedance.

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.

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
DEPT E30
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TELETYPE PELHAM 3633

PACIFIC DIVISION
DEPT E30
720 MISSION ST.
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TELETYPE PASACAL 7578

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Audited Paid Circulation

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, loran, 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 submicrosecond memory elements, preparation of thin films, ferromagnetic devices and studies of spiral walls 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

*Trademark

★ 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 4⅝" 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.

For complete specifications on Type 32D COMPULYTIC Aluminum Electrolytic Capacitors, write for Engineering Bulletin 3441B to Technical Literature Section, Sprague Electric Co., 35 Marshall St., North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:
CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

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. 33, 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 musec to 200 musec," 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 musec to 1 usec . . ."

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 "mμsec;" 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 "musec" when they mean μsec. Since we've followed a more or less consistent pattern of using the prefix "nano-" for 10^{-9}, we've grown accustomed to "nsec" and almost forgotten that "musec" 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.

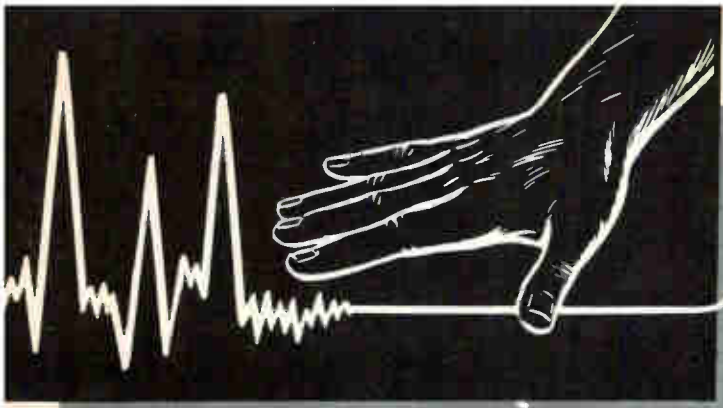
. . . and Specific

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

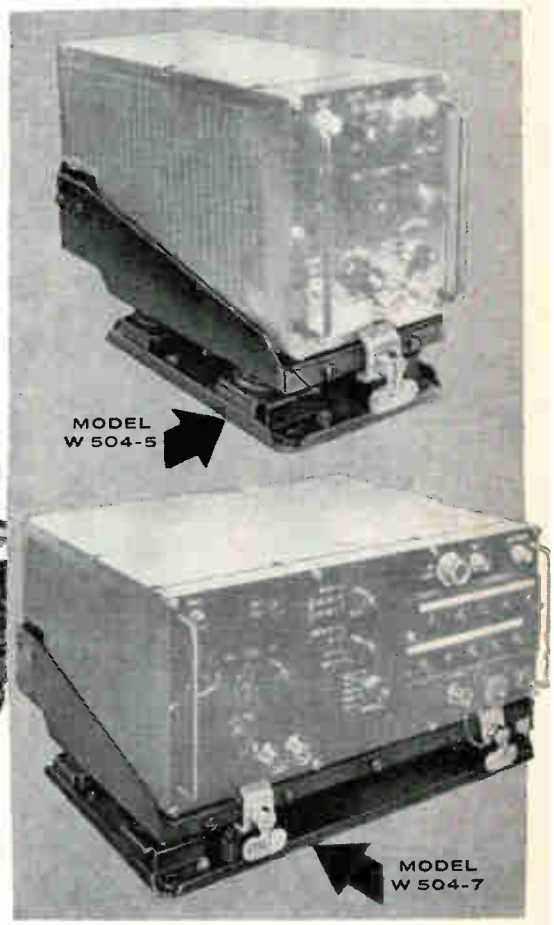


how ROBINSON *Vibration and Shock Control*

PROTECTS PERFORMANCE and assures RELIABILITY in Mobile Installations . . .

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.***



Photos Courtesy of Avco Electronics and Ordnance Division

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.

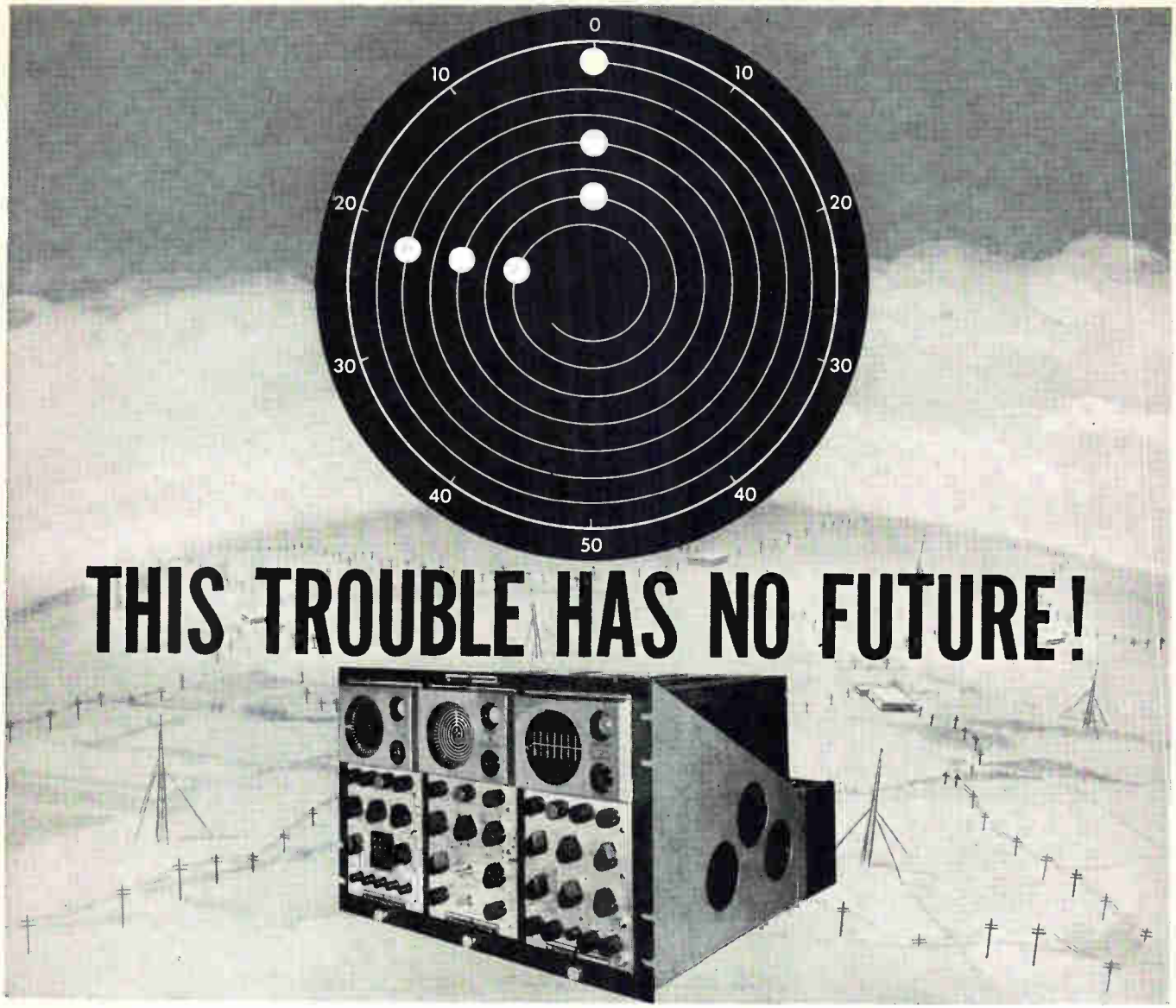
These are the first all-metal mounts to pass the Signal Corps' Ballistic Shock Test (simulating gunfire impact) and the Package Test (simulating repeated road shock). **Send for FREE brochure.**

ROBINSON *Vibration and Shock Control* **VIBRASHOCK DIVISION**

ROBINSON *Technical Products Inc* **TETERBORO, NEW JERSEY**

West Coast Engineering Office: Santa Monica, Calif.

DESIGNERS AND MANUFACTURERS OF VIBRATION CONTROL SYSTEMS



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.

TDMS performs all of these *on-line* functions: 1. Distortion transmitter; 2. Test message transmitter; 3 Distortion analyzer; and 4. Linear wave-form onolyzer.

Among ovailoble accessories are utility cort (shown above), portoble power supply, and relay-test adapter.

RADIATION
INCORPORATED

ELECTRONICS NEWSLETTER

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. R. 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 $2.59 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 countermissile, 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 Proportioneers 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 transport aircraft. That opinion was expressed strongly last month by spokesmen for Convair division of General Dynamics.

Automatic checkout could be performed by groundbased 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.

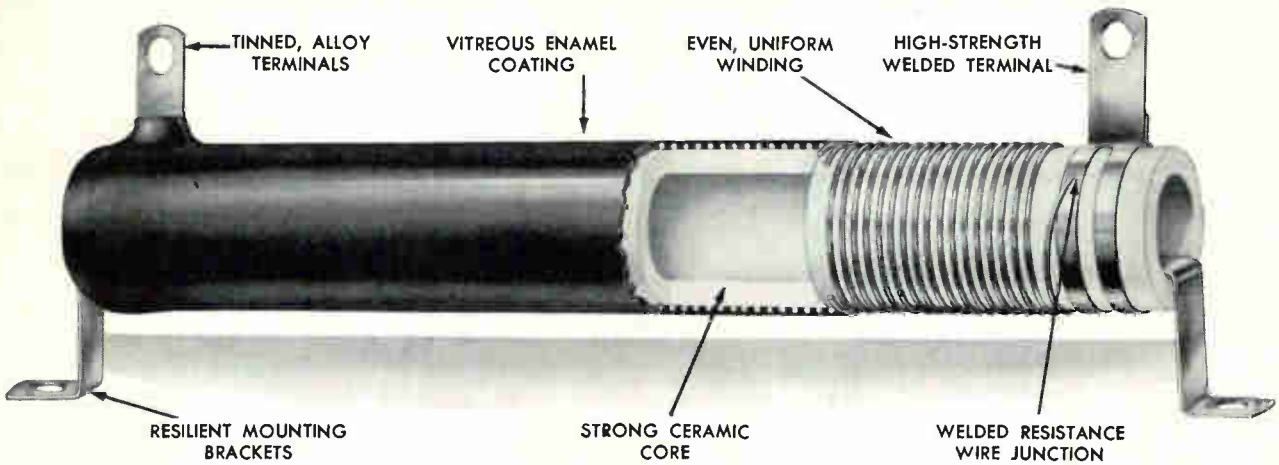
System can provide instantaneous bearing data on ionized meteor trails. Boulder lab men have it trained on the NBS field station in Havana, Ill., to observe and record best-path data on vhf forward-scatter transmissions.

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

some of the many types available

- 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 Studs
- Ferrule Mounting Resistors
- Live Bracket Mounting Resistors
- Edison Screw Base Mounting Resistors
- Riteohm® Wire-Wound Precision Resistors, Encapsulated; Vitreous Enameled; Molded Jacket; Hermetically Glass Sealed
- Riteohm® Metal Film Resistors
- Resistors to meet MIL Specifications
- High-Shock Resistors

Write on company letterhead for Catalog 58

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.

OHMITE

OHMITE MANUFACTURING COMPANY
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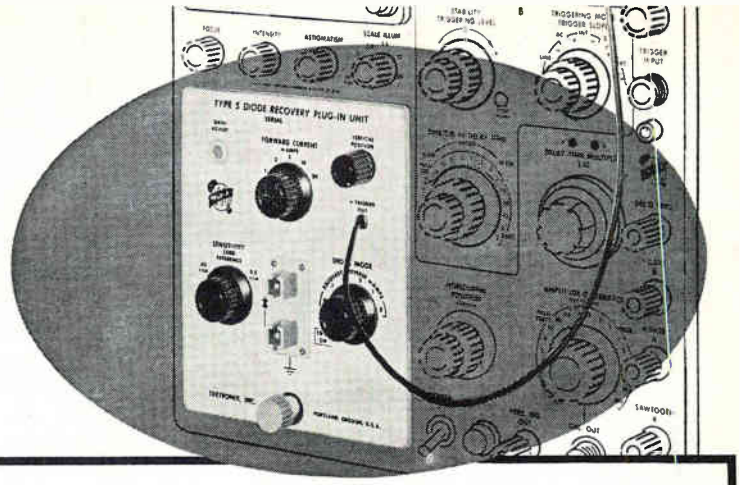
RHEOSTATS RESISTORS RELAYS
TANTALUM CAPACITORS TAP SWITCHES
VARIABLE TRANSFORMERS DIODES R.F. CHOKES

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 Plug-In Oscilloscope. With Tektronix Type 540-Series and Type 550-Series Oscilloscopes 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 most other currently employed 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.

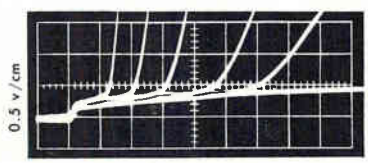
A Type S Unit, plugged into your Tektronix Oscilloscope, can save you many hours of experimentation. Call your Tektronix Field Engineer for a demonstration in your application.

MAIN CHARACTERISTICS

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

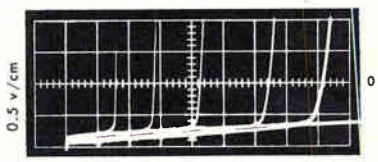
Type S Diode Recovery Unit **$250**
f.o.b. factory

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.



0.1 μsec/cm

Fig. 1—Diode A

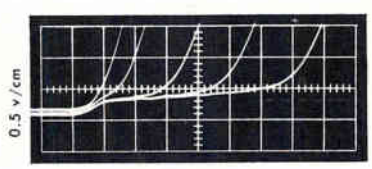


2 μsec/cm

Fig. 2—Diode B

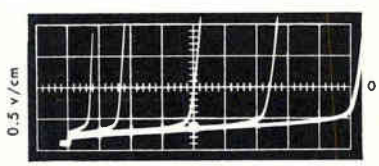
I forward—10 ma. I reverse—2, 1, 0.5, 0.2, 0.1, 0 ma.

Observation of the recovery curves of Figures 1 & 2 shows both reverse current and recombination accounting for removal of the stored charge. It is thus possible to determine not only the stored charge for any of the five forward currents available, but also the rate of recombination. With this information, it is possible to predict diode action to fast transients in any circuit.



0.02 μsec/cm

Fig. 3—Diode A

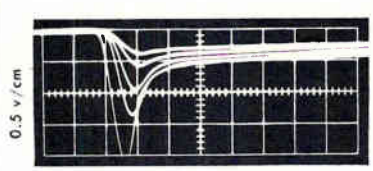


0.5 μsec/cm

Fig. 4—Diode B

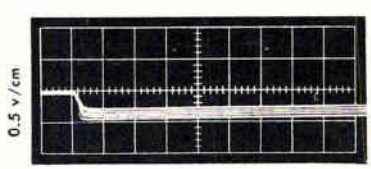
I forward—1, 2, 5, 10, 20 ma. I reverse—2 ma.

Observation of the recovery curves of Figures 3 & 4 shows that the amount of stored charge is proportional to forward current while the recovery time is so short that negligible recombination occurs. Under this condition, after the stored charge is cleared the reverse bias increase is limited only by the diode capacitance (and the shunt capacitance of the instrument). This rate of increase is easily measured at a particular reverse voltage, and thus, the diode capacitance at that voltage can also be determined.



0.02 μsec/cm

Fig. 5—Diode A



0.02 μsec/cm

Fig. 6—Diode C

Turn-on — magnified. I forward — 1, 2, 5, 10, 20 ma.

Observation of the turn-on characteristics of Figures 5 & 6 shows that the voltage drop across a diode suddenly switched on is not always initially as low as the steady-state drop. It is important to remember that the leading edge of any fast transient passed by a diode may be modified by this phenomenon.

NOTE: The above waveform photos are multiple exposures.

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. . . 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.

Fax Storage Recorder

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.

Model TO-258

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.

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.

Model 700

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

WASHINGTON OUTLOOK

COLLISION OF TWO AIRLINERS 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-23, R-25 and R-30 with handy cross-reference file cards

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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 ½, 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

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.

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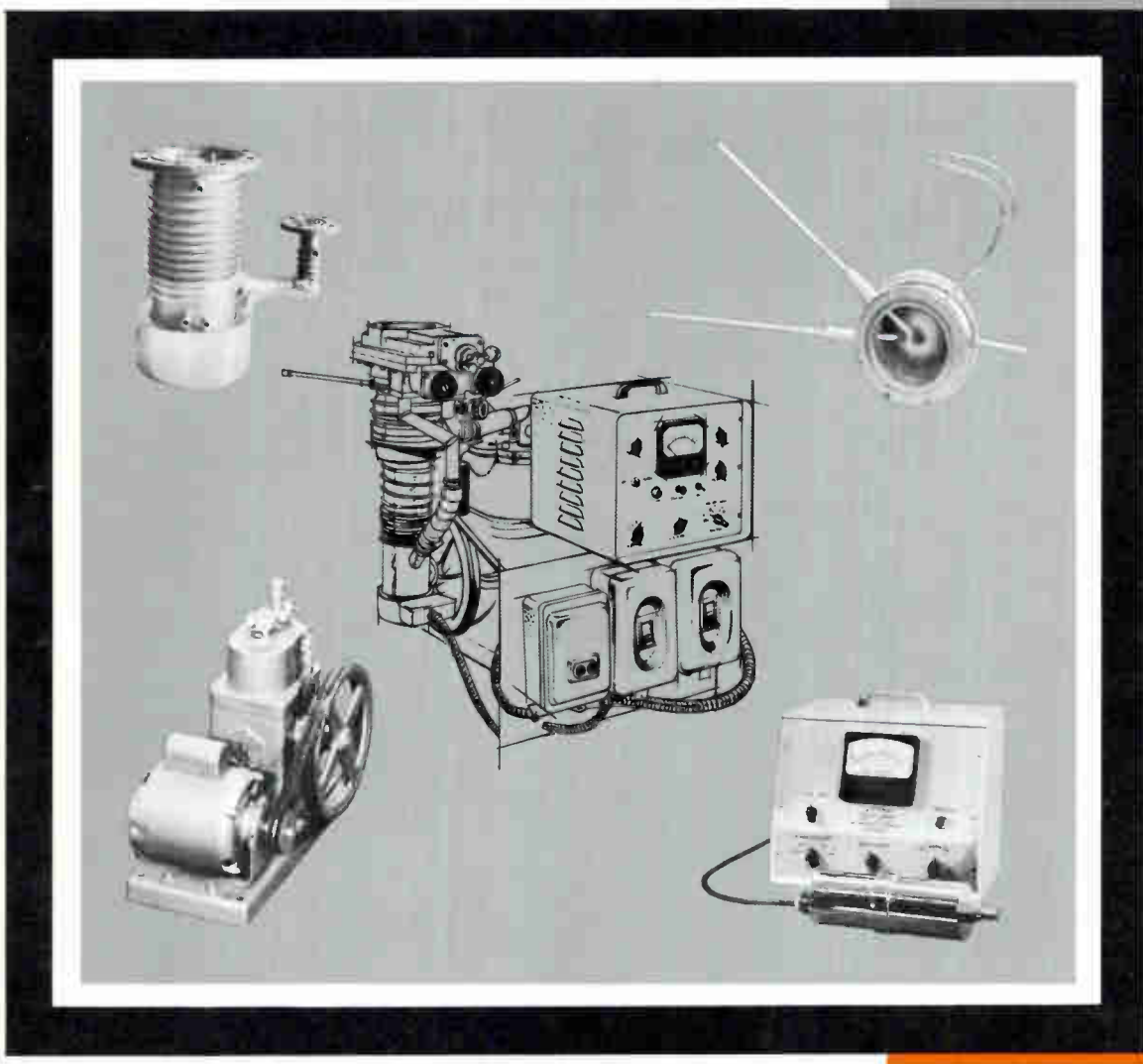

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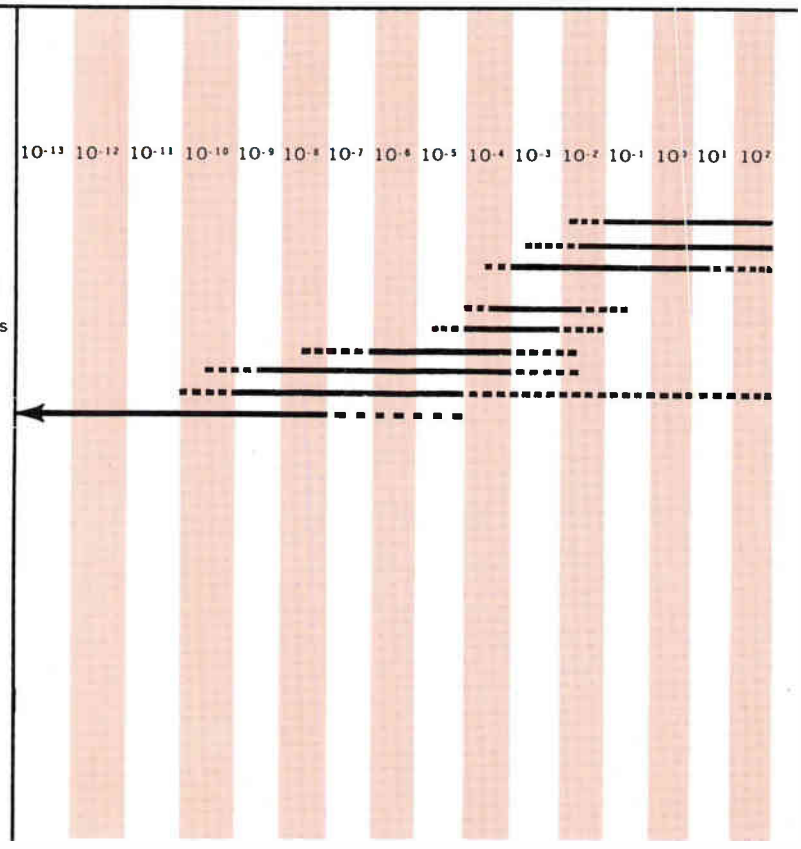
If you want to make your product lighter, stronger, smaller, more dependable, or change its appearance at low cost, try high vacuum. If sub-miniaturization is your goal, high vacuum is your answer. If purer, stronger metals are needed, high vacuum will produce them.

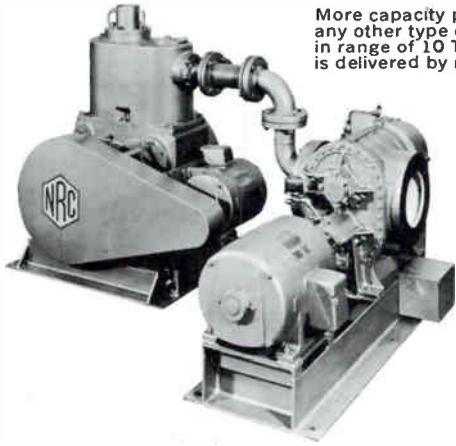
All NRC equipment is designed primarily for simplicity and reliable performance in the field. The problems that usually beset the uninitiated in the use of high vacuum equipment have been engineered out. You don't have to be a high vacuum expert to enjoy the advantages of NRC high vacuum equipment. In 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.

VACUUM RANGE FOR DIFFUSION AND MECHANICAL PUMPS

Pumps	Capacity CFM	"Clean" Vacuum	Remarks
Rotary Gas Ballast:			
Single Stage	1.25-400	no	Gas ballast keeps pump
Two Stage	1.25-400	no	oil free of condensables
Mechanical Booster	250-4500	yes	Very high speed throughout micron range
Booster Diffusion	25-6000	no	Oil and mercury
Molecular Drag	150	very	For special purpose tubes
Diffusion — Untrapped	70-70,000	no	Oil and mercury
With Cold Trap		yes	Very reliable
Titanium Adsorber	10	yes	Intermittent operation
Ion	2	very	For small UHV systems





More capacity per dollar than any other type of vacuum pump in range of 10 Torr to 10 microns is delivered by mechanical booster pumps.

Gas ballasted mechanical pumps handle water-vapor without losing efficiency. Send for bulletin No. MP59.

MECHANICAL VACUUM PUMPS

Model No.	Capacity CFM	H.P.
	SINGLE STAGE	
2-S	1.3	¼
4-S	3.3	½
6-S	6.8	¾
15-S	16.5	1
30S	30.	1.5
100S	100.	5
200S	202.	10
400S	403.	20
	DOUBLE STAGE	
2D	1.3	¼
4D	3.3	½
6D	6.8	¾
30M	30.	1.5
100M	100.	5
200M	202.	15
400M	403.	25

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.

MECHANICAL NRC PUMPS DIFFUSION

32" HS 32-33,000 delivers 70,000 CFM peak capacity, yet backstreams less than most 4" pumps. Send for bulletin No. DP-5.

NRC oil booster and diffusion pumps are known for their ability to perform as well in the field as on a test stand. Send for bulletin No. DP-5.

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.

DIFFUSION PUMPS

Model	Max. Speed liters/sec	Max. Forepressure microns	Recommended Forepump Capacity (CFM)
H-2-P	70	180	4
H-2-SP	85	250	4
A-2-P	80	200	4
C-4-P	300	200	6
H-4-P, H-4-SP	340	250	6
H-6-P	875	200	30
HS6-1500	1,500	700	15
H-10-SP	2,800	200	30
H-16-P	5,200	300	100
H-20-SP	11,500	200	100
H-32-SP	27,000	200	200
HS32-33000	33,000	550	400

BOOSTER PUMPS

Model	Max. Speed liters/sec.	Max. Forepressure microns	Recommended Forepump Capacity (CFM)
B-1	11.5	300	2
B-2	80	800	6
B-4	240	800	15
B-6	675	800	100
H-10	1,500	450	100
B-12	2,800	800	200

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.

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.

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																	
HIGH VACUUM	⅛	¼	⅜	½	¾	1	1½	2	3	4	6	8	10	12	16	20	24	32	36
Hand-Operated:																			
Cast Bronze — Globe	X						X	X	X										
Cast Bronze — Angle				X		X	X	X											
Ball		X	X		X	X	X	X	X										
Slide								X	X	X	X	X	X						
Air-Operated:																			
Cast Bronze — Globe									X										
Cast Bronze — Angle				X		X	X												
Ball		X	X		X	X	X	X	X										
Slide								X	X	X	X	X	X	X	X	X	X	X	X
Fabricated Angle											X		X	X	X	X			X
AIR RELEASE																			
Hand-Operated																			
Cast Bronze — Globe				X	X			X											
Cast Bronze — Angle				X	X			X											
Ball		X	X		X	X	X	X	X										
Air-Operated:																			
Cast Bronze — Angle				X		X	X												
Ball		X	X		X	X	X	X	X										
THROTTLING	Modification of std. globe and angle valves																		

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.

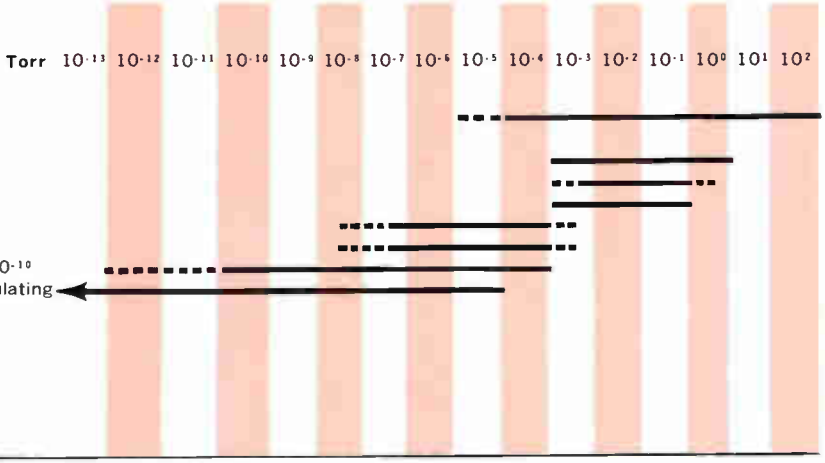
SEALS AND FEED-THRUS

High vacuum seals and feed-thrus 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.

Gauges	Linear	Immune to Atm. Press.	Remarks
Alphatron® Ionization	yes	yes	Accurate. Wide range
Log Alphatron® Ionization	no	yes	Inexpensive. Single scale
Thermocouple	no	yes	Rugged. Inexpensive
Pirani	partially	yes	Linear 1-20 microns
Ionization	yes	no	Accurate. Widely used
Spec. Ionization	yes	yes	Special filament
Nottingham Ionization	yes	no	Indirect readings below 10^{-10}
Redhead	yes	no	Direct readings. Self regulating emission.



VACUUM RANGE OF GAUGES

GAUGES

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.

Wide range, linearity, precision, and ability to operate at atmospheric pressure are features of NRC Model 520 Alphatron® Ionization Vacuum Gauges.

Pressures from 10^{-3} to less than 10^{-10} Torr are measured with high stability and linearity by Model 751 Nottingham Gauge Control, which will operate any commercial Bayard-Alpert type ionization gauge.

PORTABLE PUMPING SYSTEMS

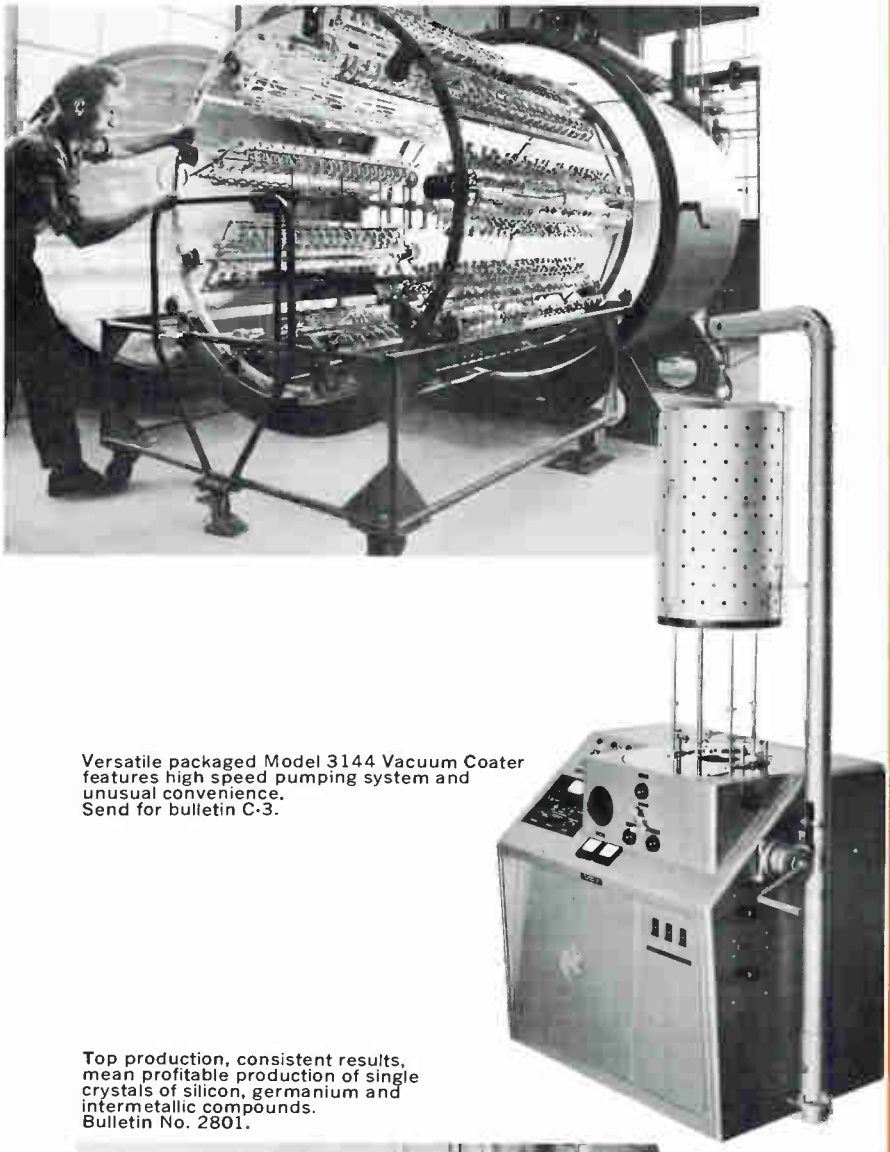
NRC portable pumping systems are complete units which incorporate rotary gas ballast pumps, diffusion pumps, optical baffle cold traps, valves and gauges, plus optional components if desired. The systems are ready to operate after making connections to power, water, and the vacuum chamber. The NRC portable pumping systems are capable of producing and measuring a clean vacuum to pressures below 10^{-6} 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.

An economical and convenient way of getting efficient high vacuum pumping and gauging is offered by standard 2", 4", 6", and 10" portable pumping systems. Write for bulletin 3300.

PROCESS EQUIPMENT



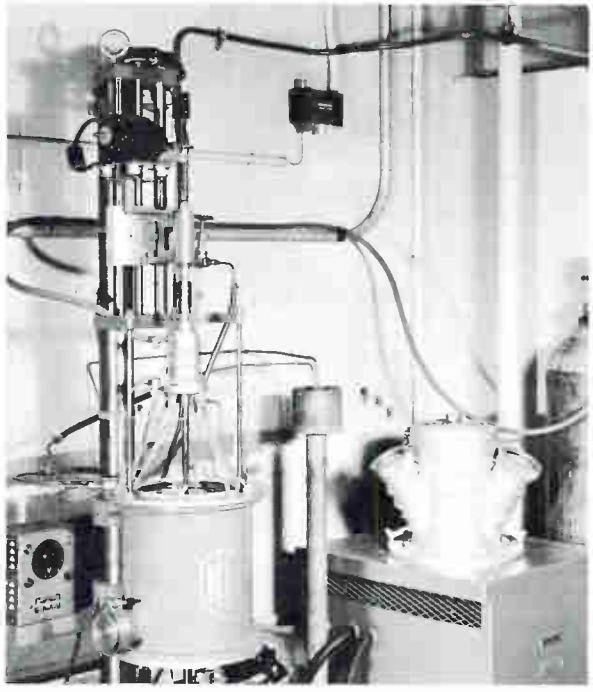
Versatile packaged Model 3144 Vacuum Coater features high speed pumping system and unusual convenience.
Send for bulletin C-3.

NRC VACUUM COATERS

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 table-top 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.

Top production, consistent results, mean profitable production of single crystals of silicon, germanium and intermetallic compounds.
Bulletin No. 2801.



NRC 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.

FURNACES INDUCTION

Model	Capacity Lbs.
2575	4 to 28 grams
2551-B	12-17
2555-B	17-75
2501	100-200
2503	200-300
2506	300-600
2510	700-1000
2520	1000-2400

RESISTANCE

Model	Hot Zone	Max. Temp.
2904-B	2½" ID x 3"	4400°F
2911	12" x 12" x 12"	4400°F
2914	3" ID x 6"	4400°F
2915	6" ID x 10"	4400°F
2917	54" ID x 144"	2000°F
2936	36" ID x 36"	2000°F

ARC

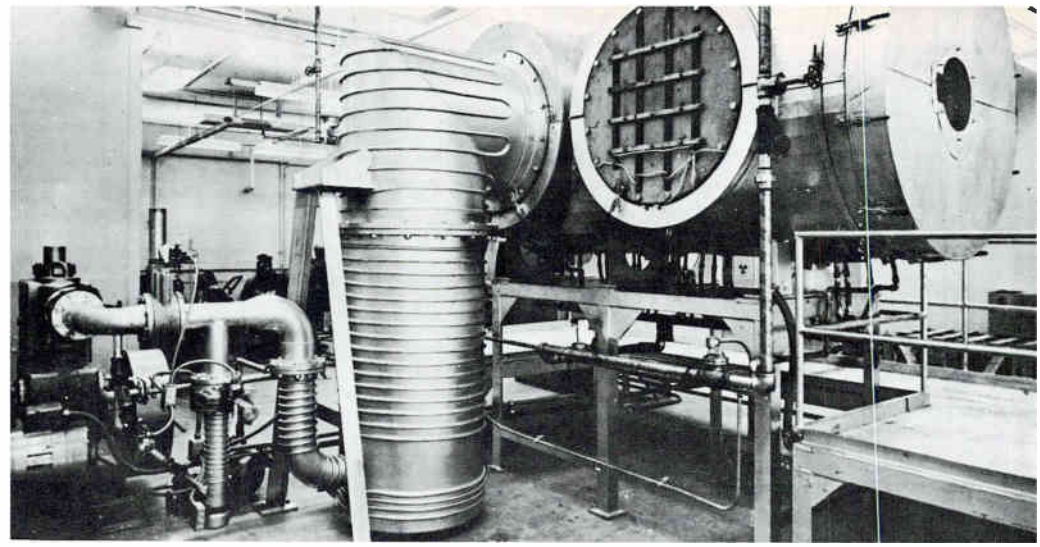
Model	Capacity Lbs.
2702	Button-8 lbs.
2703	18
2715	50
2721	100

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 1/16" 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.

Model 2915 vacuum sintering furnace can reach 4400°F in three minutes and operate below 10^{-5} Torr.
Send for bulletin No. 2915.

Simple low-cost electron beam welder for precision welds in reactive, refractory, and high performance materials.
Send for bulletin No. 2405.



ALTITUDE CHAMBERS

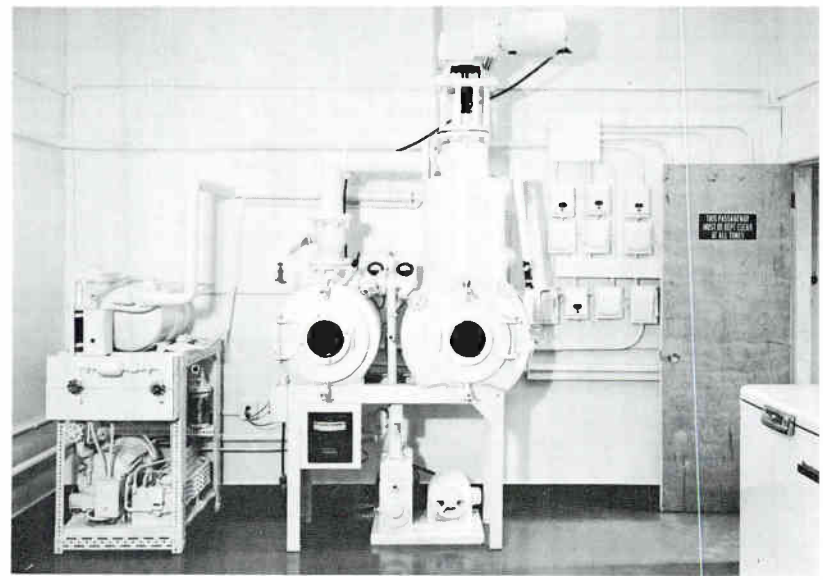
NRC Altitude Chambers that can simulate altitudes up to 400 miles (1×10^{-8} Torr) are widely used to test space-destined electronic and other components. Standard as well as custom-engineered systems, from a 12″ Bell jar to 8′ diameter tank, are available and can be furnished with automatic pressure 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.

FREEZE DRYING



NRC
EQUIPMENT CORPORATION

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Newton 61, Mass. DEcatur 2-5800
A Subsidiary of
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FACTS ABOUT

MYCALEX CORPORATION OF AMERICA

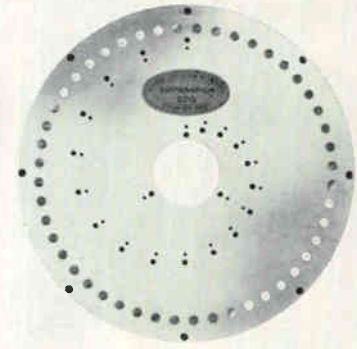
. . . the world's largest manufacturer of glass-bonded mica, ceramoplastic and synthetic mica products . . . important and versatile materials used to solve high-temperature insulation applications up to 1550°F in electrical, electronic, and nucleonic industries.

Machinable formulations:

SUPRAMICA® 620 ceramoplastic — **SUPRAMICA 500** ceramoplastic
MYCALEX® 400 glass-bonded mica — **MYCALEX 385** glass-bonded mica

Precision-molded formulations:

SUPRAMICA 560 ceramoplastic — **SUPRAMICA 555** ceramoplastic
MYCALEX 410 glass-bonded mica — **MYCALEX 410X** glass-bonded mica

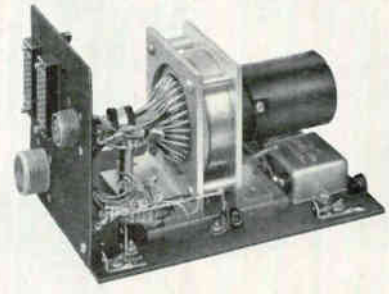


Affiliated Companies

MYCALEX ELECTRONICS CORPORATION

. . . manufacturer of electromechanical commutators for time-division multiplex telemetering, 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.

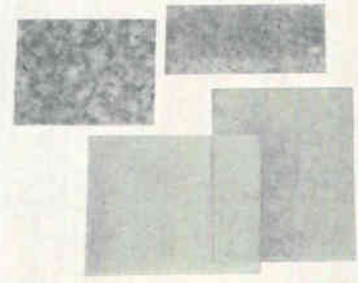
COMMUTATION SWITCHES — COMMUTATOR PLATES



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

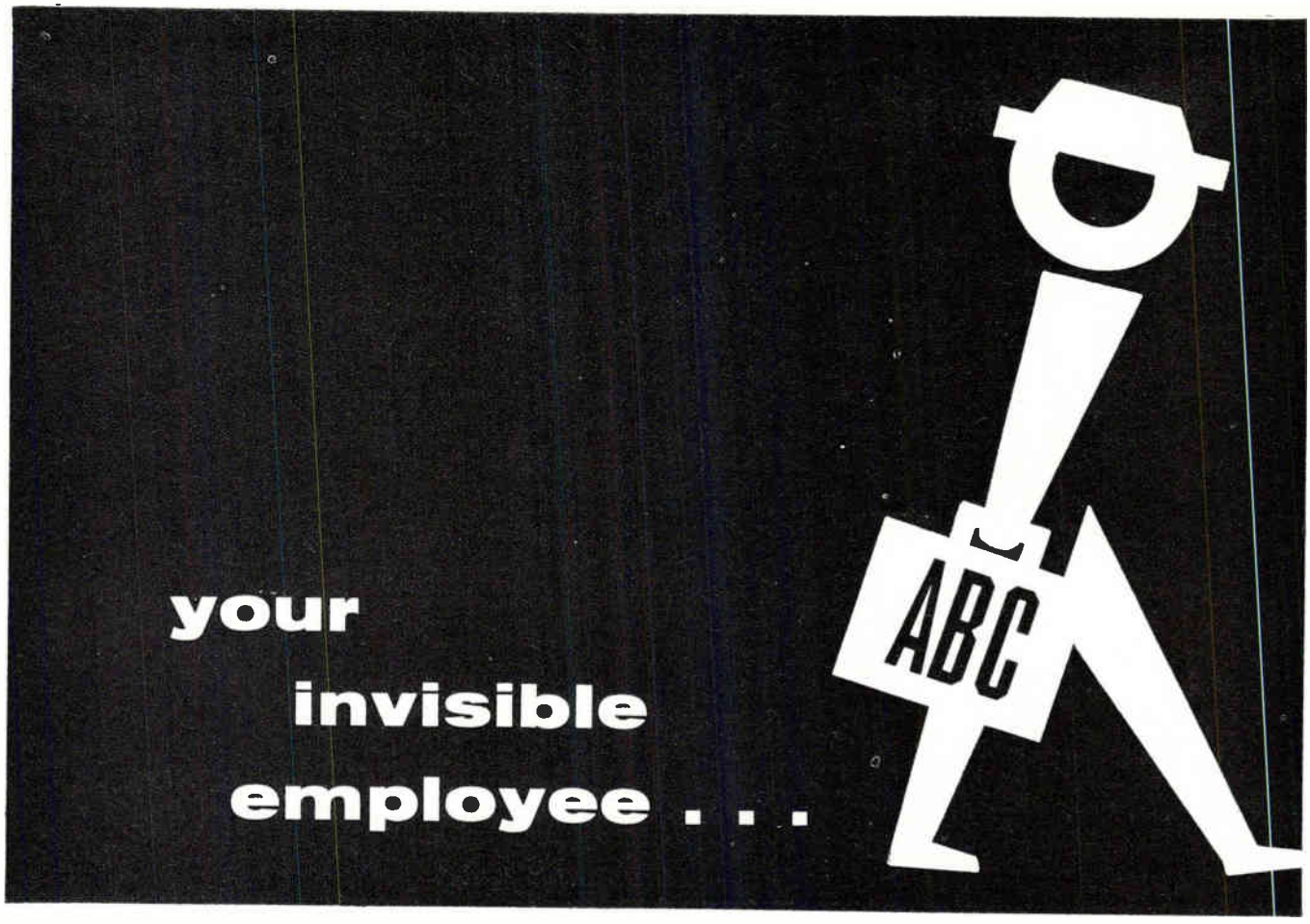
From its inception, MYCALEX CORPORATION OF AMERICA has maintained a staff of experts in the production and engineering of electrical and electronic insulating materials. Their experience includes both commercial and military projects, and present activities encompass both applied research and product 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

SYNTHAMICA® — SUPRAMICA® — MYCALEX®

MYCALEX
CORPORATION OF AMERICA

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.

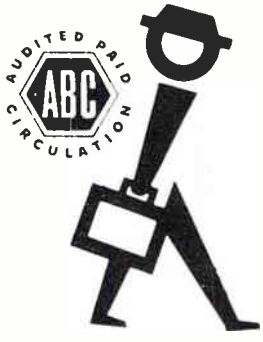
What does he do? He helps to safeguard your advertising investments in print media — by providing audited circulation facts and figures on 2,900 publication members of the Audit Bureau of Circulations*. Assuring an accurate accounting, he tells you how many people purchased the publication . . . where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



electronics

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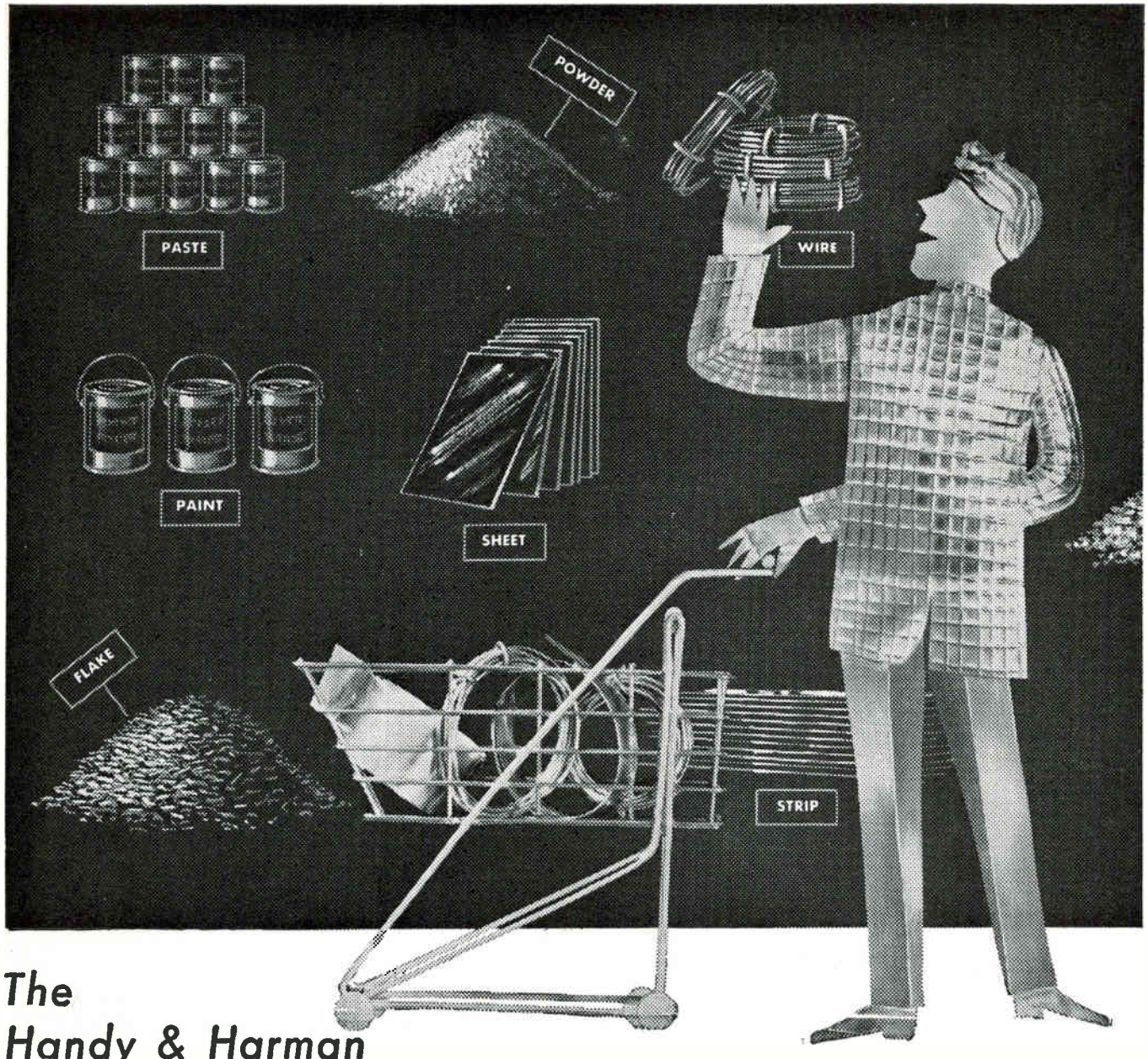

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Silver, in many forms and alloys, is a necessity in the electronics and electrical industries. To meet this need on a high quality level, Handy & Harman manufactures powder, flake, paint, paste, sheet, strip, wire, etc., for printed circuits, wiring, resistors, condensers, thermistors, contacts, printed terminal strips on glass, ceramics, plastic laminates, etc.

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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 1¼-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.

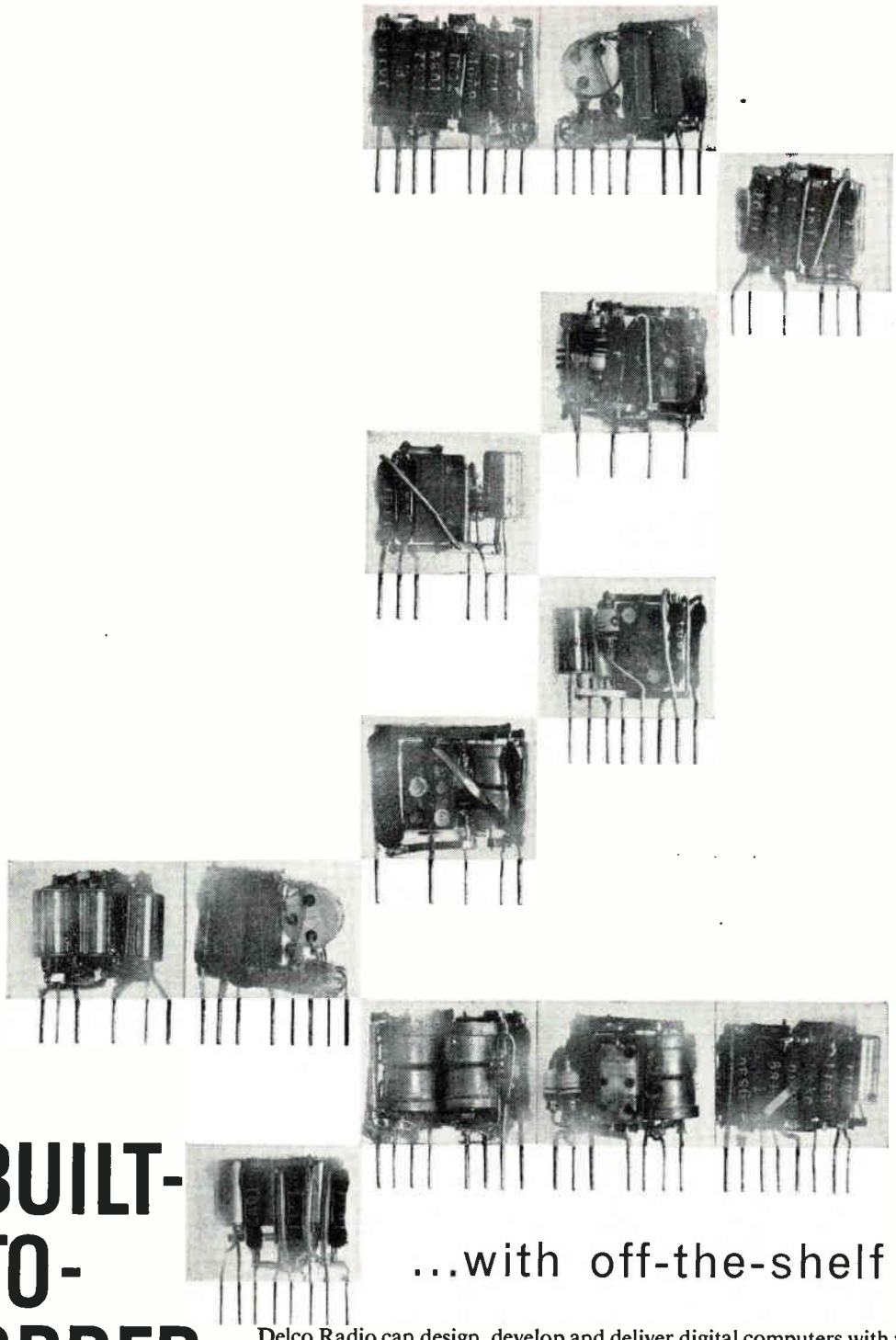
National Aeronautical Corp., Ft. Washington, Pa., shareholders received a yearend stock dividend of two percent on Dec. 30, payable to stockholders of record as of Dec. 15. Cash is being paid in lieu of fractional shares at the rate of $28 per share. NAC paid cash dividends of 5 cents per share in each 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 87½ 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.



BUILT-TO-ORDER COMPUTERS

...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

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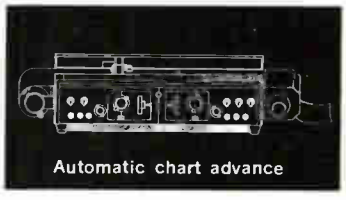
Most Versatile 11" x 17"

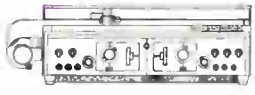
XY RECORDER

MOSELEY MODEL 2D

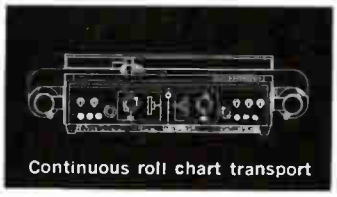
Variable speed motor drive chart transport



Automatic chart advance



Pull-through, tear-off transport



Continuous roll chart transport

All these extra features combined:

• AC or DC input on each axis • Calibrated X-axis time base
• DC accuracy 0.2% full scale • Operates direct from transducer
• Local or remote control • Vacuum recording platen

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 0.1, 0.2, 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:	DC, 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.
Slewing 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 15⅛" deep x 6¾" 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.

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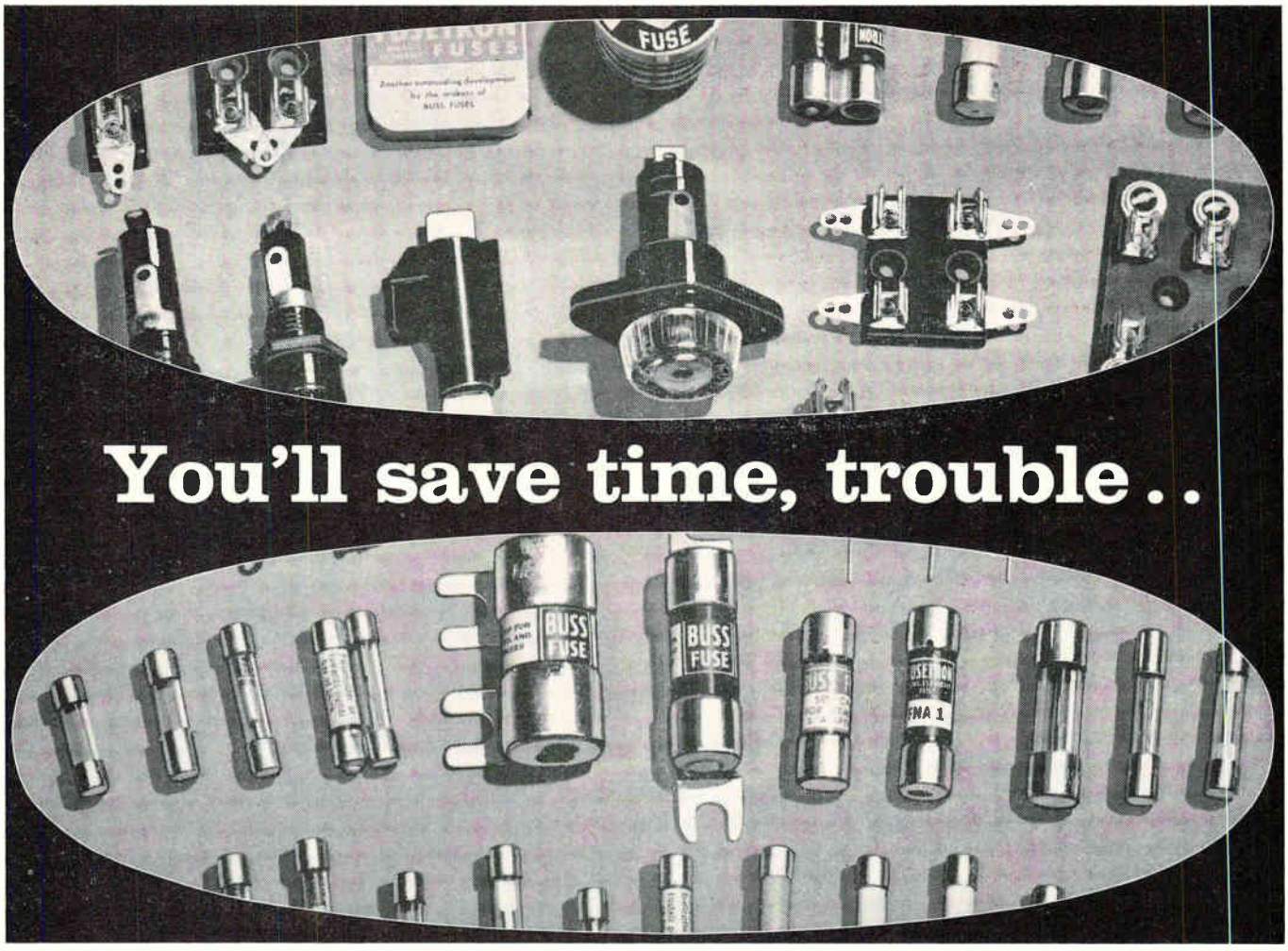

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By relying on BUSS as your source for fuses, you can quickly and easily find the type and size fuse you need. The complete BUSS line of fuses includes: dual-element "slow-blowing", single-element "quick-acting" and signal or visual indicating types . . . 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.

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ELECTRON TUBE NEWS
...from SYLVANIA

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.

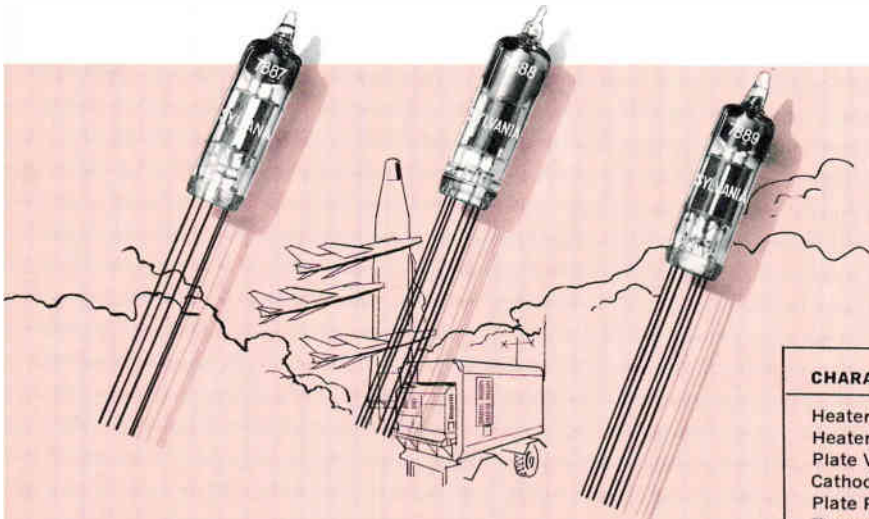
At the heart of each Gold Brand Tube is a remarkable advance in 26.5 volt heater design. This new Sylvania design makes practicable quantity-produced heaters with low heater-power requirements and high mechanical strength. The heater base is a heavy support rod (mandrel) coated with a high-temperature 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^{16}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.



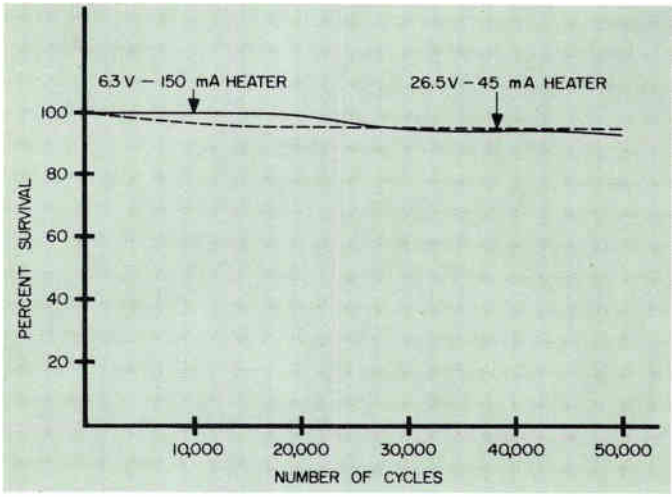
SYLVANIA–7887. Medium-mu double triode; 26.5V, 90mA heater with 100V Eb; designed for oscillator, amplifier and low-power servo circuits.

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.

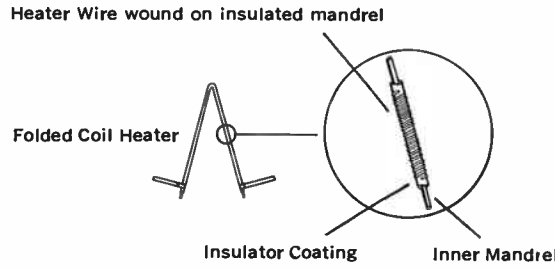
SYLVANIA–7889. High-mu double triode; 26.5V, 45mA heater with 100V Eb; intended for low level audio circuits.

CHARACTERISTICS	7887*	7888	7889*	UNITS
Heater Voltage	26.5	26.5	26.5	V
Heater Current	90	45	45	mA
Plate Voltage	100	100	100	Vdc
Cathode Resistor	220	150	1500	Ohms
Plate Resistance	4000	–	–	Ohms
Transconductance	5000	5800	1800	μmhos
Amplification Factor	20	27	70	–
Plate Current	8.5	8.5	0.8	mAdc
Grid Voltage				
Ib = 100 μAdc Max.	–9	–7	–	Vdc
Ib = 50 μAdc Max.	–	–	–2.8	Vdc

*Each Section



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.

SYLVANIA

N-9171-3

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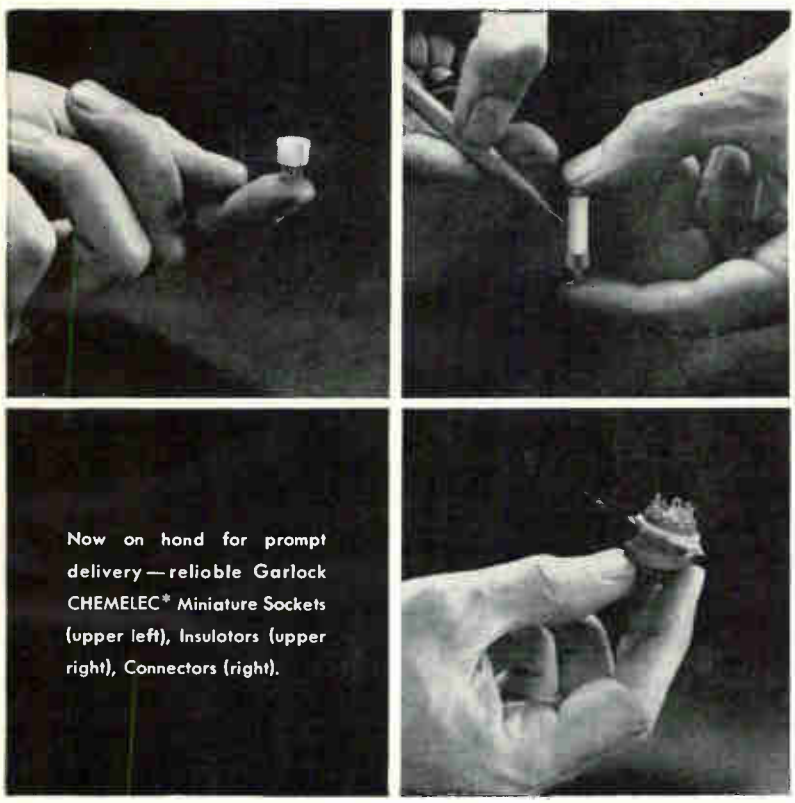
for the Electronics Industry



Now on hand for prompt delivery — relioble Garlock CHEMELEC* Miniature Sockets (upper left), Insulotors (upper right), Connectors (right).

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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:

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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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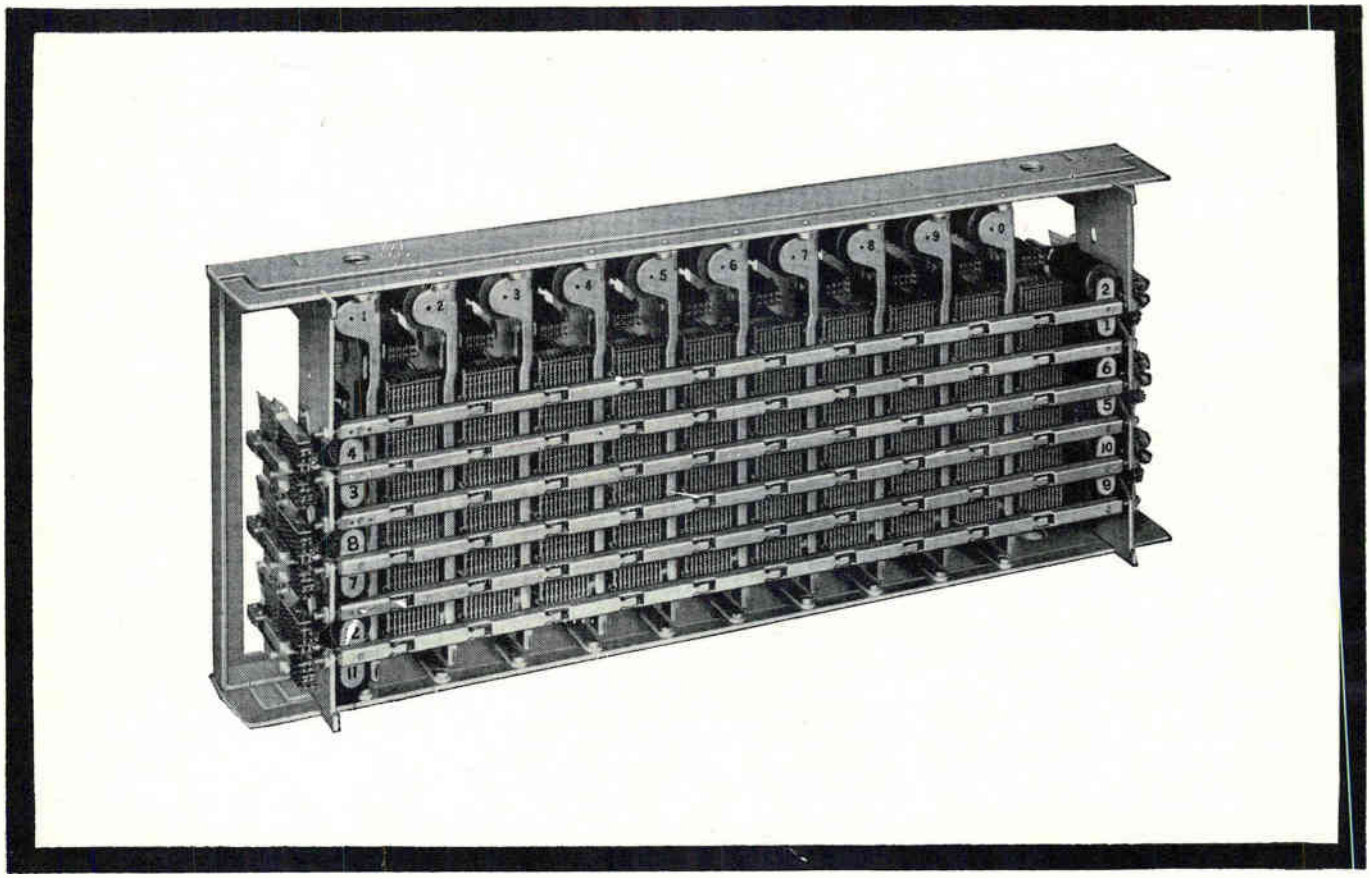

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The 10x10x12 matrix configuration of the North Crossbar Switch, providing up to 1200 switching points, gives the design engineer new efficiency, capacity and versatility in a component that requires minimum space and is economical in cost.

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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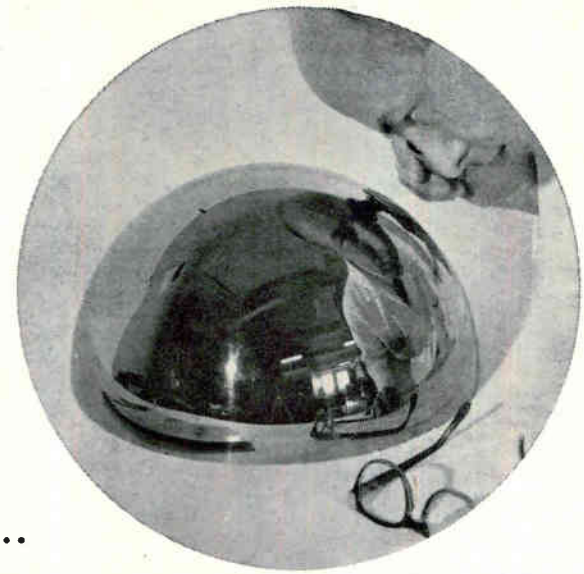

INFRARED DOMES – Largest infrared dome ever manufactured in one piece. Measuring 12 inches in diameter, SERVOFRAX® arsenic trisulfide dome is used on classified Navy search equipment.

From prototype to production...

you'll find the answer in Servo IR

POINT MUGU, Calif., Sept., 1948—*First successful hit by a powered passive radar-guided missile was scored here today. The infrared guidance head for the bullseye "Sky Lark" missile was designed and built by Servo Corporation of America*...a major feat of twelve years ago.

In the past dozen years, a series of similar Servo accomplishments has made big news, all products of Servo infrared research, engineering, and design. Today, Servo leadership is recognized for outstanding achievements in IR detection, guidance, photography, and control.

From a simple IR lens to a complex IR system—from prototype to production—Servo now makes "capability in depth" available to all areas of industry and defense. Take a problem calling for a special glass formulation. *Servo makes its own IR glass.** Or, special optics techniques. *Servo has its own lens grinding and polishing facilities.*

Perhaps a simple modification of one of the many standard Servo IR products will prove the best time- and money-saving solution.

Servo backs up this broad IR capability with development and engineering of analyzers; amplifying equipment; analog-to-digital converters; data links; communication and display equipment; and electronic, electromechanical, electrohydraulic, and electropneumatic servo devices. This is quite a combination of capabilities.

Why look any further? Any way you view the problem, you'll find the best answer at Servo.

Infrared optics

Standard and special optical shapes available in all sizes and in all transmitting materials. Single elements of Servo-manufactured SERVOFRAX® 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.

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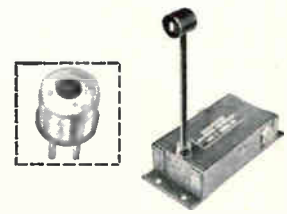
Uniformly sensitive thermistor bolometers and immersed bolometers for fast, accurate, remote infrared radiation detection from ambient to 1000° C. Sealed housings; rugged construction. Response time as low as .001 sec. SERVOFRAX windows from 2-12 microns. (Other window materials and time constants available.) SERVOTHERM circuitry



exploits speed, sensitivity, wide range, low noise, compactness, and flexibility of heat detector cells.

SERVOTHERM® IR radiation pyrometers

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.

Servo IR systems and sub-systems CLASSIFIED

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.

**Infrared optical components and systems*

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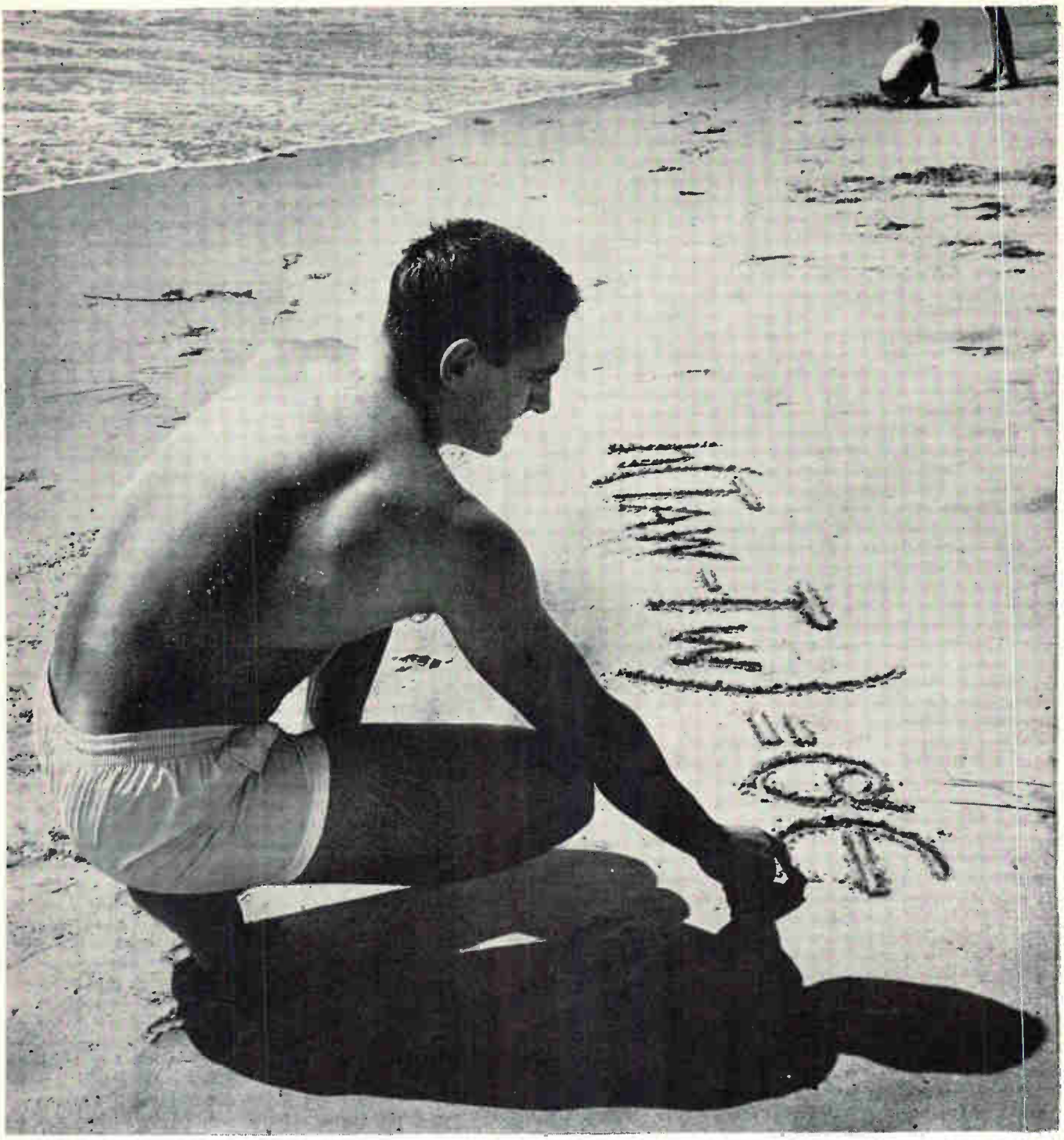

Some ideas just won't wait

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.

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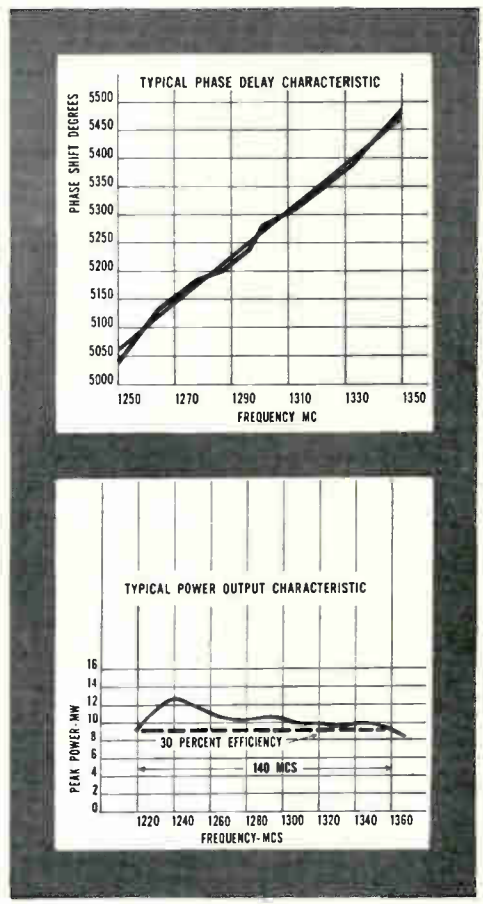
New Broadband Klystrons

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

New additions to the Litton Industries Broadband Klystron family extend broadband 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.



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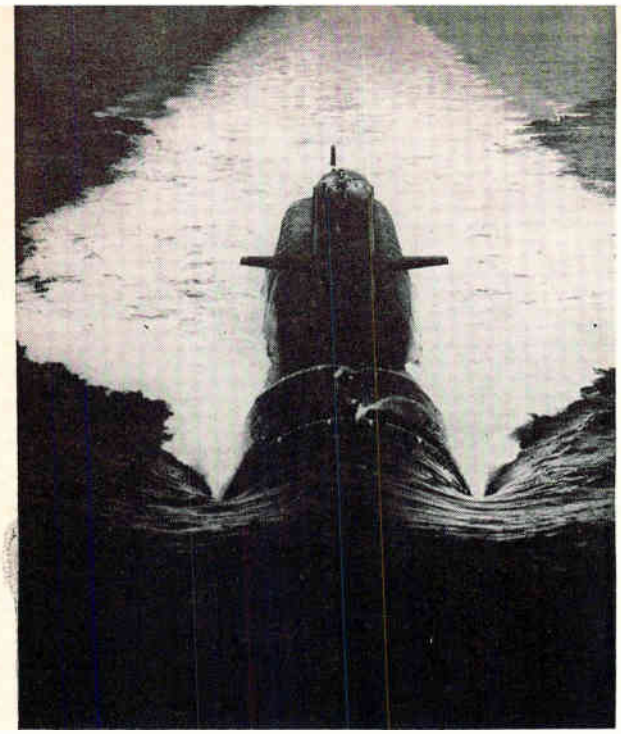
MICROWAVE TUBES AND DISPLAY DEVICES

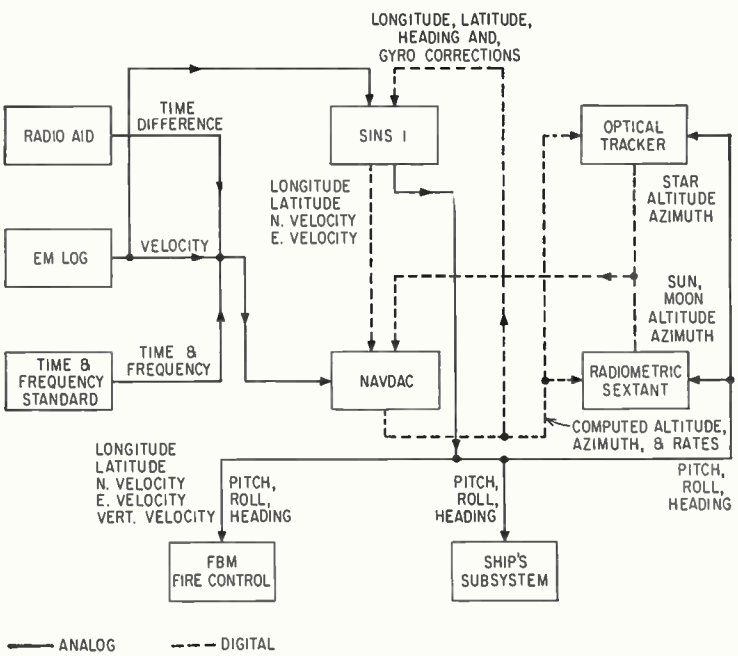
"Capability that can change your planning"

Computer Helps Polaris



NAVDAC-equipped Polaris submarine Robert E. Lee underway. Computer will maintain navigational acuracy 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

By LEON H. DULBERGER
Assistant Editor

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, Mar. 7, May 2, '58) observation of ocean-bottom topography using sonar; radio aids similar to loran with improved accuracy and undersea 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.

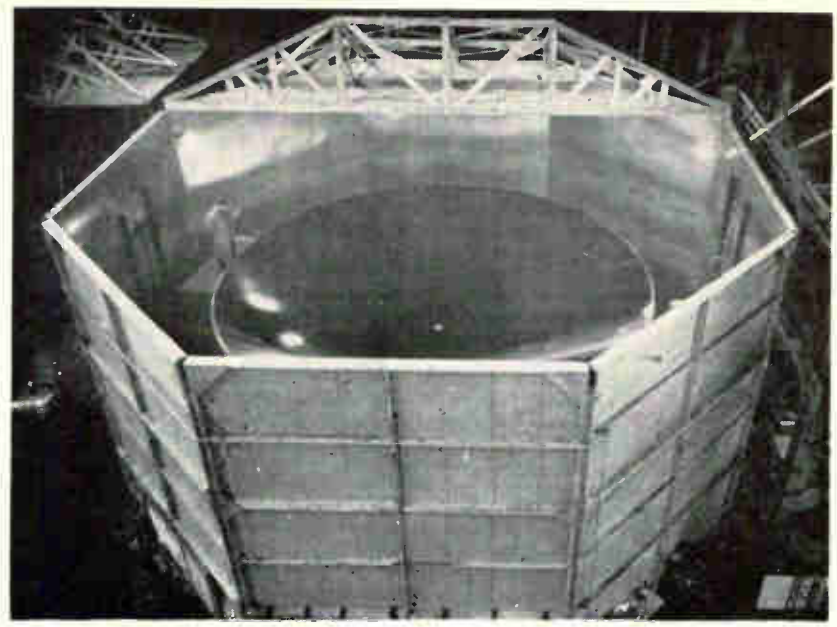
Time sharing in the computer permits many navigational techniques to be carried out at once to avoid overlong periscope exposure, allowing the nuclear powered sub to remain hidden for long periods.

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.



Twenty-eight-foot spuncast parabolic reflector, fabricated by D. S. Kennedy & Co., has precision surface needed for high-frequency radiation work

Millimeter Waves to Map Moon

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.

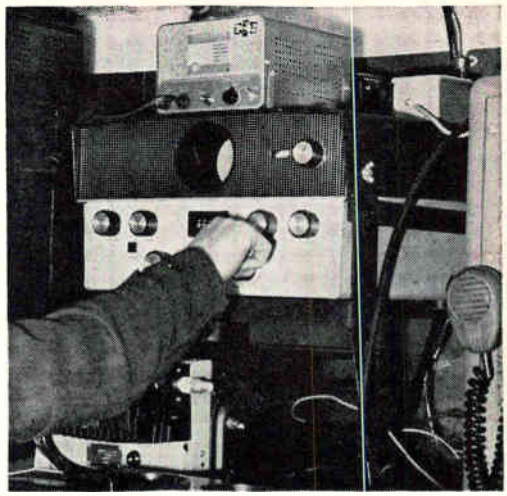
A parabolic surface of near-optical precision is said to be obtained by the spincasting process, in which a huge pool of plastic is spun on an industrial merry-go-round to produce a parabolic surface accurate to between 5 and 10 thousandths of a wavelength.

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.

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



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

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

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

Equipment

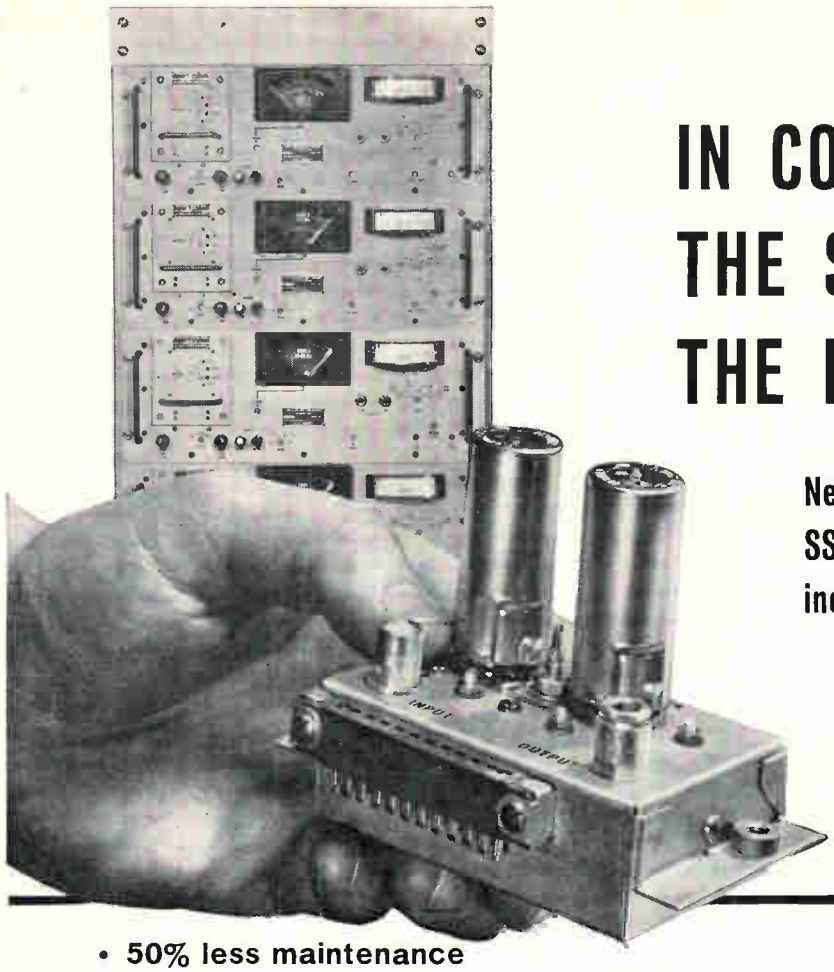
other recurring duty. This, in turn, effects a saving in operating cost.

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 fish-finder. 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.



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 communication 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.*

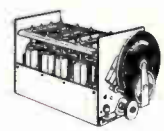
The SX-116 weighs in at just 36 lbs.—equally practical for fixed, mobile, air or seaborne installations. *And its initial cost is very substantially lower.*

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

hallicrafters

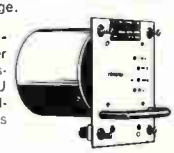
Military Electronics Division, Chicago 24, Illinois

100% modular construction—only seven basic components



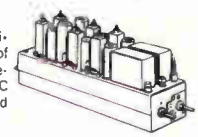
RF Module. Image and IF rejection maintained at better than 70 db. Single tuned circuit between antenna and RF grid. Four-channel, continuous tuning—2.0 mc. to 30 mc. range.

HF Crystal Oscillator Module. Stability: 1 in 10^6 per month. Capacity is four crystals; designed for HC-6/U metal or glass crystal holders. Oven temp. varies less than ±0.01°C.



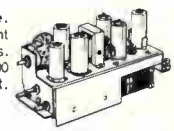
Injection Amplifier Module. AGC-controlled wide-band video amplifier provides constant injection level.

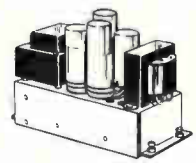
IF Module. Allows simultaneous reception of upper and lower sideband, independent AGC control of upper and lower sideband.



BFO Module. Operates at 1650.000 kc. Oscillator frequency stabilized in separate oven. Plate and filament voltages regulated.

Audio Amplifier Module. Features duel, independent 100-milliwatt line amplifiers. Hum level is 80 db. below 100 milliwatts. Harmonic dist. less than 0.5%.





Power Supply Module. Separate transformers provided for regulated and non-regulated voltages. Local oscillator and BFO filament supply are regulated for ±10% line voltage variations!

Write for complete specifications on the SX-116.

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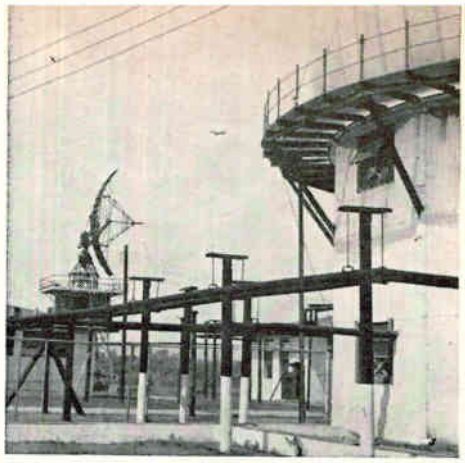


Computer gear for Air Force reconnaissance system gets final check at Burroughs plant (left). Airborne radar search system will telemeter processed data to Sage ground stations like this (right) for relay through the network.

New Radar System Going Aloft

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 reconnaisance 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-reconnaisance 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.

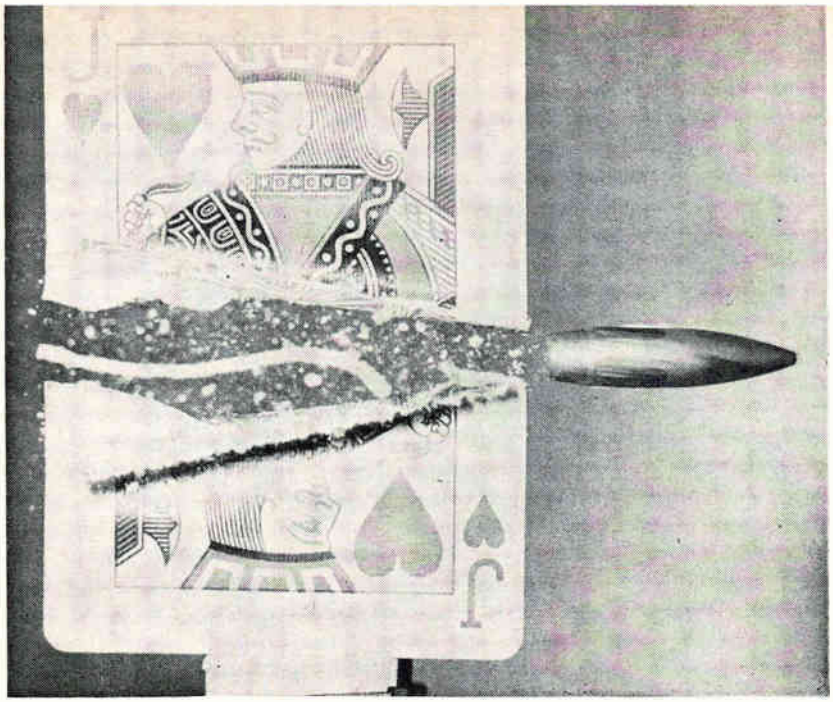
Working closely with the doppler radar suppliers is AC Sparkplug division of General Motors. Contract with the divsion calls for airborne inertial reference units. Being supplied are three-gimbal gyro-stabilized inertial platforms for providing true heading for the aircraft through continuous airborne 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.

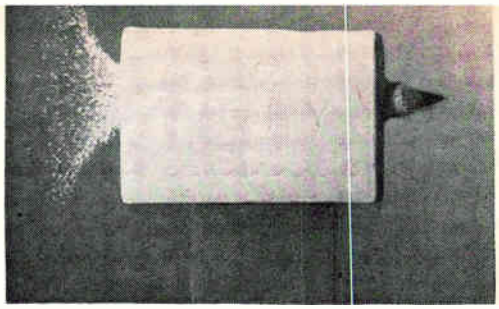
The data link for air-to-ground communications is rated at one Kw, and forms part of the equipment being supplied by Electronic Communications, Inc. Other items in ECI's $10.3 million share of the work include a complete ground receiver, an antenna positioning system, and airborne one-Kw data link and 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.

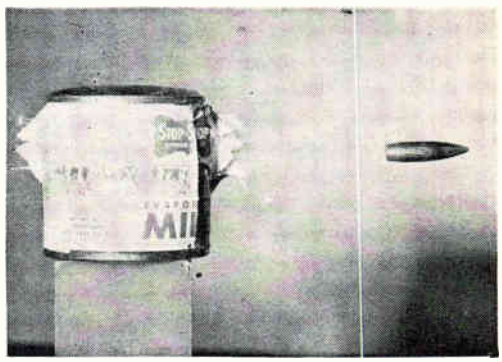
Packard Bell's Technical Products division has a subcontract for $½ million to modify the identification radar that will be used in ALRI, and also to produce the hardware and modification kits for equipment related to the Mark X SIF/IFF units. PB spokesmen report that the decoding functions of the radar system use solid-state components.

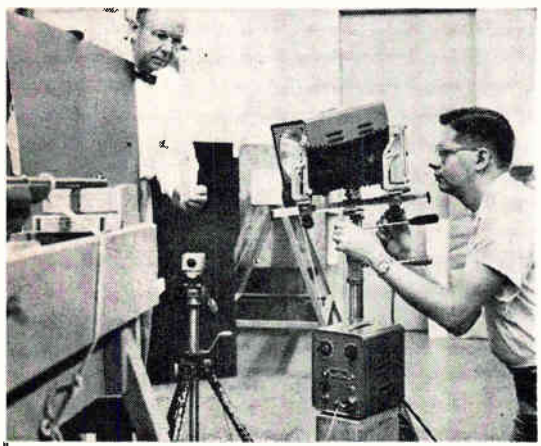
Under a $3-million contract, Philco Corp. is charged with responsibility for design and factory modification of ALRI's height finder radar gear including the addition of counter-counter measure capability, a feature not present in air reconnaisance installations of Sage.

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 candlepower 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 lamp 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.

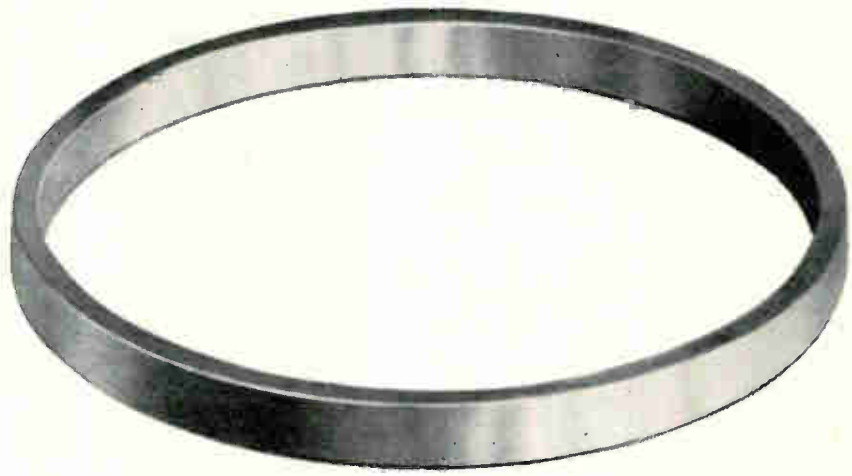
Even the limited Echo tests are proving the value of such advances as a maser amplifier so sensitive a special horn antenna had to be designed to shield it from the microwave-range heat of earth.

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 ⅝″ — 1¼″ — 1⅝″ — 2″ — 3″ — 5″ diameter in various mounting styles. It can be used with confidence over a wide range of environmental requirements.

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"INTEGRALS OF HIGH PERFORMANCE"

Computer (left) and screen of random-access projector (right) are key elements in SDC teaching machine

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.

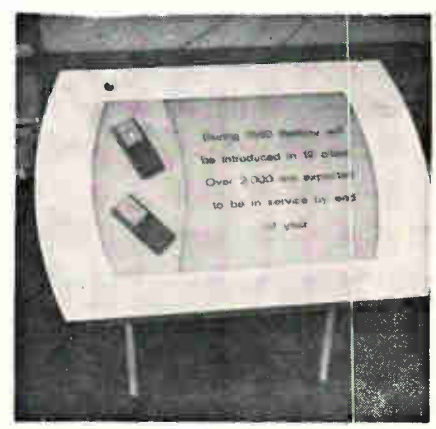
Sensitive Infared Scanner Uses Ultracooled Detector

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."

Electronics On The Move



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 ¼ 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.

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Clecomatic No. 10 Series Screwdriver– Nut-Runner

Clecomatic Right Angle Nut-Runner

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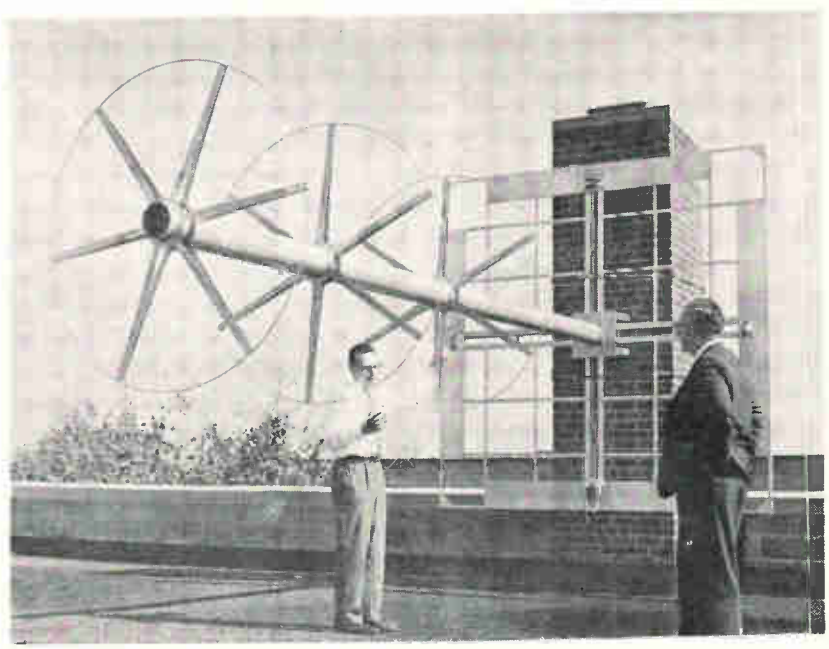
Organic Semiconductor Conference

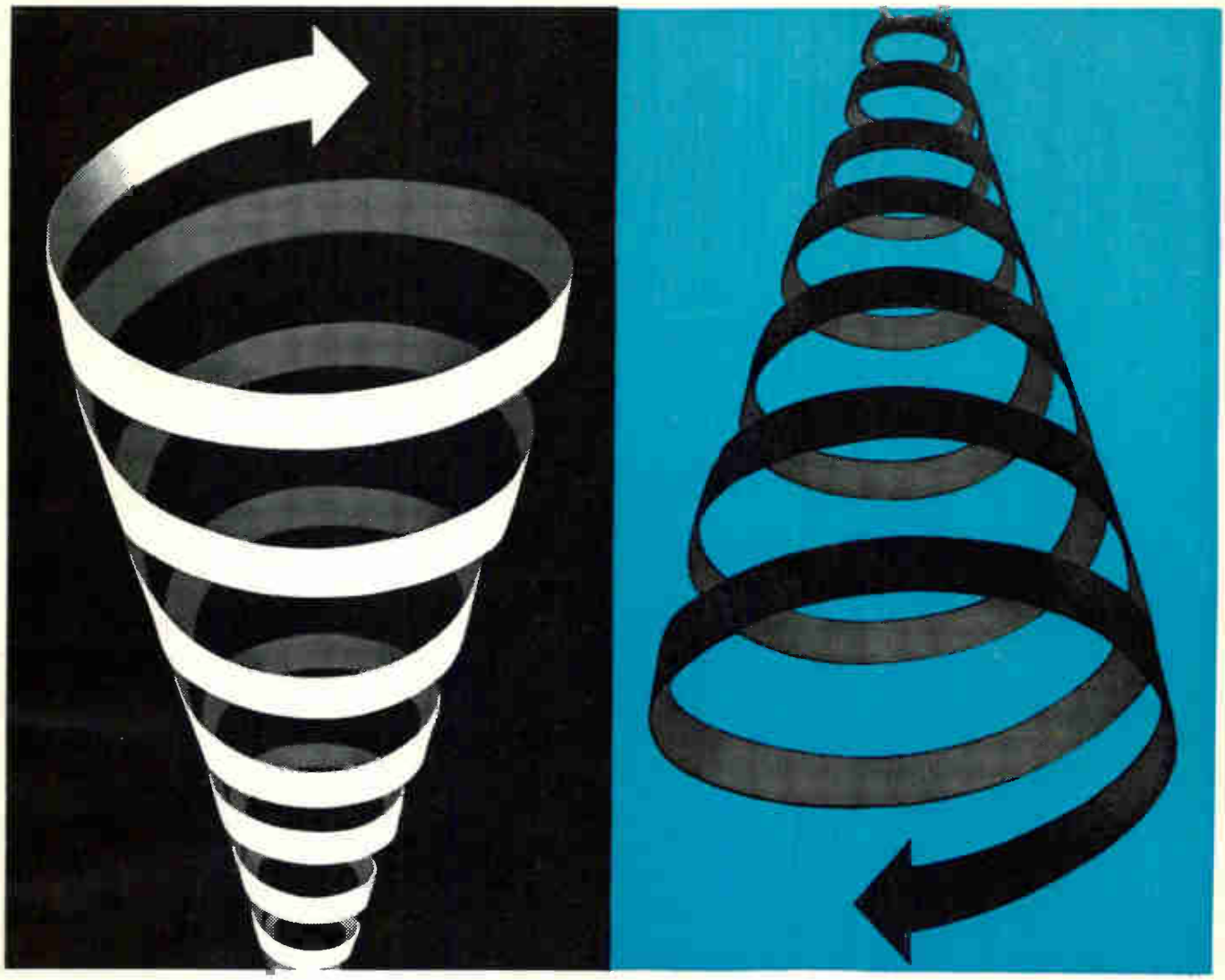
COSPONSORED by Armour Research Foundation and ELECTRONICS magazine, a special interindustry conference will be held in Chicago's Morrison Hotel on April 18 and 19. Purpose of the conference will be to present a comprehensive coverage of organic semiconductors, including the latest results of research 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 reseach 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 vhf 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



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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.

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MEETINGS AHEAD

Jan. 8-12: Thermoelectric Energy Conversion, Dept. of Defense, Joint Technical Society; Statler-Hilton Hotel, Dallas.

Jan. 9-10: Plasma Dynamics; Southern Methodist Univ., Dept. of Mech. Engineering, Dallas.

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

Jan. 12-13: Reliability of Semiconductor Devices, Working Group on Electron Tubes; Western Union Auditorium, New York City.

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. 24-27: Society of Plastic Engineers, Annual; Shoreham and Sheraton-Park Hotels, Washington, D. C.

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.

Feb. 15-17: Solid State Circuit Conf., International, PGCT of IRE, AIEE; Univ. of Penn. & Sheraton Hotel, Philadelphia.

Mar. 9-10: Engineering Aspects of Magnetohydrodynamics, PGNS of IRE, AIEE, IAS; University of Penn., Philadelphia.

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

NUMBER 5—RELIABILITY SERIES

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.

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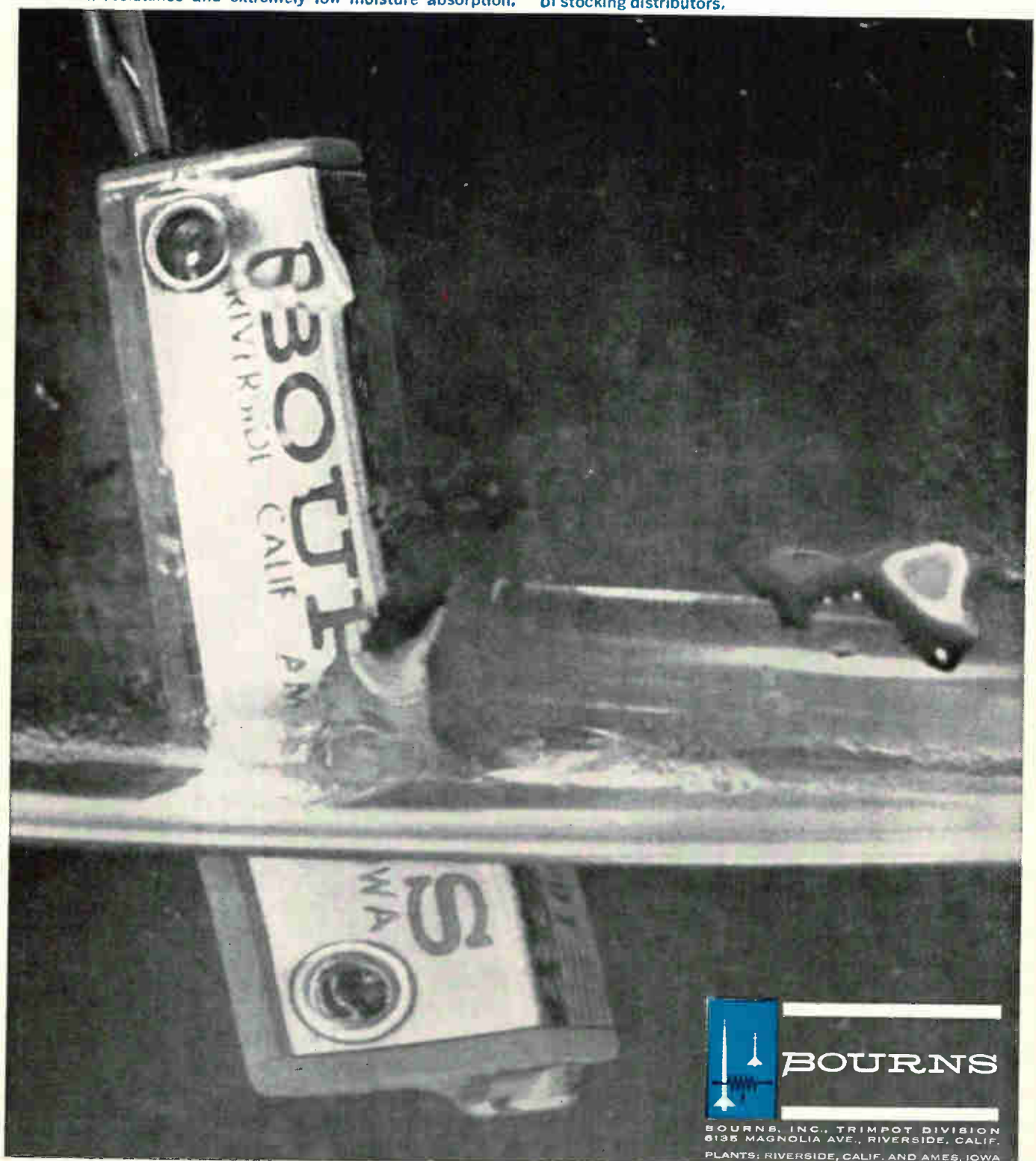
For more information about the industry's largest selection of humidity-proof adjustment potentiometers—wirewound and carbon in a variety of sizes, power ratings, operating temperatures, etc.—write for new Trimpot summary brochure and list of stocking distributors.



Exclusive manufacturers of Trimpot®, Trimit®, and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

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 producing capacity stall its investment in new facilities until the capacity is more fully used. One is that a lot of this capacity is obsolete and costly to operate. Increasingly rugged competition is creating a strong inducement to replace this antique capacity with modern, more efficient equipment which is widely available.

PLANS FOR CAPITAL SPENDING
(Billions of Dollars)

INDUSTRY	1959 Actual*	1960 Estimated*	1961 Planned	1960-1961 % Change	1962 Planned
Iron and Steel	$1.04	$1.52	$1.37	—10%	$1.18
Nonferrous Metals	.31	.34	.34	0	.32
Machinery	.91	1.15	1.11	— 3	1.11
Electrical Machinery	.52	.62	.68	+10	.63
Autos, Trucks & Parts	.64	.89	.95	+ 7	1.02
Transportation Equipment (Aircraft, Ships, R.R. Eq'pt.)	.39	.41	.37	—10	.35
Other Metalworking	.88	.97	.85	—12	.87
Chemicals	1.24	1.61	1.64	+ 2	1.59
Paper and Pulp	.63	.75	.69	— 8	.53
Rubber	.19	.24	.23	— 4	.20
Stone, Clay and Glass	.53	.63	.56	—11	.55
Petroleum & Coal Products	2.49	2.45	2.52	+ 3	2.50
Food and Beverages	.82	.94	.99	+ 5	.97
Textiles	.41	.53	.42	—21	.40
Miscellaneous Manufacturing	1.07	1.28	1.21	— 5	1.13
ALL MANUFACTURING	12.07	14.33	13.93	— 3	13.35
Mining	.99	.99	.90	— 9	.89
Railroads	.92	1.04	.79	—24	.83
Other Transportation & Communications	4.69	5.20	4.61	—11	4.18
Electric And Gas Utilities	5.67	5.89	6.14	+ 4	6.01
Commercial (1)	8.21	8.61	8.70	+ 1	8.54
ALL BUSINESS	32.55	36.06	35.07	— 3	33.80

*U.S. Department of Commerce, Securities and Exchange Commission, McGraw-Hill Department of Economics.

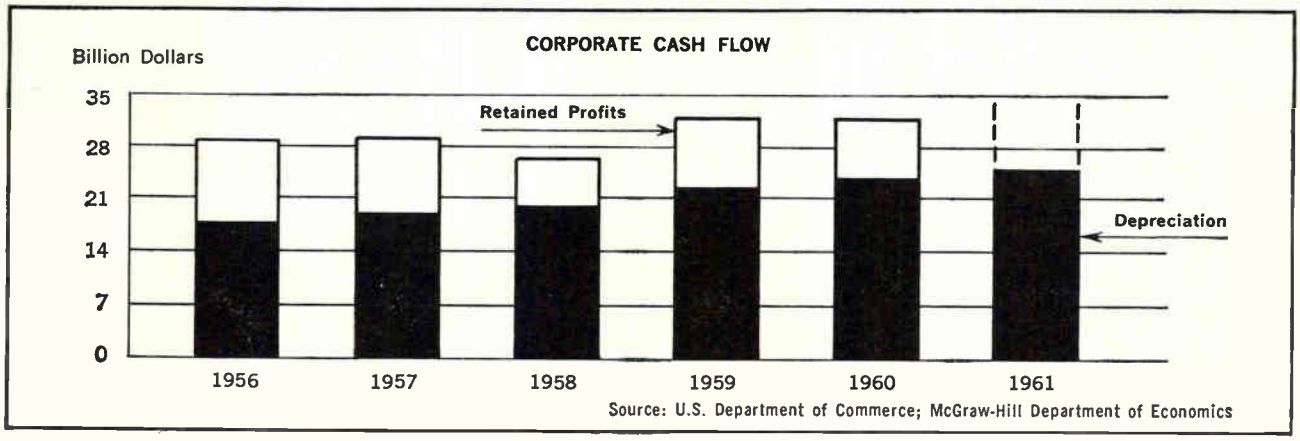
(1) Figure based on large chain, mail order and department stores, insurance companies, banks and other commercial businesses.

"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.

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



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

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.

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*The significance of this boom for American industry is analyzed in a new McGraw-Hill book, "The Research Revolution" by Leonard Silk, Economics Editor of BUSINESS WEEK. Together with other new business investment trends the "R & D" boom also constitutes a key part of another new McGraw-Hill book, "New Forces in American Business" by Dexter M. Keezer and associates — the November selection of the Business Book Club.

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 C. McGraw

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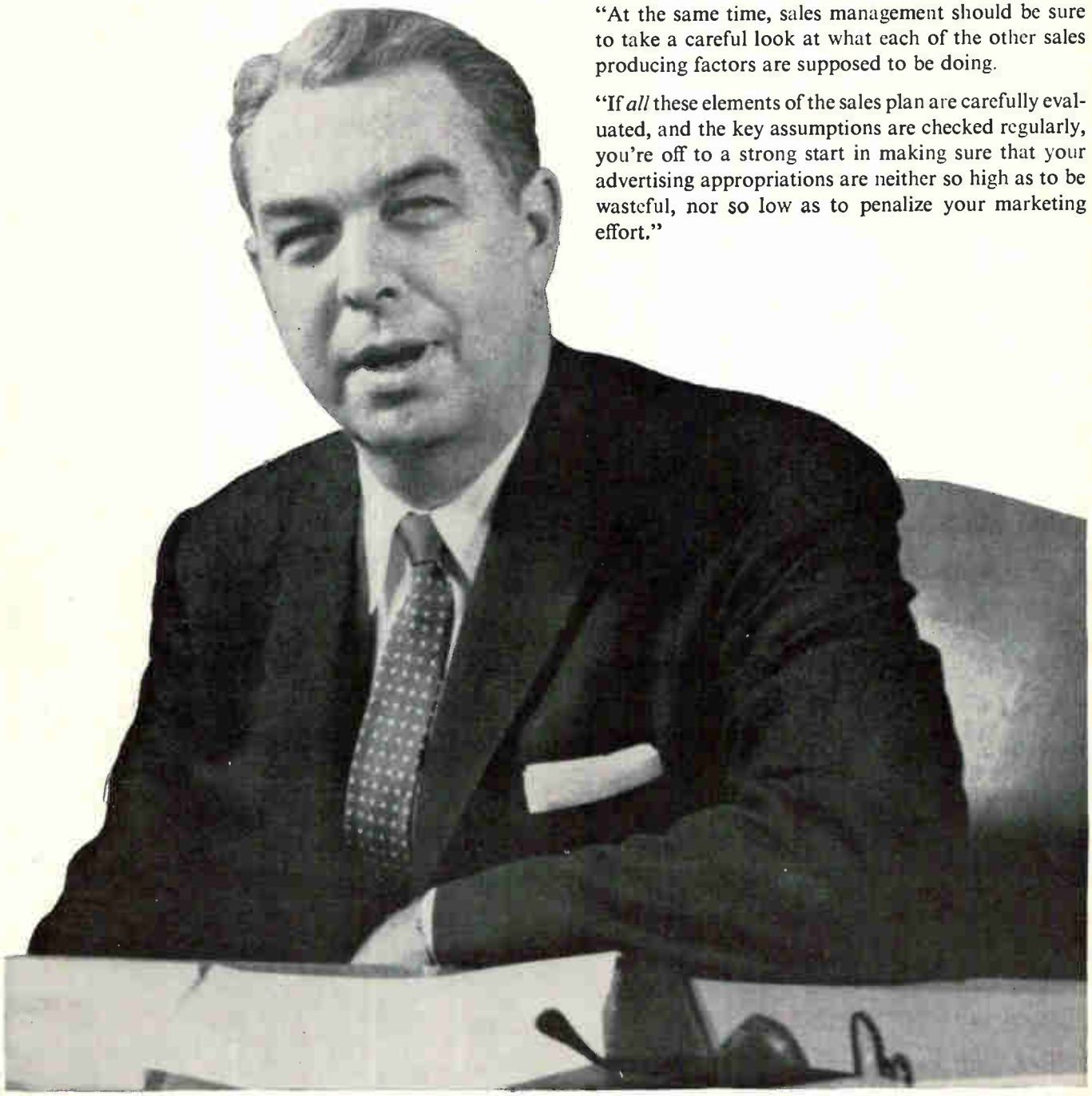

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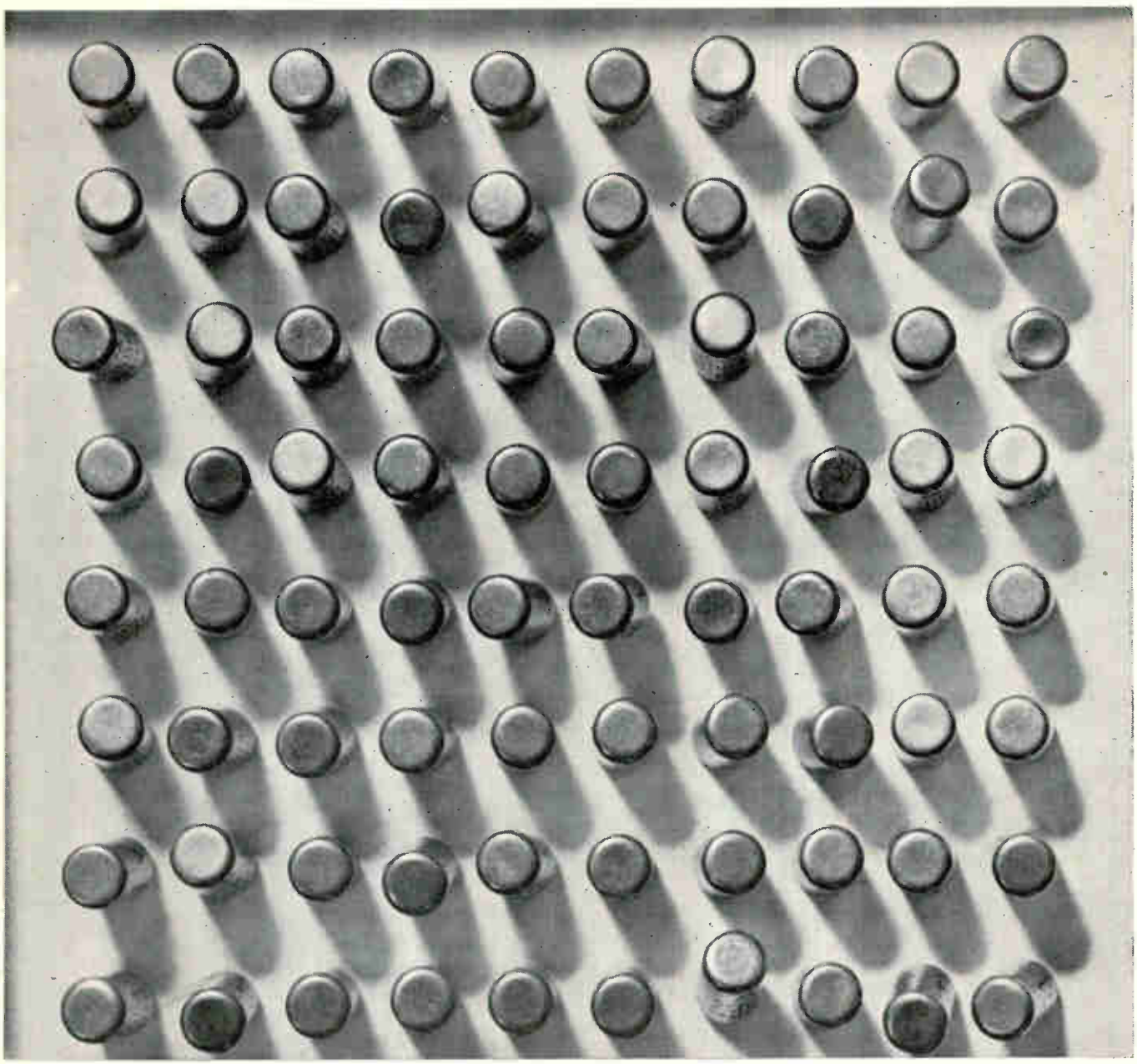

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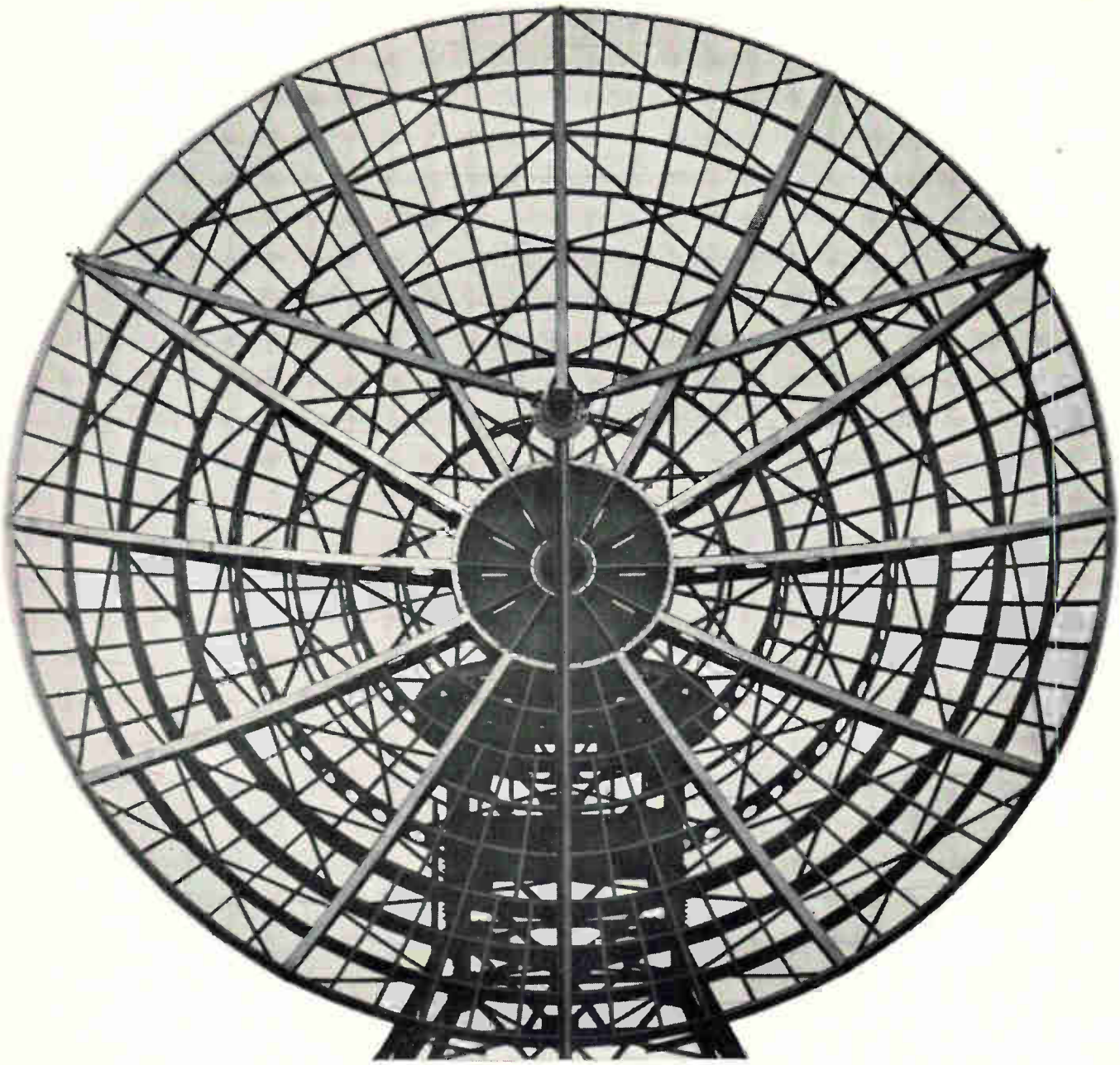

In electronics, you have to look twice at Japan

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.

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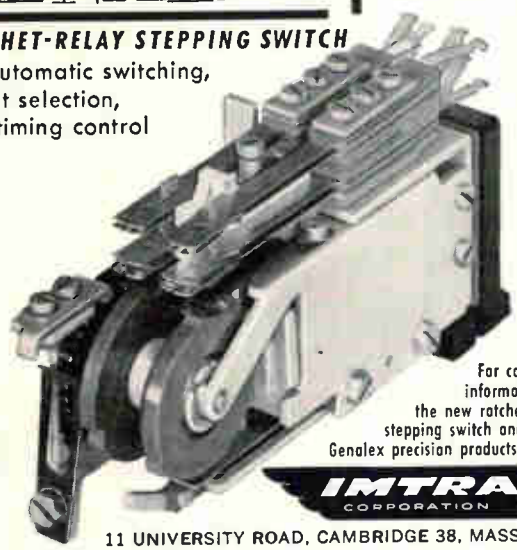

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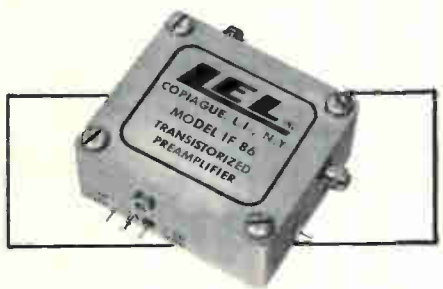

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0-7	0-10	*TO7-10	7	19	15
0-7	0-5	*TO7-5	5¼	19	15
0-7	0-3	*TO7-3	3½	19	12½
0-14	0-20	*TO14-20	15¾	19	16
0-14	0-10	*TO14-10	8¾	19	15
0-14	0-7.5	*TO14-7.5	7	19	15
0-14	0-5	*TO14-5	5¼	19	15
0-14	0-3	*TO14-3	3½	19	12½
0-32	0-30	TO32-30	15¾	19	16
0-32	0-15	TO32-15	8¾	19	15
0-32	0-10	TO32-10	7	19	15
0-32	0-5	TO32-5	5¼	19	15
0-32	0-3	TO32-3	3½	19	12½
0-36	0-30	TO36-30	15¾	19	16
0-36	0-15	TO36-15	8¾	19	15
0-36	0-10	TO36-10	7	19	15
0-36	0-5	TO36-5	5¼	19	15
0-36	0-3	TO36-3	3½	19	12½
0-60	0-15	TO60-15	15¾	19	15
0-60	0-7.5	TO60-7.5	8¾	19	15
0-60	0-5	TO60-5	7	19	15
0-60	0-2.5	TO60-2.5	5¼	19	15
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5-7.5	0-5	T6-5	5¼	19	15
5-7.5	0-3	T6-3	3½	19	12½
7-11	0-15	T9-15	8¾	19	15
7-11	0-10	T9-10	7	19	15
7-11	0-5	T9-5	5¼	19	15
11-14	0-30	T12-30	15¾	19	16
11-14	0-15	T12-15	8¾	19	15
11-14	0-10	T12-10	7	19	15
11-14	0-5	T12-5	5¼	19	15
11-14	0-3	T12-3	3½	19	12½
14-17	0-15	T16-15	8¾	19	15
14-17	0-10	T16-10	7	19	15
14-17	0-5	T16-5	5¼	19	15
17-20	0-15	T19-15	8¾	19	15
17-20	0-10	T19-10	7	19	15
17-20	0-5	T19-5	5¼	19	15
20-23	0-15	T22-15	8¾	19	15
20-23	0-10	T22-10	7	19	15
20-23	0-5	T22-5	5¼	19	15
22.5-27	0-30	T25-30	15¾	19	16
22.5-27	0-12	T25-12	8¾	19	15
22.5-27	0-10	T25-10	7	19	15
22.5-27	0-5	T25-5	5¼	19	15
22.5-27	0-3	T25-3	3½	19	12½
25-31	0-30	T28-30	15¾	19	16
25-31	0-12	T28-12	8¾	19	15
25-31	0-10	T28-10	7	19	15
25-31	0-4.5	T28-4.5	5¼	19	15
25-31	0-3	T28-3	3½	19	12½
31-33.5	0-30	T32-30	15¾	19	16
31-33.5	0-12	T32-12	8¾	19	15
31-33.5	0-10	T32-10	7	19	15
31-33.5	0-5	T32-5	5¼	19	15
31-33.5	0-3	T32-3	3½	19	12½
33.5-36	0-30	T35-30	15¾	19	16
33.5-36	0-12	T35-12	8¾	19	15
33.5-36	0-10	T35-10	7	19	15
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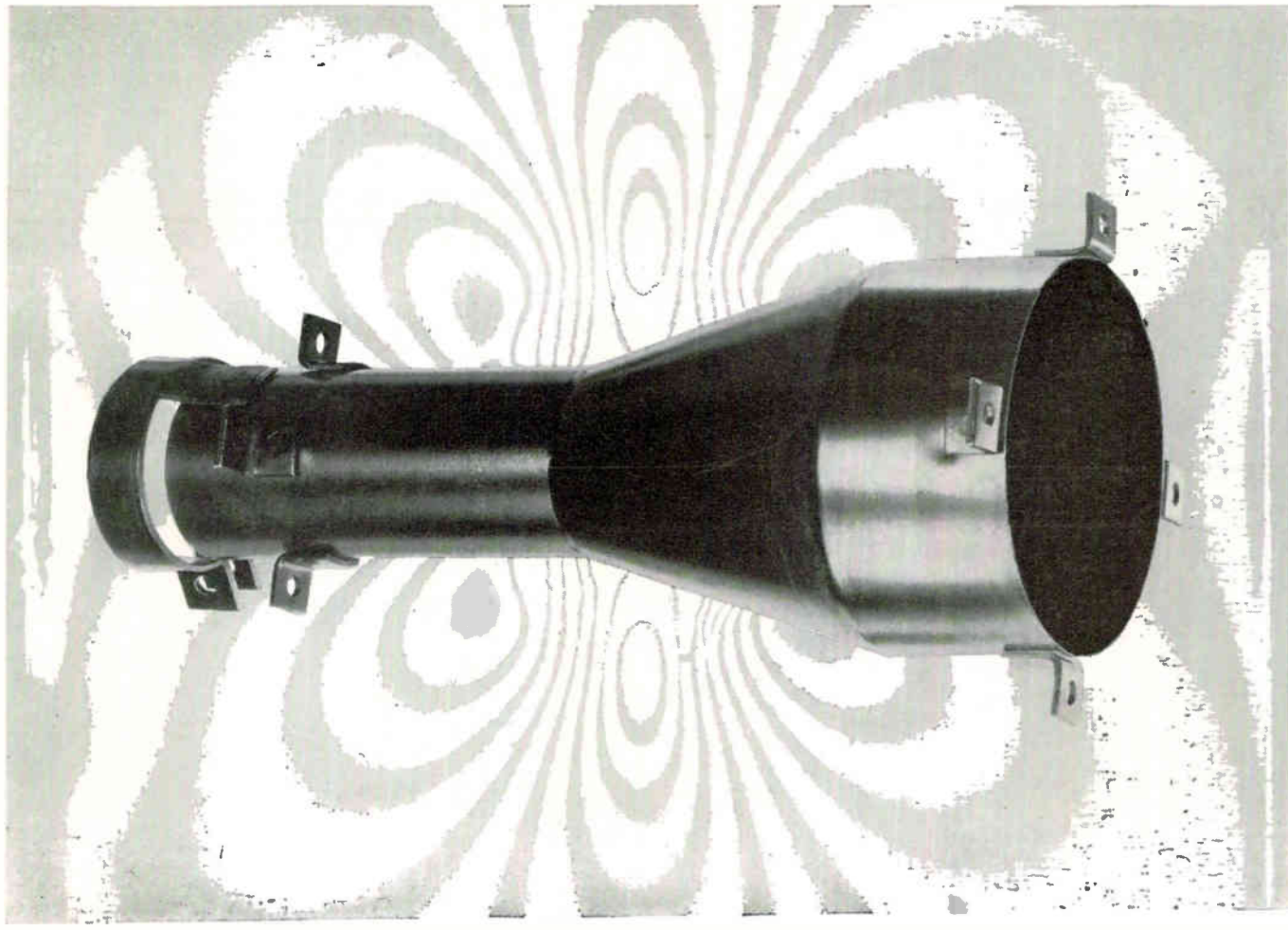

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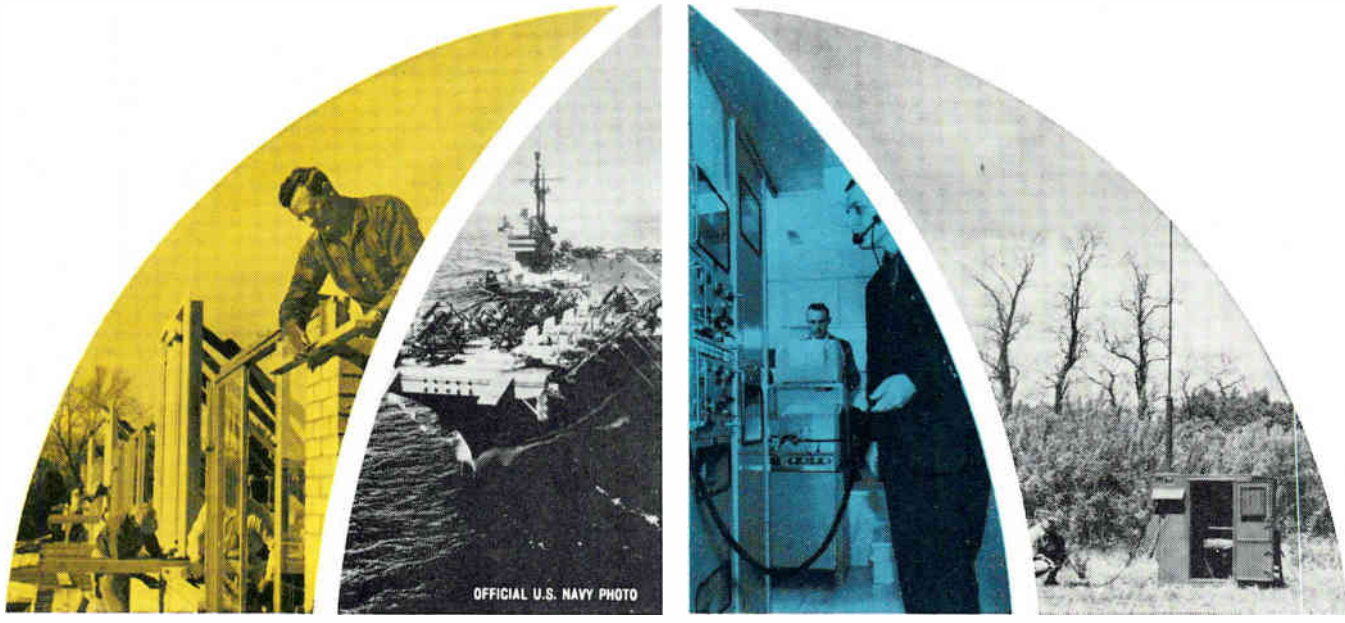

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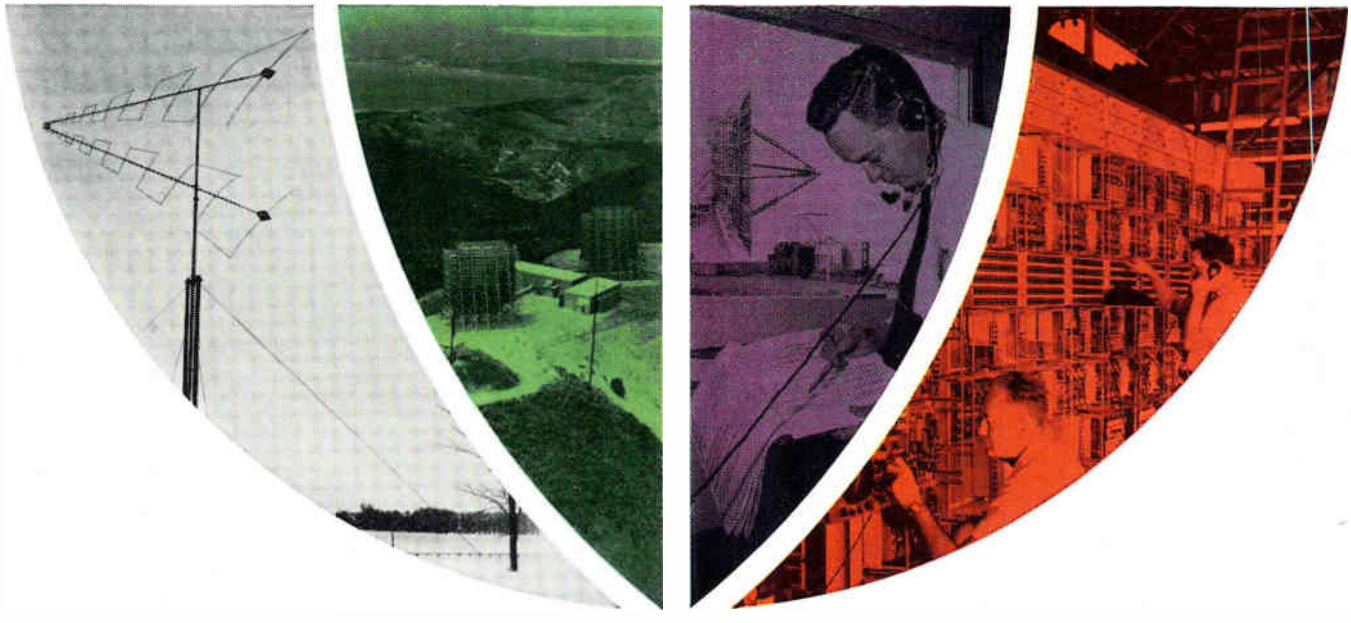
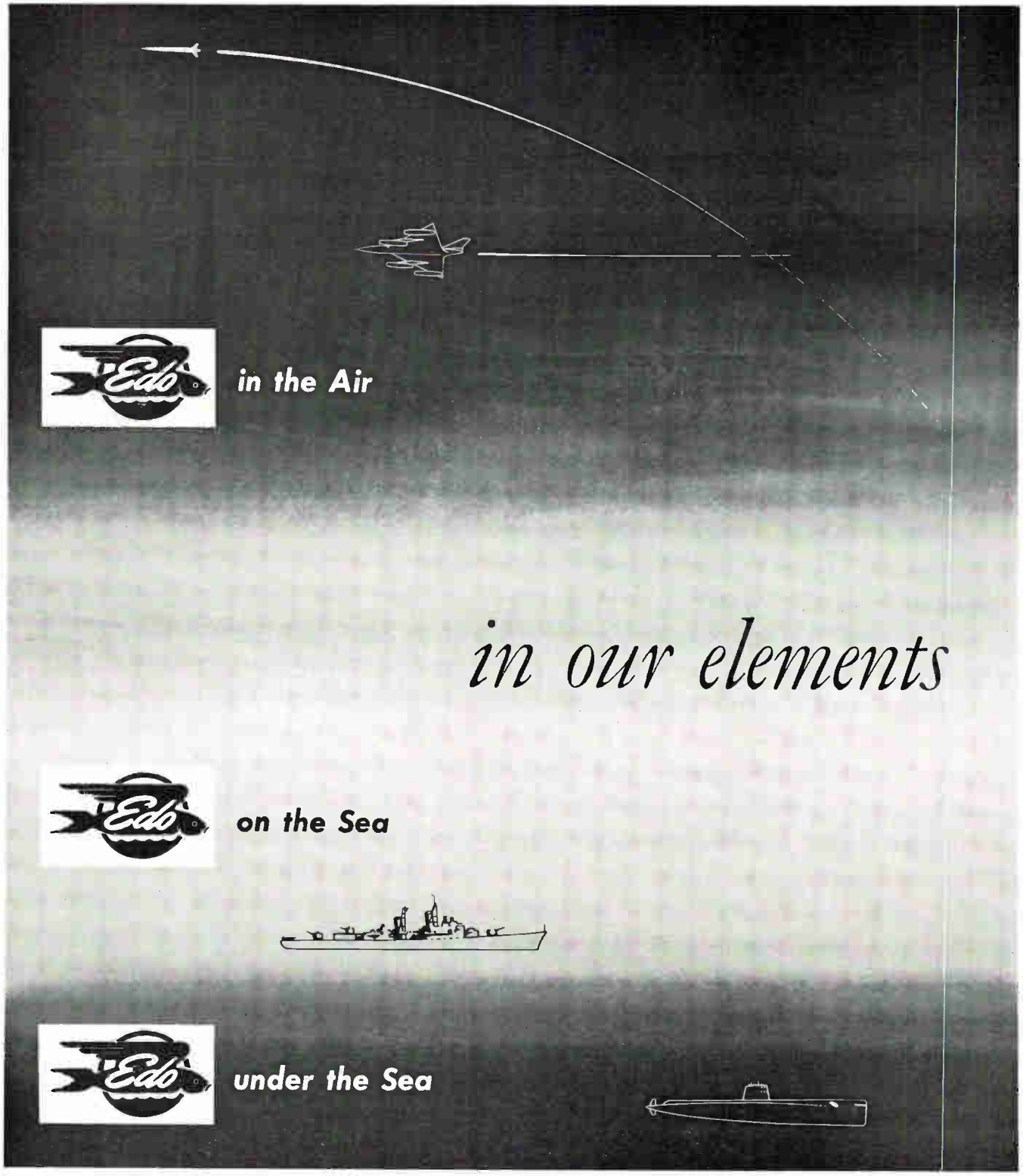




EDO, specialist in underwater electronics, designs and manufactures a wide range of echo-ranging and listening sonar equipments for the Navy's surface ships and submarines. Edo-built sonar "eyes"—looking upward, downward and ahead—have helped the nuclear submarines NAUTILUS, SKATE, SARGO and SEADRAGON 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.

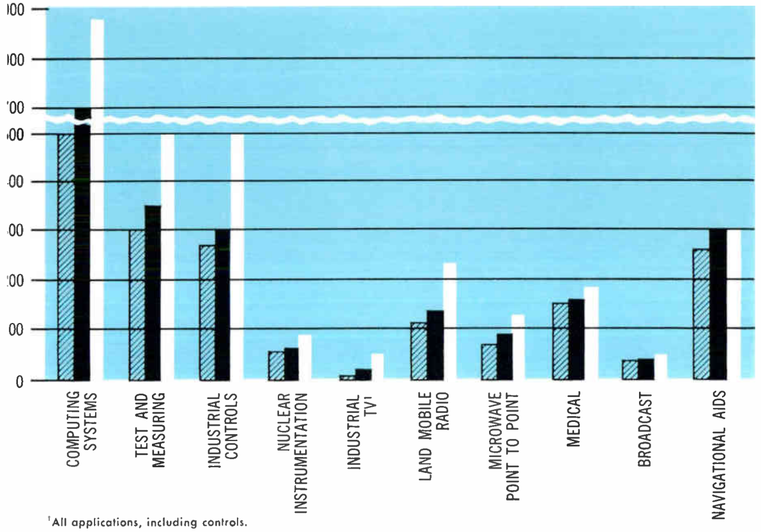
Edo CORPORATION
College Point, N.Y.

Since 1925

Edo (CANADA) Ltd.
Cornwall, Ontario

ELECTRONICS MARKET 1960 1961 1965 1970

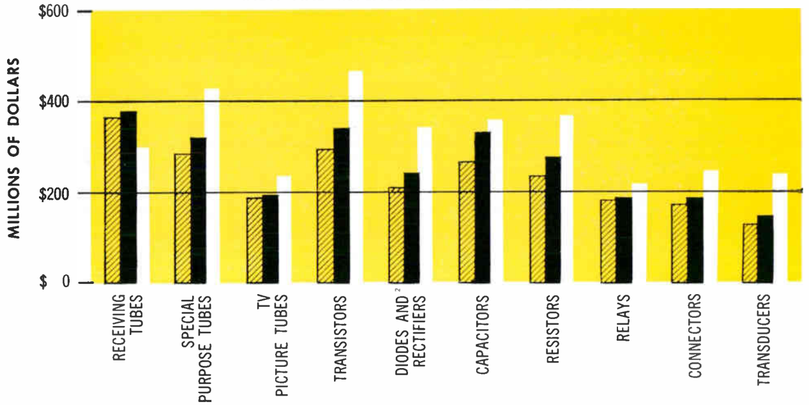
INDUSTRIAL ELECTRONICS



[1]All applications, including controls.

COMPONENTS[1] MARKETS

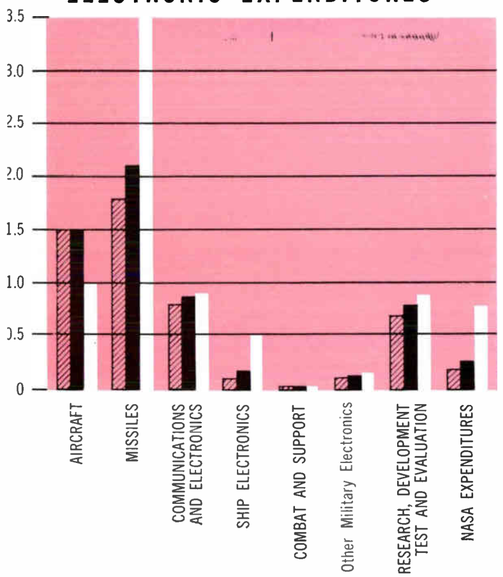
(NEW AND REPLACEMENT SALES COMBINED)



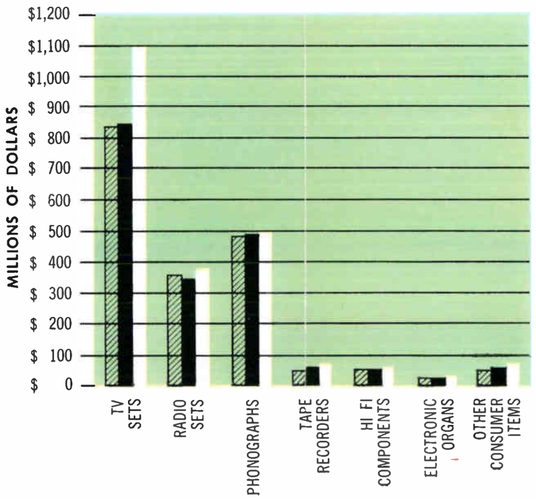
[1]Chart shows totals for selected components, for detailed listings see other side.

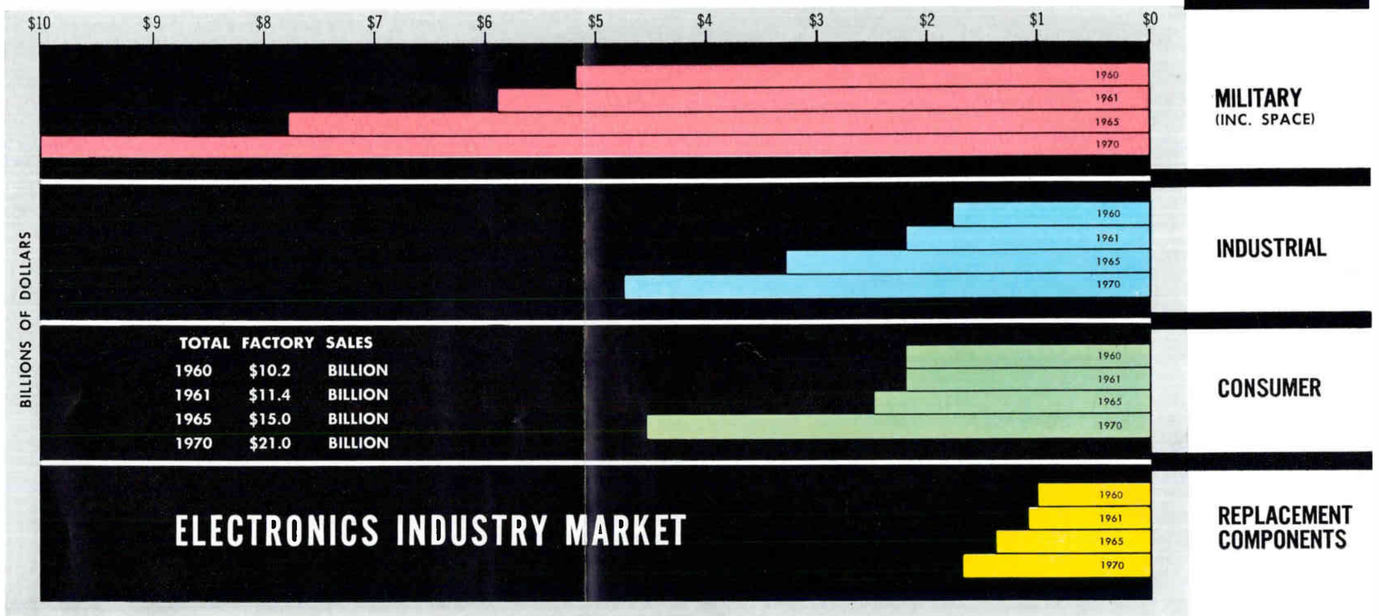
[2]Special diodes and rectifiers excluded—see tables other side.

MAJOR MILITARY ELECTRONIC EXPENDITURES



CONSUMER ELECTRONIC PRODUCTS





1960 1961 1965

Electronics Market Research Tables 1960, 1961, 1965

INDUSTRIAL ELECTRONICS

COMPUTERS	1960	1961	1965
Digital Computers	Millions of Dollars		
General Purpose	$500	$600	$1,950
Special Purpose	4	6	50
Total Digital	$504	$606	$2,000
Analog Computers			
General Purpose	12	11	10
Special Purpose	15	17	20
Total Analog	$ 27	$ 28	$ 30
Total Computers	$500-561[1]	$634-700[1]	$1,800-2,030[1]
Auxiliary Comp. Equip. (incl. above)			
Converters-Analog to Digital	18-22	22-28	45-65
Converters-Digital to Analog	20-30	22-28	55-65
Converters-Card to Tape	2	2	2.5
Paper Tape Readers	9-11	11-13	23-27
Magnetic Disk Files	—	24-26	140-160
Data Recorders & Readers	9.5-11	14-16.5	20-30
Magnetic Drums	20	22-40	40-125
Magnetic Tape Equip.	—	70-80	190-210
Memory Core Equip.	—	140-160	475-525
Digital Plotting	16	18	27
Total Auxiliary Equip.	$350[1]	$400[1]	$ 600[1]
TEST & MEASURING EQUIPMENT			
Converters; Frequency-Time Standards; Counters	21-23	24-26	40-50
Electronic Timers	6	7	10
Oscilloscopes and Oscillographs	60	70	80
Transmitter and R-F Test Equipment	3	4	5.5
Other Signal Generators	20	21	23
Standing Wave Ratio Meas. Insts.	1-2	3-4	25
Voltmeters, All	12	15	25
Static Inverters	2-10	2-12	3-15
D-C Amplifiers	5	—	10
Digital Voltmeters	8	—	25
X-Y Plotters	4	—	8
Strip-Chart Recorders	20	—	—
R-F Test & Measuring	28	—	—
Recording Instruments	35	—	—
Automotive Test	28	—	—
Tube Test & Measuring	15	—	—
Microwave Test	15	—	—
Sound-Level Audiometers	6	—	—
Ultrasonic Test	8	—	—
Transmitter Test	4	—	—
Total Test & Measuring Equip.	$300[1]	$350[1]	$ 500[1]
INDUSTRIAL CONTROLS			
Automatic Control	1-2	2-3	5-6
Dimension Controls	7-9	9-11	18-22
Machine-Tool Controls	22	26	45
Photoelectric Controls	5-7	6-8	10-11
Industrial Tv Controls	3-5	5-7	18-22
Spectrophotometers	25	26	32
Spectrum Analyzers	28	—	—
Remote Controls	60	—	—
Electronic Heating	27	—	—
Infrared Controls	18	—	—
Ultrasonic Controls	15	—	—
Total Industrial	$270[1]	$300[1]	$ 500[1]
MEDICAL & THERAPEUTIC EQUIPMENT			
Ultrasonic Cleaning	1	2	3
Electron Microscopes	10	—	—
Hearing Aids	40	42	45
Electrocardiographs	12	13	15
X-Ray Equipment	95	97	105
Total Medical Equip.	$155[1]	$160[1]	$ 180[1]
NUCLEAR INSTRUMENTS & CONTROLS			
Particle Accelerators	11	12	18
Dosimeters	1	1	1
Geiger Counters	5	5	5
Radiation Detection	18	20	22
Reactor Controls	27	30	45
Total Nuclear	$ 55[1]	$ 60[1]	$ 90[1]
INDUSTRIAL TV			
Educational and Medical	2.5	3.8	6
Security Systems	1	1	2
Theater Systems	1	2	6
Total Industrial Tv	$10.7[1]	$ 20[1]	$ 50[1]
BROADCAST EQUIPMENT			
Transmitters & Amplifiers, A-M	—	11	15
Transmitters & Amplifiers, F-M	—	5-7	—
Transmitters & Amplifiers, Tv	7-9	8-10	9-11
Consoles & Speech-Input Equipment	—	2-3	—
Transmitter Accessories	—	10-12	—
Total Broadcast	$ 37[1]	$ 38[1]	$ 42[1]
LAND MOBILE EQUIP.	110	135	230
MICROWAVE POINT-TO-POINT EQUIP.	70	90	125
HIGHWAY TRAFFIC CONTROLS	18	22	25
NAVIGATIONAL AIDS			
Autopilots	—	7-8	—
Beacons and Transponders	—	3-5	—
Direction Finders	5	5.5	11
Flight Control Equip.	—	7-8	—
VHF Omnirange	—	1	—
Air Traffic Control	45-55	55-65	70-80
GCA Equipment	18-22	23-27	35-45
Collision Warning	1.2	2.2	35-45
Total Nav. Aids	$260[1]	$300[1]	$ 300[1]

	1960	1961	1965
COMMUNICATIONS EQUIPMENT			
Transmitters and R-F Ampl, Airborne	—	4-6	—
Receivers, Airborne	—	7-8	—
Carrier-Current Equip.	—	15-17	—
Facsimile	—	30	—
Total Comm. Equip.	—	$175[1]	—
COMMERCIAL SOUND			
Intercoms	30	—	—
Total Comm. Sound	$145[1]	—	—

[1]Totals do not agree with sum of individual items, as estimates not received on all categories. Totals and individual items may be separately estimated

Note 1: Use midpoint of ranges if total of individual figures actually reported is desired

Note 2: Dashes indicate no usable estimates

CONSUMER ELECTRONIC PRODUCTS

	1960	1961	1965
TV SETS	Millions of Dollars		
Black & White Tv	$775	$775	$ 850
Color Tv	60	65	250
Total Tv Sets	$835	$840	$1,100
RADIO SETS			
A-M and A-M/F-M Table	100	80	83
A-M Portable Radios	100	100	115
A-M Auto Radios	120	120	130
Total A-M and A-M/F-M Combinations	$320	$305[4]	$ 328
Total F-M Radios	$ 38	$ 45	$ 55
Total All Radios	$363[4]	$350[4]	$ 383[4]
PHONOS			
Monaural	180	—	200
Stereo Hi-Fi	310	—	300
Total Phonos[1]	$490	$495	$ 500
Hi-Fi Amplifiers	14	15	18
Hi-Fi Loudspeakers	14.5	15	19
Hi-Fi Tuners	10	11	12
Cartridges and Turntables	10	9.3	10.6
Total Hi-Fi Components	$ 60[4]	$ 60[4]	$ 65[4]
HI-FI COMPONENTS			
TAPE RECORDERS	$ 50	$ 63	$ 75
PHONO RECORDS	$285	$289	$ 415
PRERECORDED TAPE	$ 7	$ 25	$ 100
OTHER CONSUMER PRODUCTS[3]			
Organs	25	25	30
Home Intercoms (wired)	3	5	10
Citizens-Band Equipment[2]	35	40	60
Kits, Consumer	38	42	65

[1]Incl. record players and radio-phonos
[2]Home intercom and marine radio
[3]Includes: Garage door openers, ovens, ultrasonic dishwashers, refrigerators, tv boosters, tv amplifiers, uhf adapters, dust eliminators, etc.
[4]Totals do not always agree with sum of individual items as estimates not received on all categories. Totals and individual items may be separately estimated

COMPONENTS MARKETS[1]

	1960	1961	1965
ELECTRON TUBES	Millions of Dollars		
Receiving Tubes			
Subminiature	$ 27	$ 26	$ 20
Miniature	231	234	182
Standard Glass (G&GT)	87	92	48
Ceramic and Special	14	24	50
Total Receiving Tubes	$359	$376	$ 300
Tv Picture Tubes	$187	$192	$ 240
Special-Purpose Tubes			
High-Vacuum Rect	5	6	5
H-V Triodes & Multigrid	43	44	50
Gas & Vapor Rect	33	33	35
Ignitrons	6	6	6
Hydrogen Thyratrons	4	5	6
Klystrons	50	55	80
Magnetrons	51	48	44
Traveling-Wave Tubes	17	34	70
Backward-Wave Tubes	4	7	26
Duplexer Tubes	8	9	10
Light Sensing & Emitting	25	28	37
Storage Tubes	5	6	11
X-Ray Tubes	4	4	5
UHF Planar Tubes	14	16	20
Radiation Detection	12	14	13
Vacuum Capacitors, Switches & Others	6	8	12
Total Special-Purpose Tubes[2]	$287	$323	$ 430
Total All Tubes	$833	$891	$ 970
SEMICONDUCTORS			
Transistors			
Germanium	193	232	300
Silicon	100	110	50-250
Gallium Arsenide	—	—	20
Total Transistors	$293	$342	$ 470[2]
Diodes & Rectifiers			
Germanium	44	49	49
Silicon	140	170	258
Selenium	19	17	11
Copper Oxide	4	4	4
Gallium Arsenide	—	—	21
Total Diodes & Rect[2]	$207	$240	$ 343
Special Diodes & Rect			
Zener Diodes	27	34	40
Tunnel Diodes	1	4	20
Silicon Controlled Rect	10	18	80
Total Special Diodes & Rectifiers	$ 38	$ 56	$ 140
Other Devices			
Solar Cells	4	5	11
Photocells	4	4	6
Infrared Detectors	—	—	—
Total Semiconductors	$500[2]	$625[2]	$1,000[2]
ANTENNAS			
Broadcast (except towers)	5	6	9
Communications	125	130	140
Total Antennas	$130[3]	$136[3]	$ 149[3]

	1960	1961	1965
CAPACITORS			
Paper & Metalized-Paper Dielectric	76	81	—
Film Dielectric	17	21	—
Aluminum	50	48	—
Tantalum	41	46	—
Mica	17	19	—
Ceramic	34	—	—
Vitreous Enamel	23	99	—
Air Dielectric	16	17	—
Total Capacitors	$274	$331	$ 360[2]
COMPLEX COMPONENTS			
Modular Circuits	5	10	60
Molecular Circuits	1.5	3	70
Other Assemblies	7	18	61
Other Complex Components	10	25	70
Total Complex Components	$ 24	$ 56	$ 261
CONNECTORS			
Coaxial	20	23	30
Multicontact Cylindrical	70	75	80
Multiple Contact	35	43	60
Fusion Sealed	10	12	12
Printed Circuit	13	15	20
Other	22	17	45
Total Connectors	$170	$185	$ 247
DELAY LINES	$ 12	—	—
FILTERS, ELECTRONIC	$ 35	$ 40	$ 90
MAGNETIC HEADS			
MICROPHONES	$ 13	$ 13	$ 14
PHONOGRAPH CARTRIDGES & PICKUPS	$ 24	—	—
PRINTED-CIRCUIT BOARDS	$ 45	$ 55	$ 75
RELAYS			
Electromagnetic	147	149	158
Meter Movement	34	36	54
Total Relays	$181	$185	$ 212
RESISTORS			
Fixed Composition	48	55	75
Variable Composition	39	40	66
Film	28	35	53
Deposited Carbon	22	29	44
Wire-Wound, Fixed & Adjustable	30	32	40
Wire-Wound, Variable Nonprecision	14	21	23
Wire-Wound, Variable Precision	46	49	52
Varistors and Thermistors	12	13	19
Total Resistors	$239	$274	$ 372
SWITCHES,			
Coaxial	7	11	27
Rotary Wafer	5	6	9
Pressure	15	17	28
Other	18	16	26
Total Switches	$ 45	$ 50	$ 90
TRANSDUCERS			
Accelerometers	10	11	15
Pressure	34	37	46
Strain	16	—	—
Temperature	32	—	—
Force	7	—	—
Motion	8	—	—
Vibration	8	—	—
Displacement	15	—	—
Total Transducers	$130	$150[2]	$ 240[2]
TRANSFORMERS	$145	$157	$ 223

[1]Includes new and replacement sales
[2]Totals do not necessarily agree with sum of individual items as estimates were not received on all individual items in categories. Totals and individual items may be separately estimated
[3]Not including home and entertainment type antennas

Note 1: Use midpoint of range if total of individual figures actually reported is desired

Note 2: Dashes indicate no usable estimates received

ELECTRONICS INDUSTRY MARKET

(by major product groups)

	1960	1961	1965	1970
	Billions of Dollars			
Military & Space	$5.2	$5.9	$7.8	$10.0
Industrial	1.8	2.2	3.3	4.75
Consumer	2.2	2.2	2.5	4.55
Replacement Comp.	1.0	1.1	1.4	1.7
Total Industry[1]	$10.2	$11.4	$15.0	$21.0

[1]Total industry definition is same as that used by Electronic Industries Association
EIA definition excludes electronics expenditures for Operation and Maintenance — currently worth $900 million to $1 billion annually; and included in last year's market estimates by ELECTRONICS

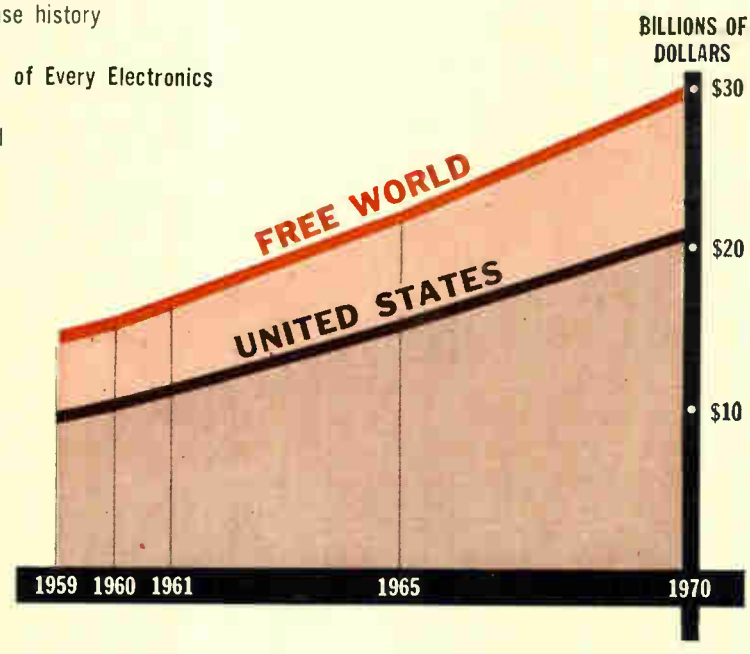
MAJOR MILITARY ELECTRONICS

Millions of Dollars

	1960	1961	1965
Aircraft	$1,500	$1,500	$1,000
Missile Airborne	(800)	(900)	(1,600)
Missile Ground	(1,000)	(1,200)	(1,900)
Total Missiles	1,800	2,100	3,500
Communications & Electronics	810	880	935
Ship Electronics	100	200	500
Combat & Support Vehicles	3.5	3.5	3.0
Other Military	125	130	135
Research, Development			
Test & Evaluation	700	800	900
Total Military	5,038	5,613.5	6,973
NASA Expenditures	200	300	800
Total Military (Incl. NASA)	$5,238.5	$5,913.5	$7,773

Our Industry Today and Tomorrow

By EDWARD DeJONGH
market research



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 marketeers' 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:

	Annual Percentage Sales Increases			
	1960/1959	1961/1960	1965/1960	1970/1960
Military Electronics	6%	13%	50%	92%
Industrial Electronics	13%	22%	83%	177%
Consumer Electronics	3%	No change	14%	82%
Replacement Parts	10%	10%	40%	60%

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.

Military Electronics Markets

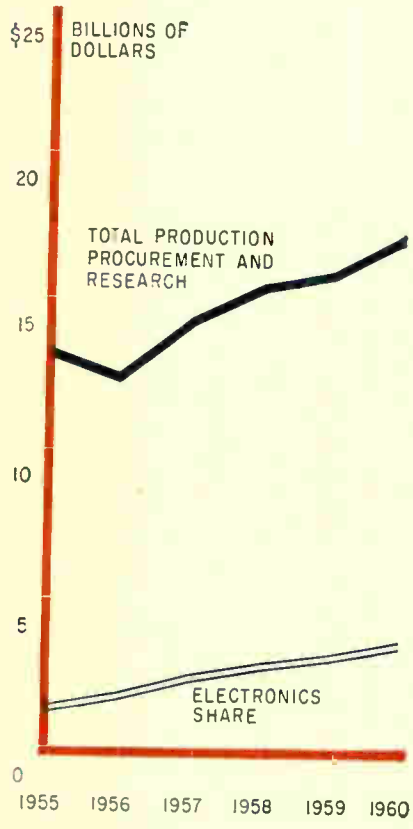
Gradually rising defense expenditures plus steadily increasing electronics share of DOD spending mean more military dollars

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.

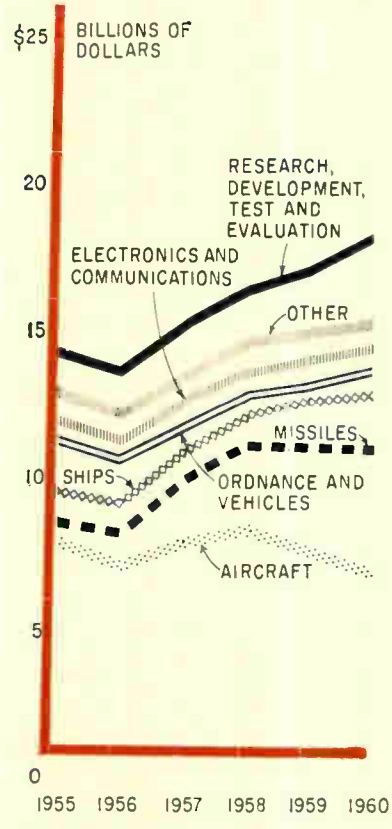
(2) The electronics share of the DOD dollar will amount to nearly 32 percent in 1965. Last year it was estimated at 27.5 percent and compares with 15.8 percent five years ago. The historical trend is shown on the accompanying chart, Department of Defense Expendi-

TOTAL DEPARTMENT OF DEFENSE EXPENDITURES FOR PRODUCTION PROCUREMENT AND RESEARCH (FY1955-1960)



SOURCE: MANSFIELD, SYLVANIA

BREAKDOWN OF TOTAL DOD SPENDING FOR PRODUCTION PROCUREMENT AND RESEARCH (FY 1955-1960)



SOURCE: MANSFIELD, SYLVANIA

ESTIMATED EXPENDITURES MILITARY ELECTRONIC EQUIPMENT
Years 1960, 1961 and 1965

	Millions of Dollars 1960	1961	1965
Aircraft			
Communications	279	277	270
Radar	208	237	282
Navigation	300	325	400
Computers	185	190	201
Controls	250	300	300
Others	300	300	300
Missile Airborne			
Guidance	400	500	1,000
Computers	150	200	350
Missile Ground			
Radar	60	70	300
Checkout & Test	290	335	200
Telemetry	210	225	100
Computers	144	161	420
Range Instruments	15	17	20
Other	382	407	455
Electronics & Communications			
Radar	87	110	325
Computer	550	610	825
Countermeasures	27	35	45
Communications	66	135	925
Detection	175	190	200
Meteorological	70	75	80
Other	70	75	80
Ship Electronics (excl. missiles)			
Navigation	2	3	5
Radar	10	15	20
Communications	49	100	130
Combat & Support Vehicles			
Mobile Radio	110	120	140
Research and Development			
Aircraft	280	260	200
Missiles	320	320	520
SPACE ELECTRONICS (NASA)			
Vehicle — Communication	15	50	125
Vehicle — Checkout & Test	169	175	205
SYSTEM EXPENDITURES BY TYPE OF EQUIPMENT (Used in All Above Categories)			
ASW Electronics	270	300	600
Computers Analog	320	370	740
Computers, Digital	500	560	1,000
Infrared	130	150	500
Radar	700	750	800
Sonar	50	59	101
Telemetry	220	240	325

tures, 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 overall 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 controls 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 represent 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 of 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."

Consumer Electronics

New consumer products will substantially boost sales of consumer electronics in the next five years

CONSUMER ELECTRONICS is the only segment of the industry expected to be affected to any serious degree by any general business downturn in 1961.

Net result of general business movement will be a volume for the year about comparable with 1960.

Consumer sales will be hurt in the early months of the year because of declining expenditures for consumer durable goods, which includes television, radios and phonographs.

Effects of the shift in consumer buying habits is already being felt. Current forecasts of television set retail sales for 1960 are for six million sets, half a million sets less than predictions at the beginning of the year.

However, by the middle of the decade, consumer electronics will experience an upsurge, largely under the influence of new products, as the following sampling of comments from market research managers show:

"About 1966, a breakthrough in color television should take place, at which time the monochrome-color set mix will change sharply."

"Phono sales will benefit from the emphasis expected to put on teaching devices in the early 1960's."

"Phonograph records will also benefit from the emphasis to be put on teaching devices in the early 1960's."

"Teaching aids will enhance the general market for prerecorded tape."

"Over 140,000 licenses were issued in 1960 for citizens-band communications."

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 Thyratrons: "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."

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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

young industry is beginning to feel the strength in its limbs and put it to work. The evidence is all about us.

In exhibits, we've grown up from the blue-draped hardware display booths of the post-war IRE shows to the sophisticated, dramatic exhibits of the 1960 show with their well-organized ideas effectively presented.

In some companies, sales to distributors are handled by special groups or divisions, designed solely to best meet the unique problems of selling through distributors.

More electronics firms are sending key personnel to seminars and training sessions of the American Marketing Association and participating in sales management round-table meetings at Harvard Business School, Syracuse, and Pennsylvania's Wharton School.

The competition is growing keener. Competition is not measured solely in the increasing number of electronics manufacturers. The squeeze is at every step: improved products, better salesmen, quicker delivery, better customer service and pooled purchasing requirements. Nor is the competition limited to this country, as many transistor radio manufacturers learned when the Japanese invaded the domestic market.

FALLING PROFITS, DANGER SIGNAL—Sales and earnings statements of many of the largest companies are sounding the alarm of rising sales but falling profits. This pinch on profits places increased responsibility on the marketing manager to deliver optimum performance in spite of rising salaries for salesmen and clerical assistants, higher costs for meals, travel and communications services. Falling profit ratios are prodding more and more firms to review their distribution methods. They look both for ways of increasing sales and of trimming off excess fat.

Meeting competition in price and quality is just a starter in the tougher market that lies ahead in 1961. Many collateral functions will help make the difference. Top-flight customer service is essential. Manufacturers will compete in applications engineering and field service.

For example, in selling precision welding equipment applications engineering and field service play the key role in winning the sale. Helping the customer to use your product most effectively and solving his problems also has been the principal advantage enjoyed by U. S. transistor manufacturers in the competition for the industrial market.

More and more attention is being given to manufacturing and scheduling efficiency as an order lost is often an account lost.

Quick action in filling orders and answering special customer problems is getting more attention, too. One manufacturer, driven by competition to rush a product into the market before it was completely tested, found it a good investment to finance a major recall program to improve the machines already sold.

Protecting the manufacturer's reputation and safeguarding one sale already made can be worth more than prospecting for new accounts. Repeat business is the most profitable business. No longer can a manufacturer assume that a previous customer is forever his alone.

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 multidivision 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.

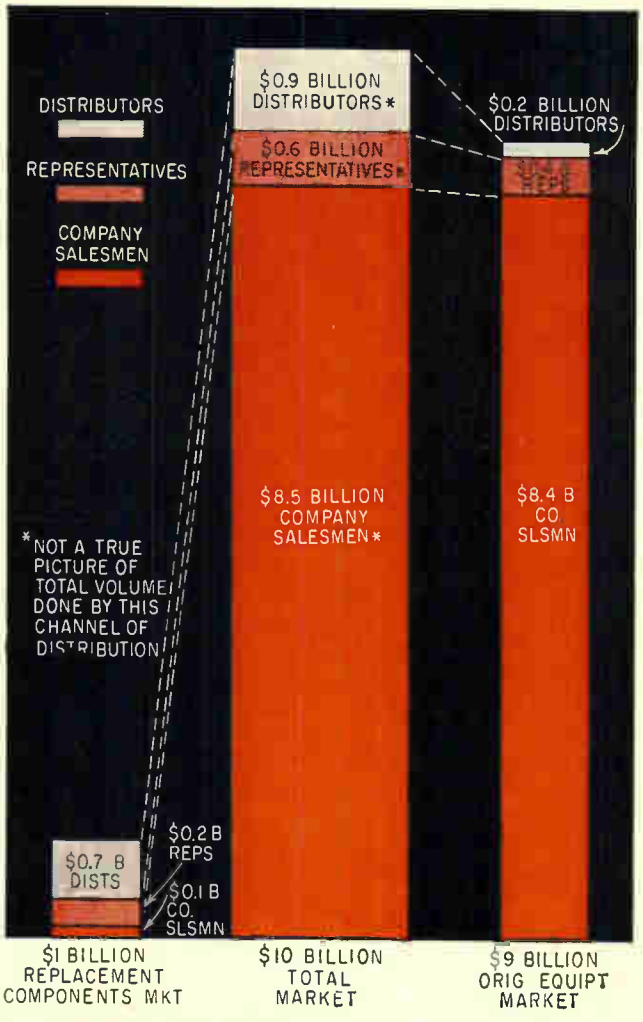
Many electronics companies are organized into operating divisions, each specializing in certain product lines. The trend has been to make these divisions semiautonomous, with the division management being assigned profit and loss responsibility along with the authority needed to do the job.

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-

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

(Factory sales value: original equipment and replacement components)



Source: Lewis & Galper, Raytheon

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.

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

semiconductor and receiving tube divisions. On the other hand, the communications equipment division and industrial products division are in only one business between them.

(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.

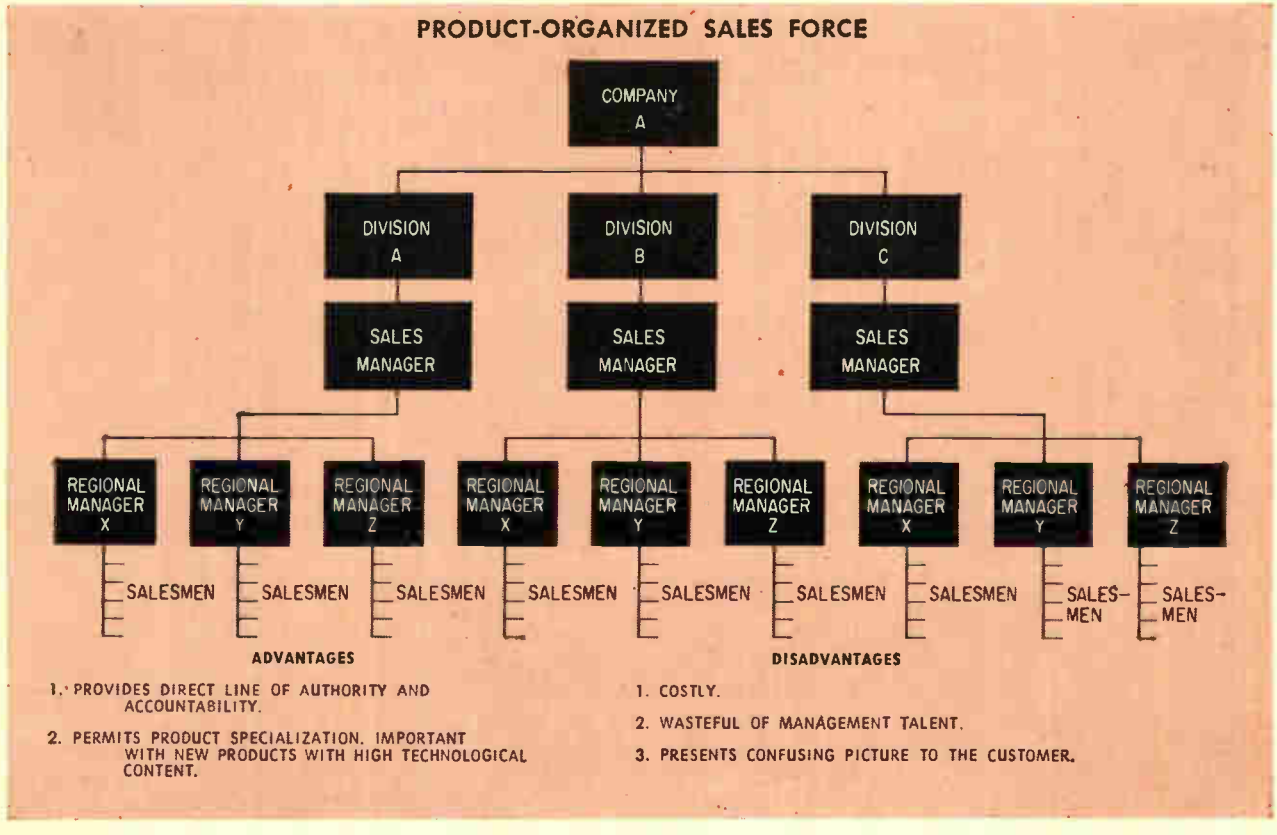
STAFFING THE SALES ORGANIZATION—But well-considered organization charts can't in themselves insure greater sales. Having graduated from the period in which management's chief concern was to make the product to the problem of selling it most efficiently, management everywhere is taking a critical look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

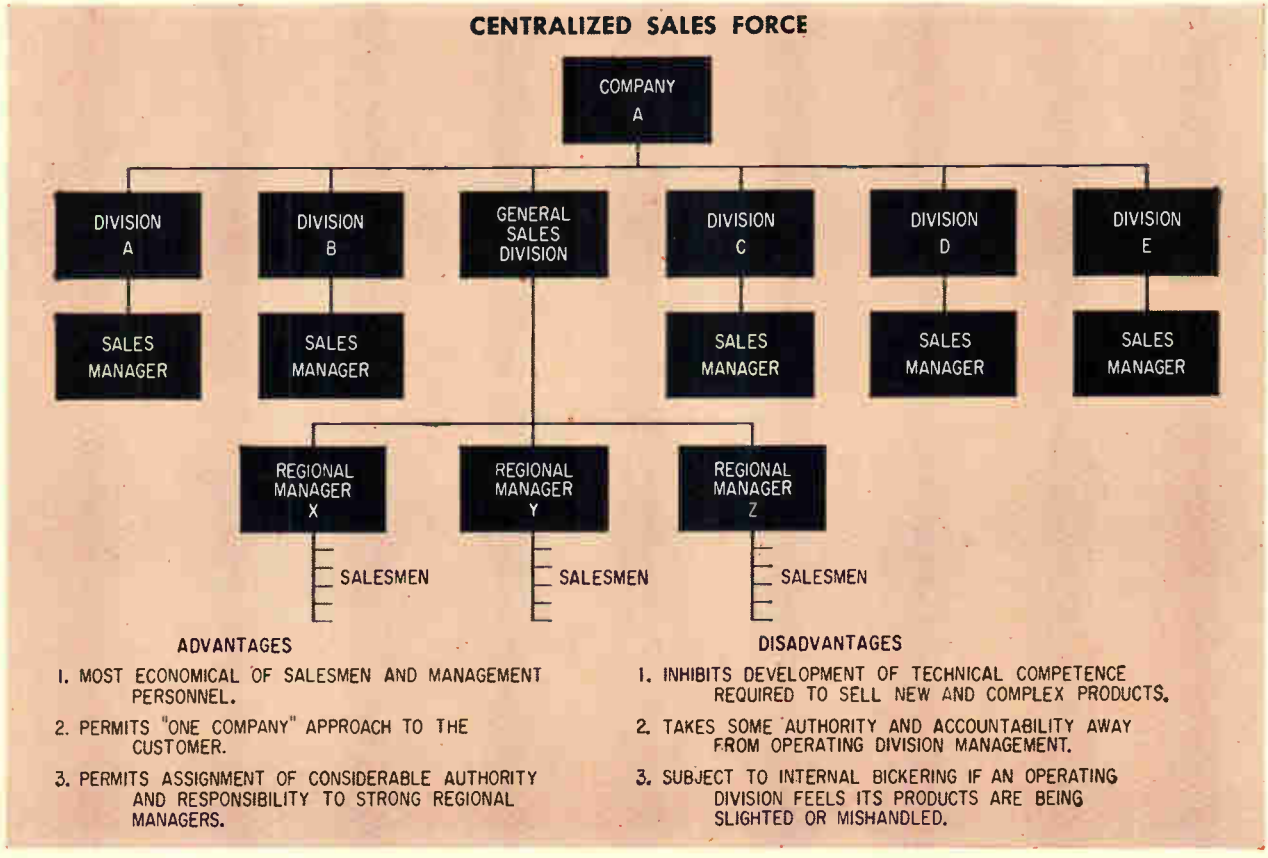
The high dollar cost of salesman-turnover is of such significance that too much attention cannot be given to the selection, training, compensation and evaluation of the sales force. This also applies, in varying degree, to the sales forces employed by distributors and manufacturers' representatives.

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





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.

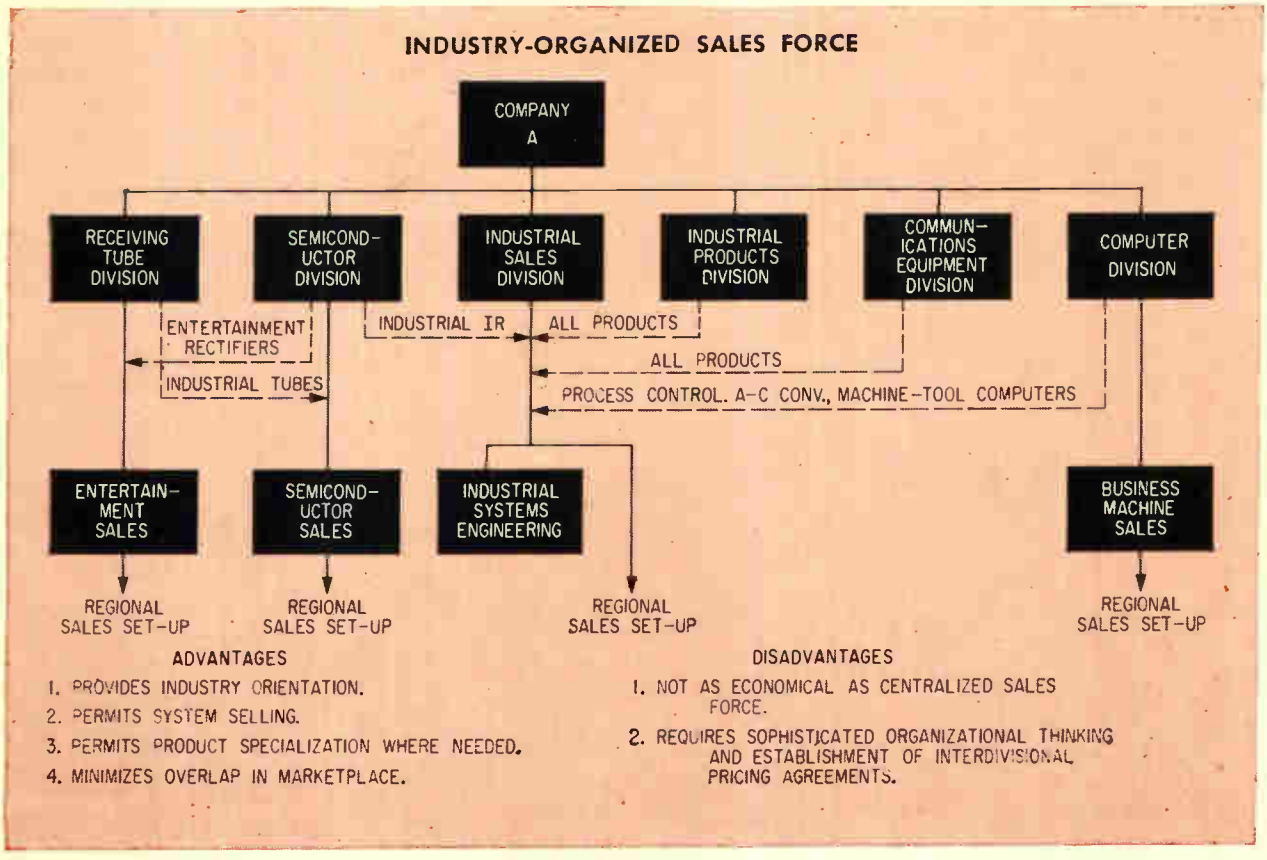
TRAINING—A primary responsibility of a manager is the development of the people under him to build the company's management depth, and to satisfy the human need to grow in ability and prestige.

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



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

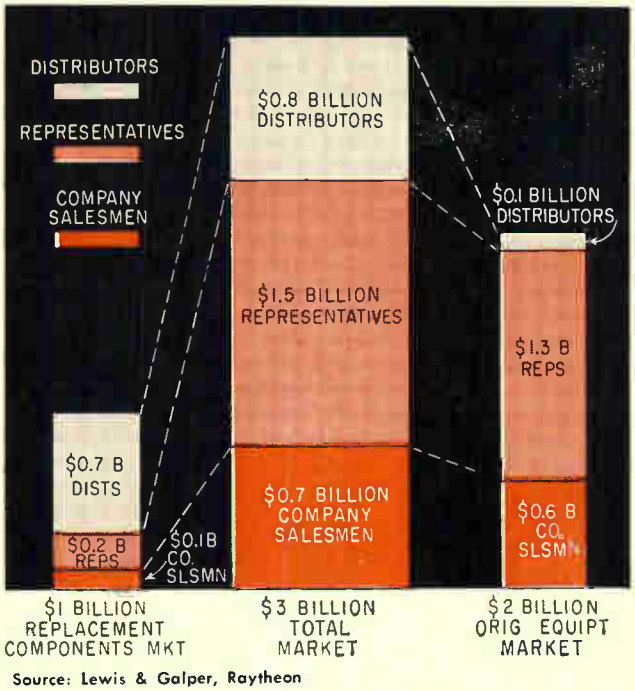
The electronics manufacturers' representative is often the most efficient and economical solution to the field-selling problem

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 economics both of the industry and the sales problem.

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

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



Source: Lewis & Galper, Raytheon

Not a picture of total volume by this channel of distribution; $1 billion resold within the electronics industry. See Fig. 3

CHARACTERISTICS OF REPS—A manufacturers' representatives has these typical characteristics:

(1) Demonstrated sales ability.

(2) Substantial experience in the electronics industry.

(3) A self-starter: enjoys independence of self-employment.

(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 manufacturers' 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

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 repeatly 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.

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.

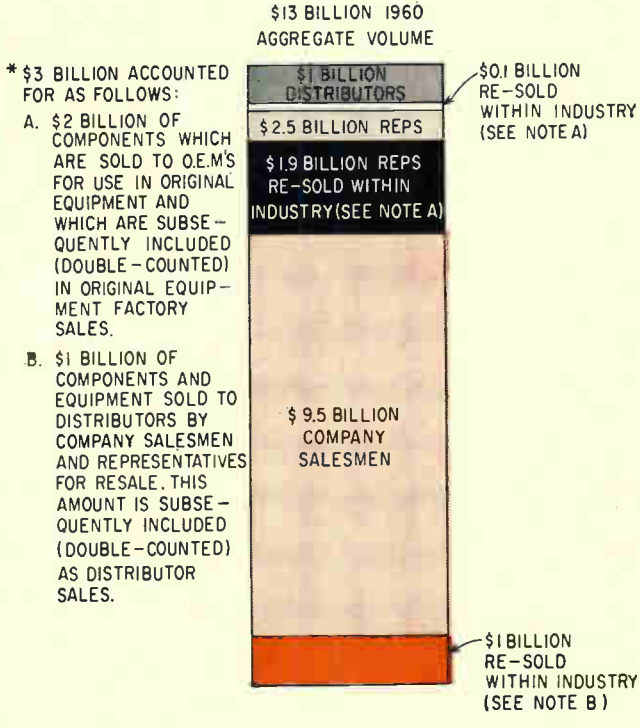
MANUFACTURER-DISTRIBUTOR AGREEMENTS—Agreements with distributors should clearly define the promotion and product brand emphasis that the manufacturer might reasonably expect. The manufacturer must settle either for exposure with many other product lines or establish more limited distribution with fewer 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



Source: Lewis and Galper, Raytheon

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 illwill.

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 Dorfman, 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.

ALFRED DI SCIPIO
Vice President and Director of Marketing and Commercial Development, International Telephone and Telegraph Corp., New York

FRANK M. VILES, JR.
President, ITT Distributor Products division, International Telephone and Telegraph Corp., New York

MARKET PLANNING IN THE ELECTRONICS INDUSTRY

By ALFRED DI SCIPIO and FRANK M. VILES, JR.

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.

Changing Picture in the Electronics Industry

Production capacity in the electronics industry today is in excess of consumption. Marketing concept offers our industry an approach to meet this challenge

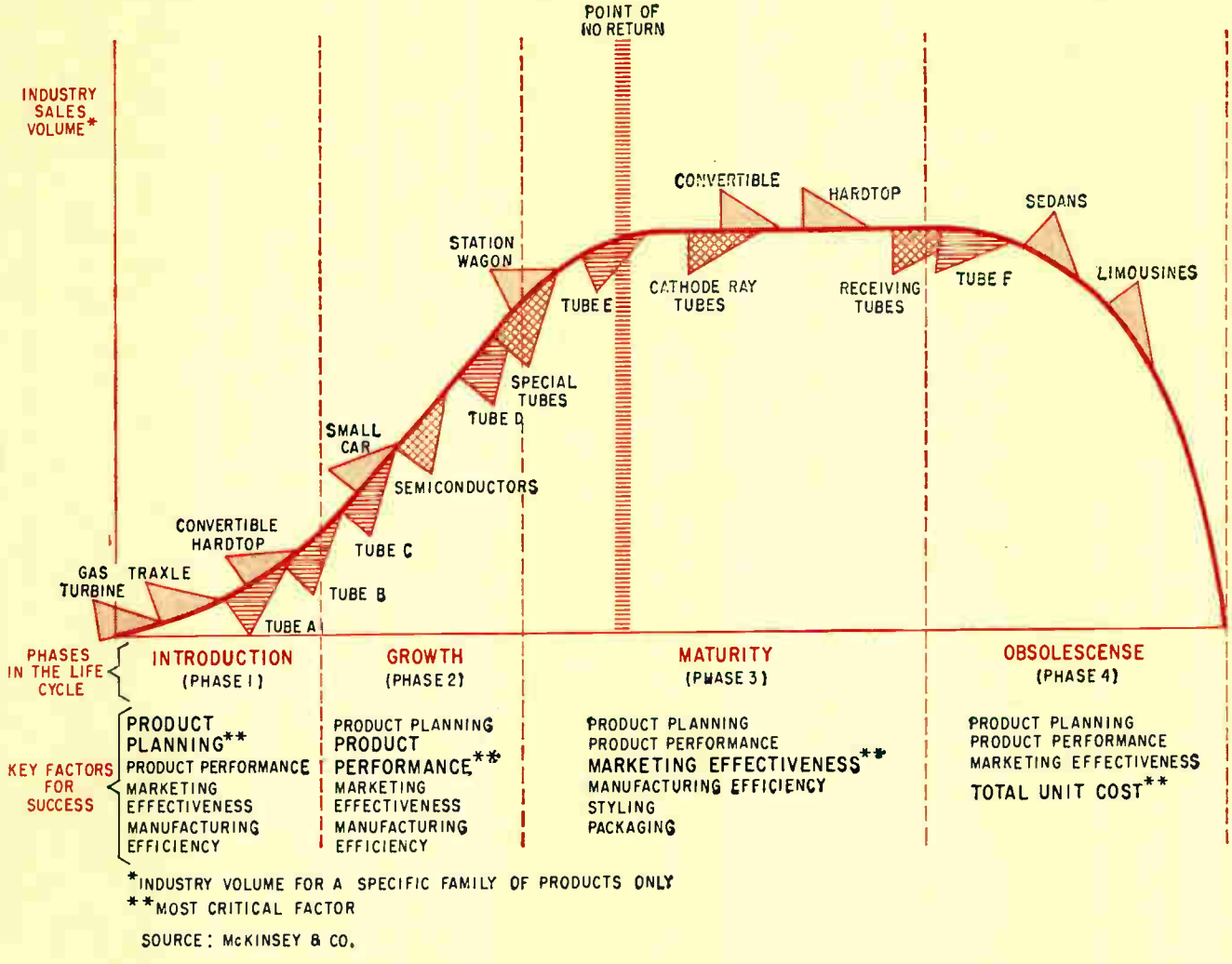
THE INDUSTRY soon found that it was no different from others when it came to high production and the problems this condition generates. Today, that production capacity is in excess of consumption. Competition has become not only more intense but highly complex as well—almost to the point of frustration.

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

LIFE CYCLE OF A PRODUCT (ELECTRONIC COMPONENTS COMPARED WITH AUTOMOBILE BODY STYLES)



*INDUSTRY VOLUME FOR A SPECIFIC FAMILY OF PRODUCTS ONLY
**MOST CRITICAL FACTOR

SOURCE: McKINSEY & CO.

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.

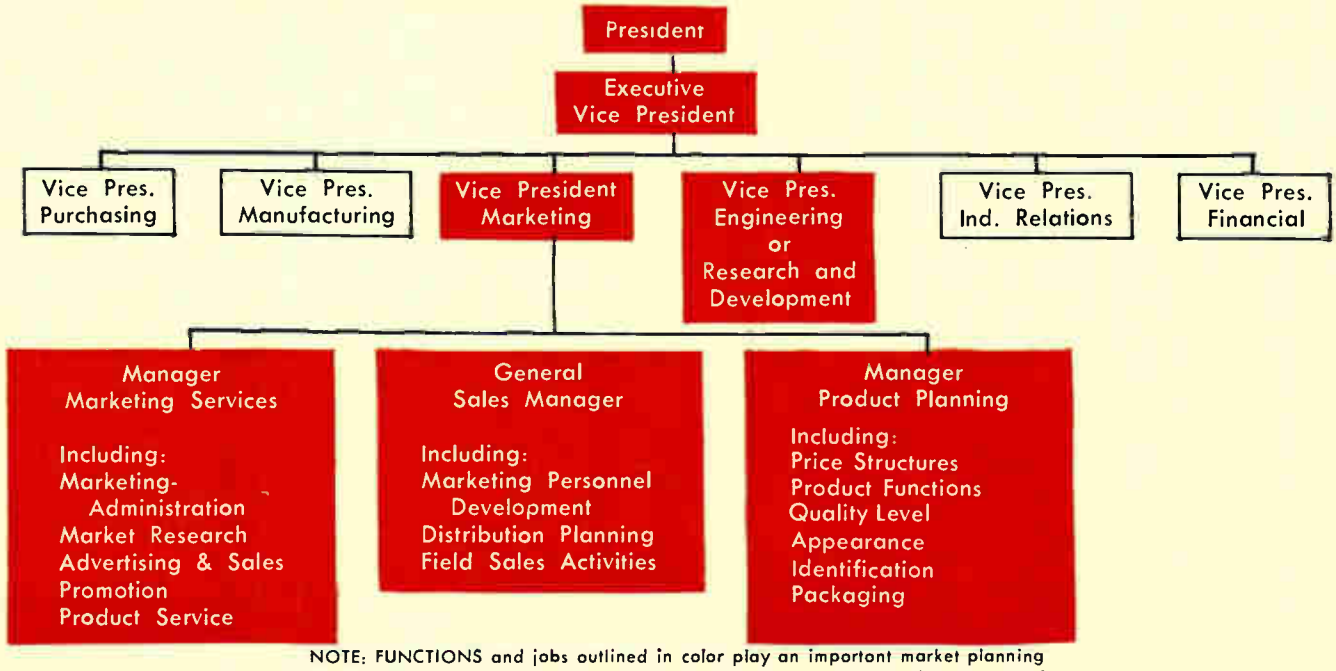
It is concerned with the evaluation and selection of markets, identifying and defining customer needs and wants, and sometimes creating needs and wants.

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-

HOW MARKET PLANNING FITS INTO THE ORGANIZATION



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

tribution channels, pricing philosophy and compatibility with existing products are other vital aspects.

Utilization by individual companies of market-planning techniques depends primarily upon: corporate size, diversification of markets covered and scope of the product content of the line.

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.
(2) Analyse U.S. electronic distributors' portion.
(3) Inventory and screen all ITT products on basis of:
  (a) market compatability.
  (b) adequate gross margins.
  (c) rate of inventory turnover,
  (d) manufacturing sources,
  (e) technical compatability 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)

Distributor Total $800[1]

Antennas, Wire, Tools, Hardware	$102.4	Loudspeakers	$18.4
Batteries	18.4	Transistors	11.3
Capacitors	47.2	Picture Tubes	81.6
Coils, Filters & Transformers	62.4	Power Tubes	32.8
Diodes	2.3	Receiving Tubes	204.0
Relays and Solenoids	12.8	Hi Fi, Radio, Tv & Sound Equipment	94.4
Resistors and Volume Controls	38.4	Technical Literature	10.4

Source: International Telephone & Telegraph Corporation
[1]Approximate figure

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 organiaztion 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) temporarily 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.

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 subassemblies, the price disadvantage could be wiped out. (2) 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.

(3) 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.

(4) 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.

(5) American business men should also recognize that in foreign countries economic competition is often closely related to government policy and that they may have both an economic and a political problem to face.

STANLEY C. ALLYN
Chairman of Board,
National Cash Register Company, Dayton, Ohio

Exports

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.

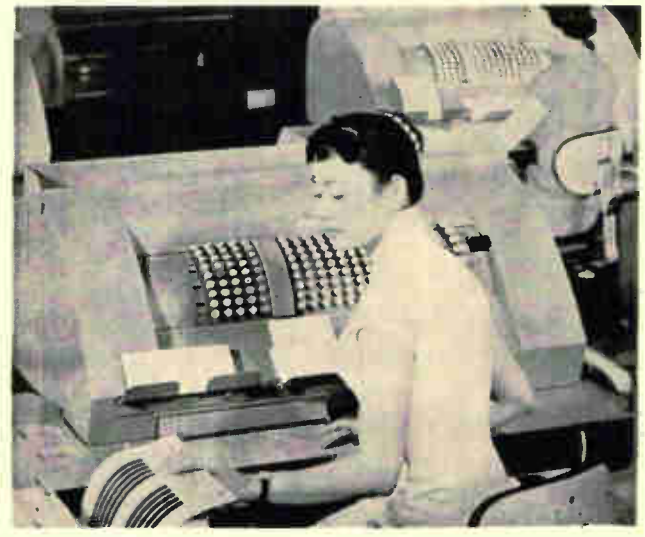
OUR HOME MARKETS—They are the largest, wealthiest and most diverse in the world. The greater volume made possible by this huge domestic market is capable of sustaining massive expenditures for research and development. This is perhaps the chief reason for our technological lead.

TECHNOLOGICAL DIVIDENDS—We shall continue to enjoy countless technological dividends as a by-product 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.



These NCR electronic posting machines are used by Hongkong and Shanghai Banking Corp. They use magnetic ledger cards to keep track of checking accounts

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.

ROBERT C. SPRAGUE

Chairman, EIA Electronic Imports Committee and Chairman of Board, Sprague Electric Co.

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.

Shipments 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 International 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 40 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.

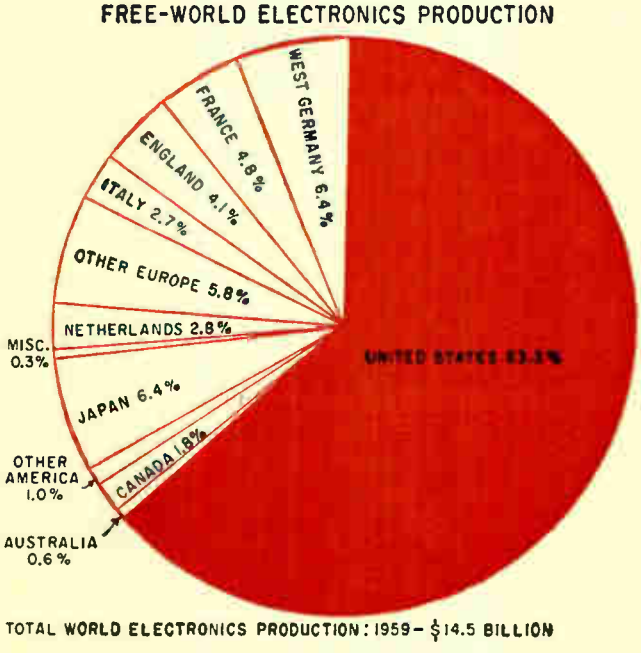
EIA, to date, has not sought government relief directly on behalf of its members. Instead, the association has chosen to focus attention upon the implications for the nation's defense potential of a surge in Japanese transistor imports to about 25 percent of the U. S. market

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 tenfold 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.



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.

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 affiliates 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 guaranties 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-

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 ½ 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 guarantee 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 existent 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.

PIERRE F. SIMON
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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.

UNITED STATES DOMESTIC

Commodity Description
Radio broadcast transmitting equipment and parts
Tv broadcast transmitting equipment and parts
Radio and tv broadcast 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[3]:
Radio communications equipment
Electron tubes not elsewhere classified
Electronic detection & navigation apparatus not elsewhere classified
Total

EXPORTS OF SELECTED ELECTRONIC PRODUCTS BY DESTINATION

(Value in thousands of dollars)

CALENDAR YEAR 1959							JANUARY-JUNE, 1960						
Total	Canada	Am. Republics	EFTA[1]	EEC[2]	Japan	Other	Total	Canada	Am. Republics	EFTA[1]	EEC[2]	Japan	Other
3,621	405	1,131	36	527	13	1,509	1,110	191	295	28	239	....	354
3,441	179	1,864	442	496	12	448	1,584	262	760	24	9	18	511
1,463	96	543	292	33	98	401	786	222	149	25	23	117	250
9,931	2,044	1,494	2,131	793	2,520	949	6,538	1,218	1,527	1,087	700	670	1,336
1,493	177	59	392	42	59	764	387	27	97	20	9	....	234
1,782	471	1,154	8	68	.....	81	745	249	401	6	14	3	72
916	135	667	21	9	.....	84	274	86	137	11	3	2	35
4,086	1,374	1,661	303	123	14	611	1,572	417	608	98	119	8	322
935	203	712	2	3	.....	15	446	164	226	6	2	....	48
17,631	1,709	12,053	291	461	59	3,058	6,599	973	4,180	99	67	42	1,238
2,901	224	1,555	412	575	.....	135	1,012	166	327	.....	495	....	24
14,671	4,454	6,384	777	1,693	38	1,325	6,290	1,999	2,280	330	922	32	727
1,682	233	155	16	498	719	61	591	62	100	12	108	272	40
13,757	819	2,625	2,946	7,176	38	153	6,603	159	1,204	2,175	2,675	61	329
889	184	23	259	261	110	52	821	134	91	181	147	231	37
4,987	1,773	746	378	1,272	181	637	3,495	920	586	194	1,271	146	378
9,148	1,548	980	1,743	2,900	551	1,426	7,645	1,336	337	1,818	2,937	701	516
6,102	2,320	2,192	345	819	13	413	3,625	1,412	839	430	611	14	319
4,175	1,341	1,302	518	759	23	232	2,324	915	365	408	447	43	146
3,970	940	1,569	174	735	31	521	1,600	526	443	137	201	34	259
2,137	614	986	76	133	2	326	888	277	365	41	60	1	144
2,628	958	809	35	80	.....	746	626	89	197	17	43	3	277
3,317	803	1,331	98	249	19	817	1,418	375	537	75	93	26	312
1,172	298	91	224	358	61	140	633	153	46	130	169	49	86
10,986	2,770	1,337	1,984	2,277	643	1,975	6,691	1,347	615	1,815	1,021	490	1,403
38,613	15,829	7,689	2,729	6,195	470	5,701	20,003	9,224	3,185	1,962	2,763	227	2,642
11,020	1,040	2,461	1,467	5,572	12	468	5,963	413	518	946	3,720	7	359
2,144	28	153	149	1,647	16	151	950	20	54	56	651	1	168
3,108	269	2,566	25	54	3	191	1,014	88	788	17	26	1	94
6,864	1,805	2,385	799	1,348	8	519	3,035	552	1,241	391	606	2	243
10,704	1,933	4,582	731	1,498	163	1,797	5,363	834	1,722	633	1,126	99	949
4,651	814	312	843	1,433	409	840	3,053	563	161	802	546	388	593
7,623	1,023	223	2,359	2,792	640	586	5,863	785	156	1,706	2,342	411	463
16,955	4,193	1,417	2,556	5,678	695	2,416	8,977	2,568	768	1,289	2,320	660	1,372
17,055	1,822	744	3,412	5,496	5,036	545	12,805	753	1,212	2,408	4,673	2,985	774
5,820	583	187	799	3,170	676	405	3,931	338	100	198	2,209	456	330
252,378	55,411	66,142	29,772	57,223	13,332	30,498	135,263	29,820	26,617	19,875	33,367	8,200	17,384
90,691							44,560						
13,340							9,533						
44,316							22,018						
400,725							211,374						

[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.
Source: U. S. Department of Commerce, Bureau of the Census: preliminary, unpublished data.
Electronics division, Business and Defense Services Administration U. S. Department of Commerce, November 15, 1960.

United States Imports of Selected Electronic Products, 1959 and 9 mo. 1960

(Value in thousands of dollars)

COMMODITY DESCRIPTION	12 Mo. 1959	9 Mo. 1959	9 Mo. 1960[1]
Television cameras and parts	227	79	750
Television tubes and parts	387	208	323
Television apparatus and parts, other	688	469	1,112
Radio apparatus and parts	72,724	43,261	61,639
Photocells and other electron tubes and parts (except tv, X-ray and radio)	1,358	956	1,892
Phonographs, etc., n.s.p.f.	1,813	772	993
Phonograph needles	13	12	14
Phonograph parts, n.e.s.	950	476	650
Sub-total	78,160	46,233	67,373
Phonographs records	3,551	2,568	2,755
Total	81,711	48,801	70,128
New classes established January 1, 1960[2]	[3]	[3]	25,004
Grand total in 1960	.....	.....	95,132

[1] Preliminary.
[2] Includes imports of electronic testing, recording, instruments and apparatus; radar equipment; microphones and parts; loudspeakers; radio-phono combinations; record players and parts; and other electronic sound devices and parts utilizing an electronic transducer device.
[3] Not shown separately in 1959.

Source: U. S. Department of Commerce, Bureau of the Census: preliminary, unpublished data except for the year 1959.
Electronics division, Business and Defense Services Administration, U. S. Department of Commerce, November 29, 1960.

United States Domestic Exports of Selected Electronic Products 9 mo. 1960

(Value in thousands of dollars)

COMMODITY DESCRIPTION	9 mo. 1959	9 mo. 1960
Radio broadcast transmitters & parts	2,938	1,558
Tv broadcast transmitters & parts	3,058	2,413
Radio and tv audio equip & parts	1,163	1,125
Tv studio equipment & parts	7,443	9,297
Beacon transmitters and parts	1,312	657
Automobile radio receivers	1,171	1,030
Radio-phono combinations (no tv)	694	402
Radios, home-type (no tv)	2,833	2,306
Radio chassis, home-type (no tv)	797	556
Television receivers	12,506	9,679
Television receiver chassis	2,483	1,639
Electron tubes, receiving type	11,058	10,229
Television camera tubes	1,118	964
Television picture tubes	10,529	13,922
Cathode-ray tubes (n. e. c.)	598	1,404
Parts for electron tubes	3,502	4,931
Crystal diodes and transistors	6,161	11,729
Capacitors	4,718	5,439
Resistors	3,127	3,819
Inductors (including transformers)	3,083	2,669
Loudspeakers	1,544	1,195
Carrier-current equipment and parts	2,158	850
Audio amplifiers and systems	2,295	2,009
Amplifiers (except audio) and parts	853	1,295
Recorders (disk, tape, wire) & parts	8,119	9,806
Electronic equipment n. e. c. & parts	25,851	30,745
Coin-operated phonographs, new	8,809	8,064
Coin-operated phonographs, used	1,578	1,542
Phonographs, except coin-operated	2,034	1,425
Phonograph parts	5,254	4,360
Phonograph records and blanks	7,495	7,839
Signal generators	3,481	4,455
Test instruments	5,681	8,776
Test instrument parts	14,417	13,480
Electronic computers	12,168	21,133
Parts for electronic computers	4,026	5,921
Subtotal	186,655	208,663
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

Source: U. S. Department of Commerce, Bureau of the Census: preliminary, unpublished data.
Electronics division, Business and Defense Services Administration U. S. Department of Commerce, November 29, 1960.

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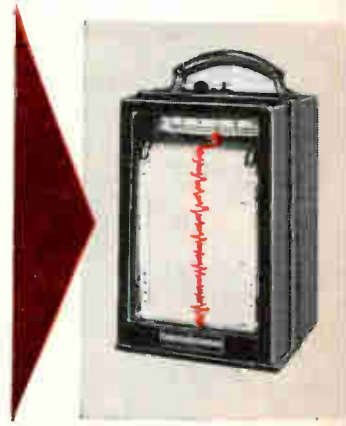

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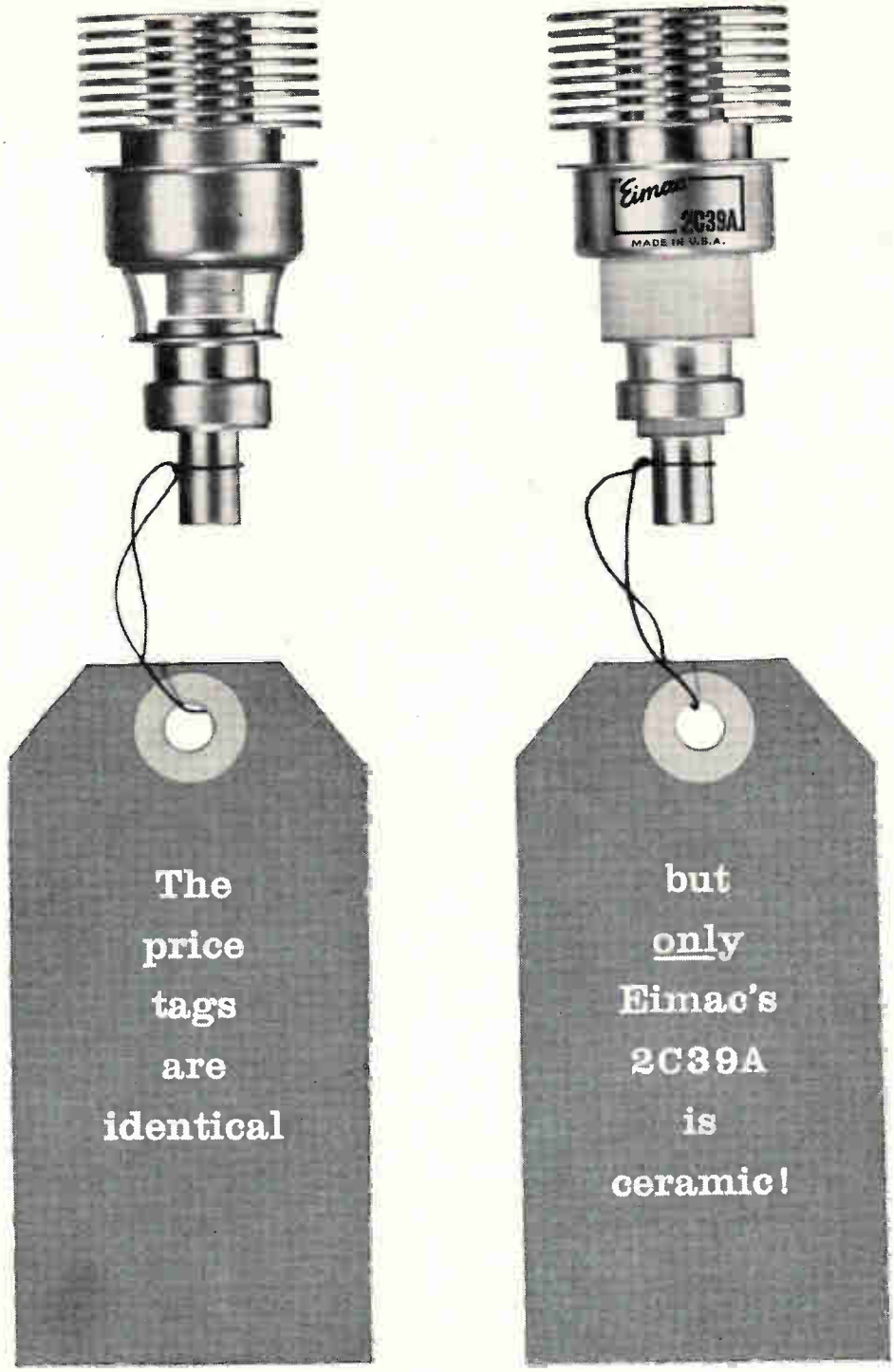

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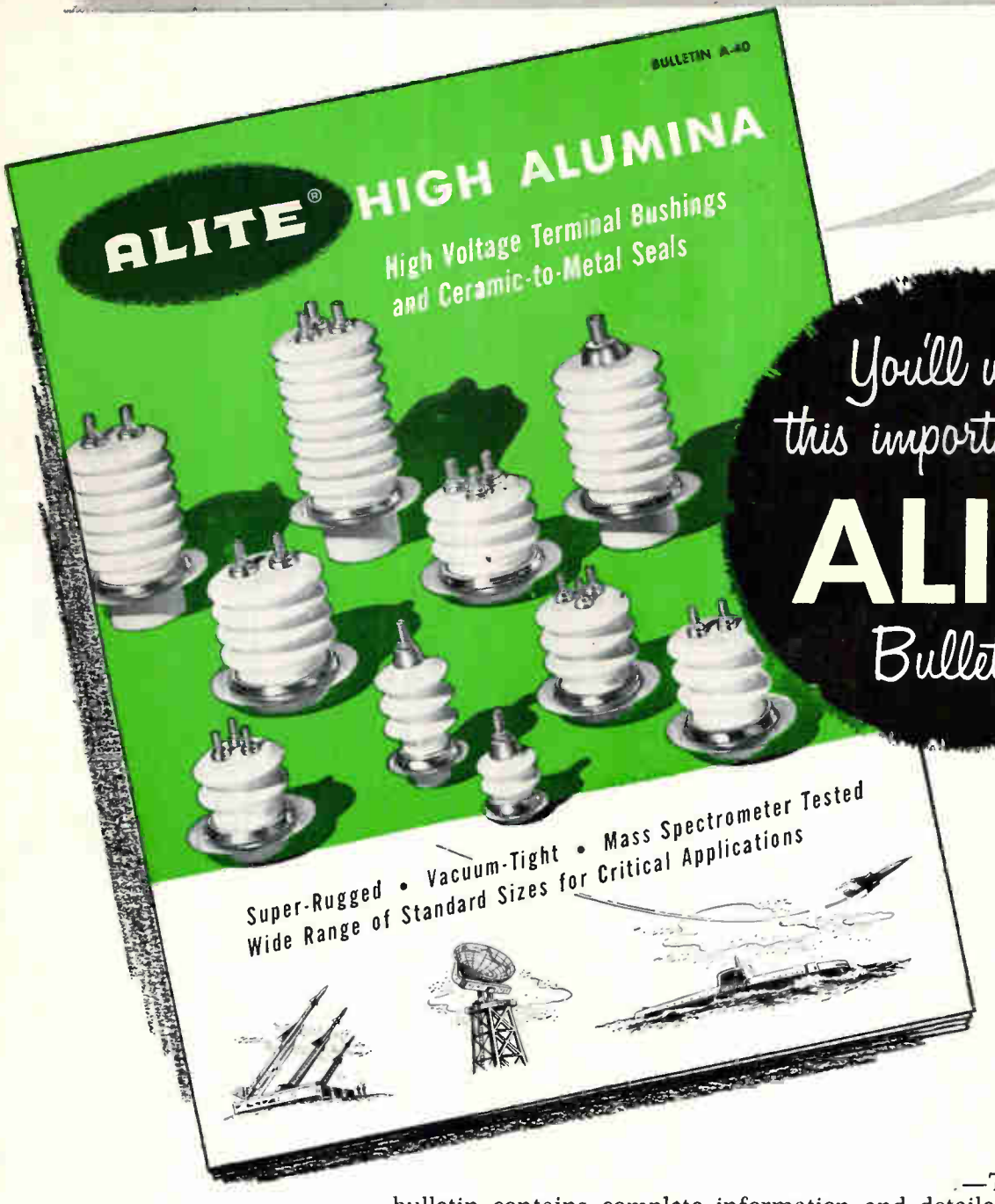

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2N861	25v	150	0.1	30	100	7.5
2N862	15v	150	0.1	20	60	8
2N863	15v	150	0.1	40	120	10
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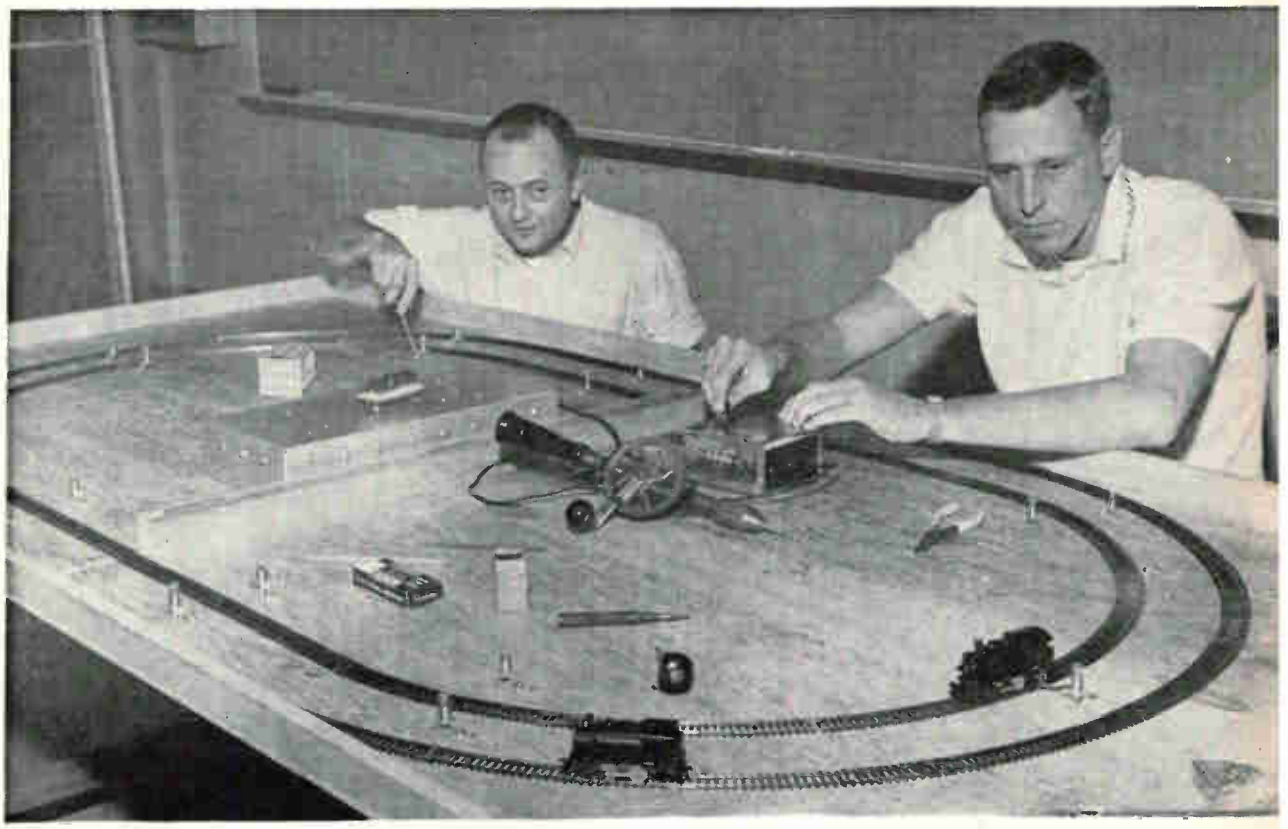

Constructing working model to investigate design problems for proposed control circuits

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

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Using analog computer to study characteristics of future highway system

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

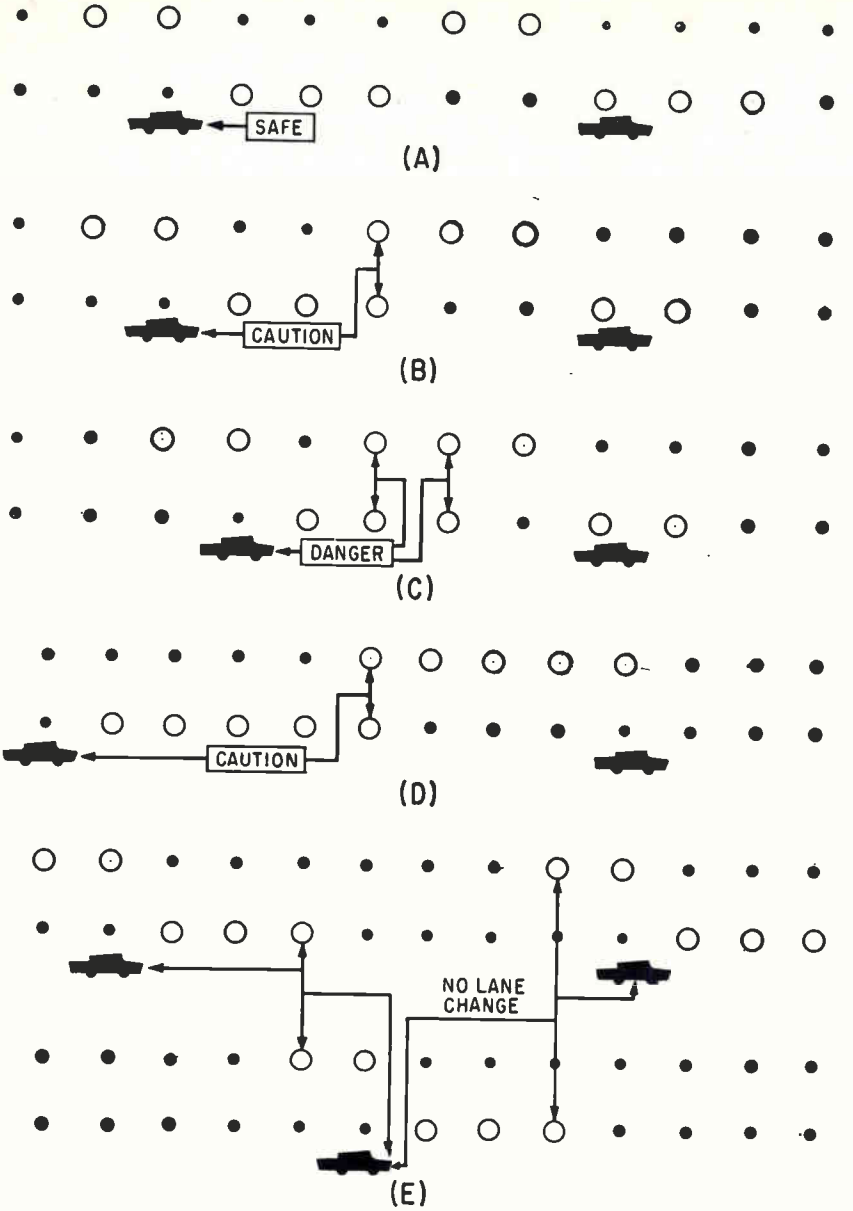


FIG. 1—Action of proposed guidance system is indicated by examples of headway (A to D) and lane changing (E)

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 nonrelated 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

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

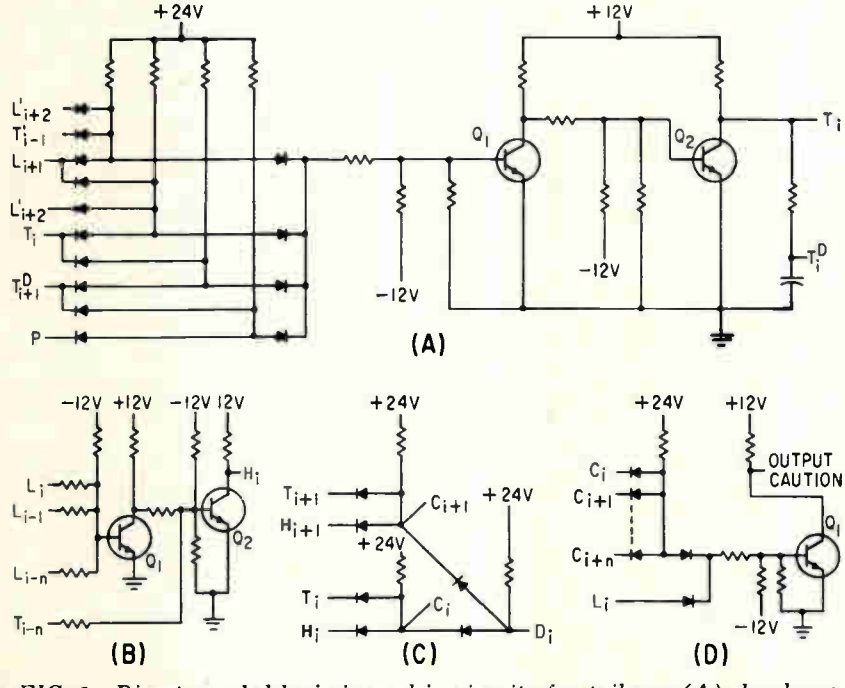


FIG. 2—Direct-coupled logic is used in circuits for tailzone (A), headzone (B), guidance (C) and personalized warning logic (D)

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

$$T_i = (L_{i+1}L'_{i+2}T'_{i-1}) + (L_{i+1}L'_{i+2}T_i) + (PT^D_{i+1}) + (T_iT^D_{i+1}) \quad (1)$$

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-1} 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

$$T_{i-1} = (L_iL'_{i+1}T'_{i-2}) + (L_iL'_{i+1}T_{i-1}) + (PT^D_i) + (T_{i-1}T^D_i) \quad (2)$$

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^D_i 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 coincident with the above tailzone conditions is controlled by the circuit in Fig. 2B and is given by

$$H_i = T_{i-n}(L_i + L_{i-1} + \ldots + L_{i-n}) \quad (3)$$

This indicates that the headzones will be ON if there is a vehicle between L_i and L_{i-n} unless T_{i-n} 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_i 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, analagous 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

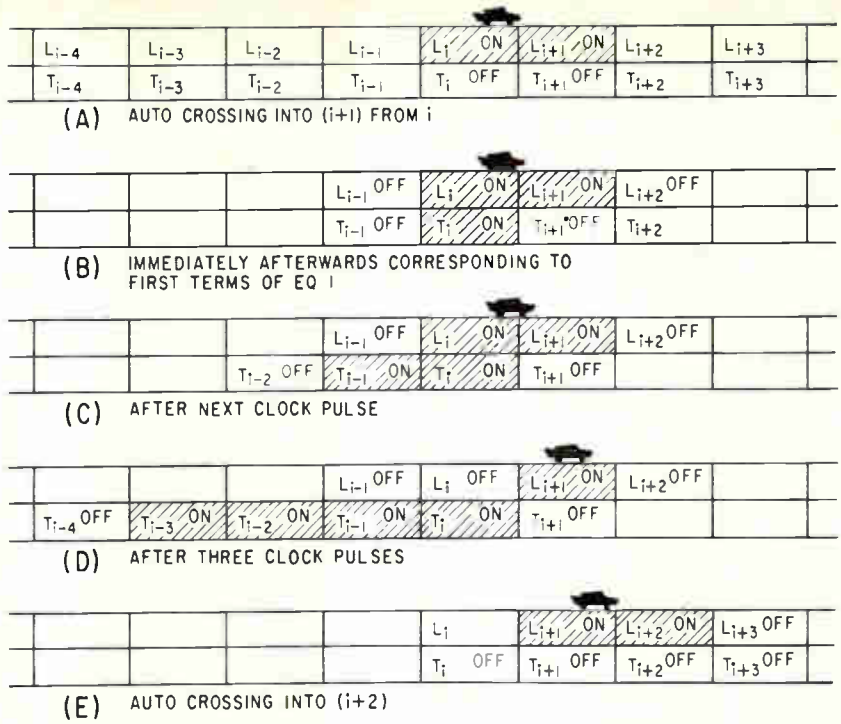


FIG. 3—Cases (A) to (E) show propagation of tailzone signals

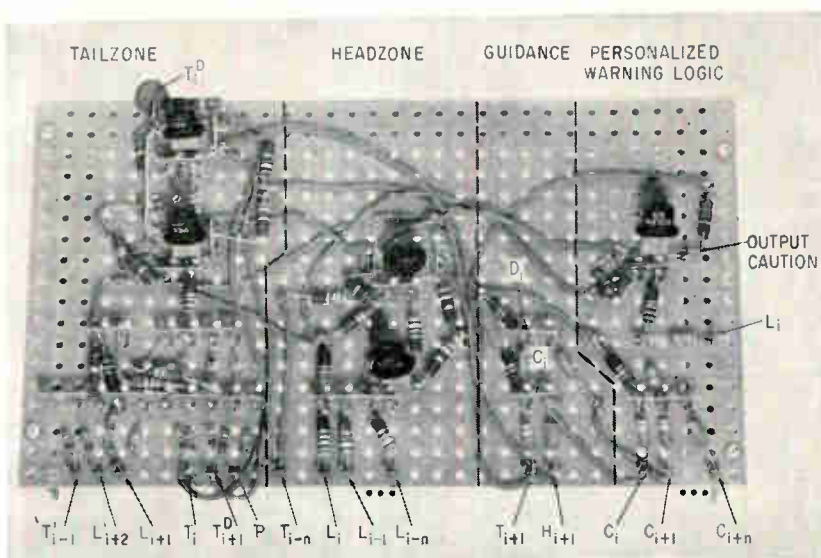


FIG. 4—Research model of each highway zone uses transistors

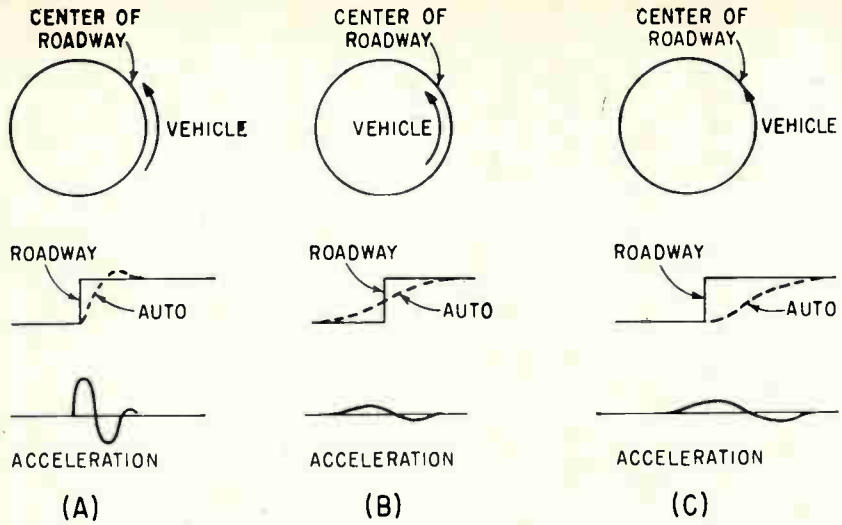


FIG. 5—Comparison of results for single cable (A), radar (B) and dual signal (C) systems

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 autmobile 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 1959 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.

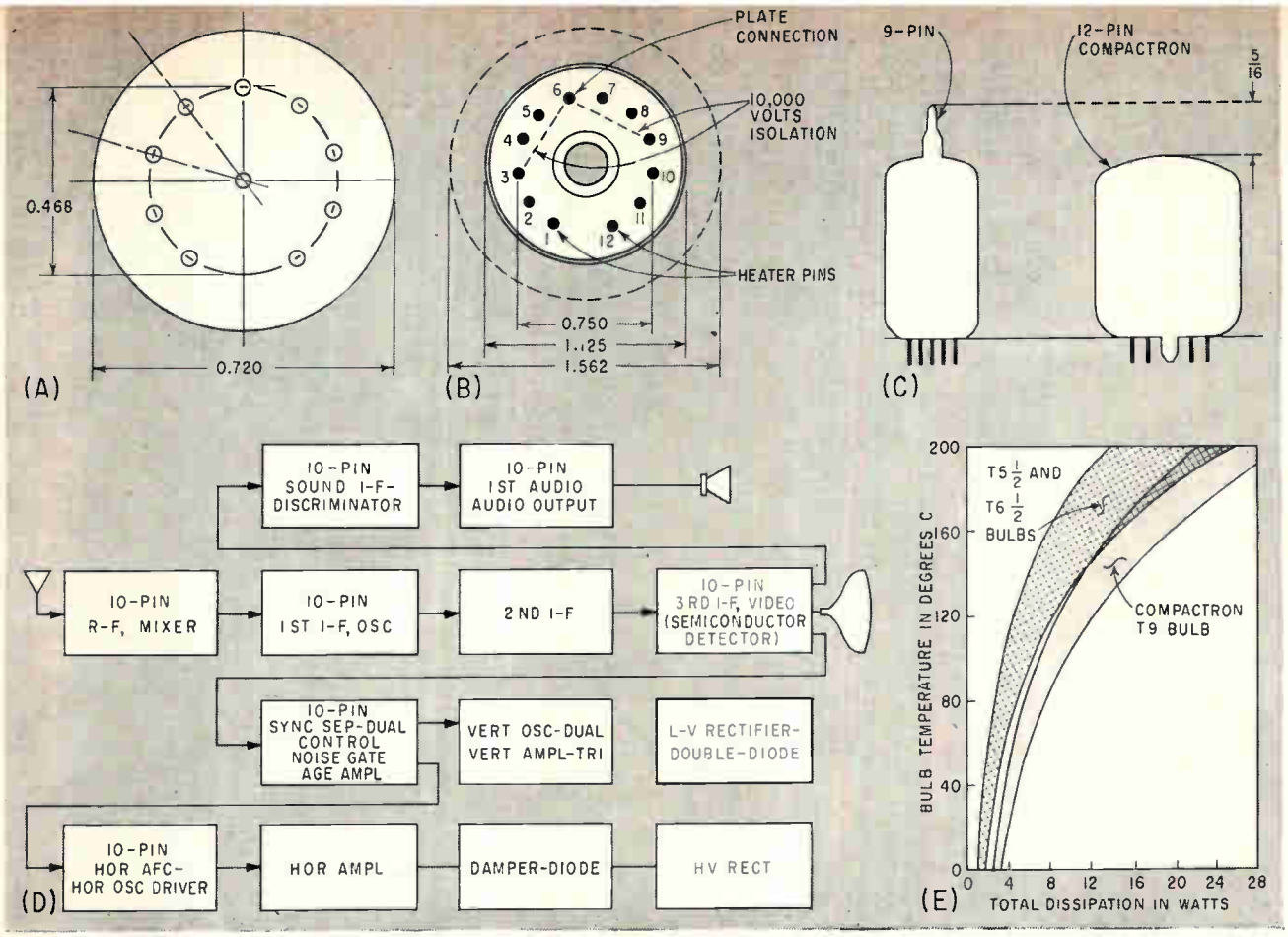


FIG. 1—Standard 9-pin base gets another pin (A); 12-pin Compactron will come in two envelope sizes (B) and be a little shorter than 9-pin type (C). Multifunction tubes reduce tube complement in black and white tv (D). Bulb temperature of Compactrons is relatively cool (E)

ENGINEERING TRENDS IN

CONSUMER ELECTRONICS

New multifunction tubes and increasing numbers of transistors are being incorporated into home entertainment equipment

By GEORGE J. FLYNN,
Associate Editor

INTRODUCTION OF 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[1] of Sylvania and the 12-pin Compactrons[2] 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.[3] 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 ¼ watt of heater power. Circuits investigated[5] 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.

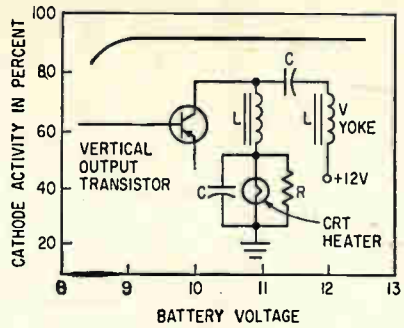


FIG. 2—Low-power heater of special crt's can be supplied from various sources, saving battery power

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[5]. 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

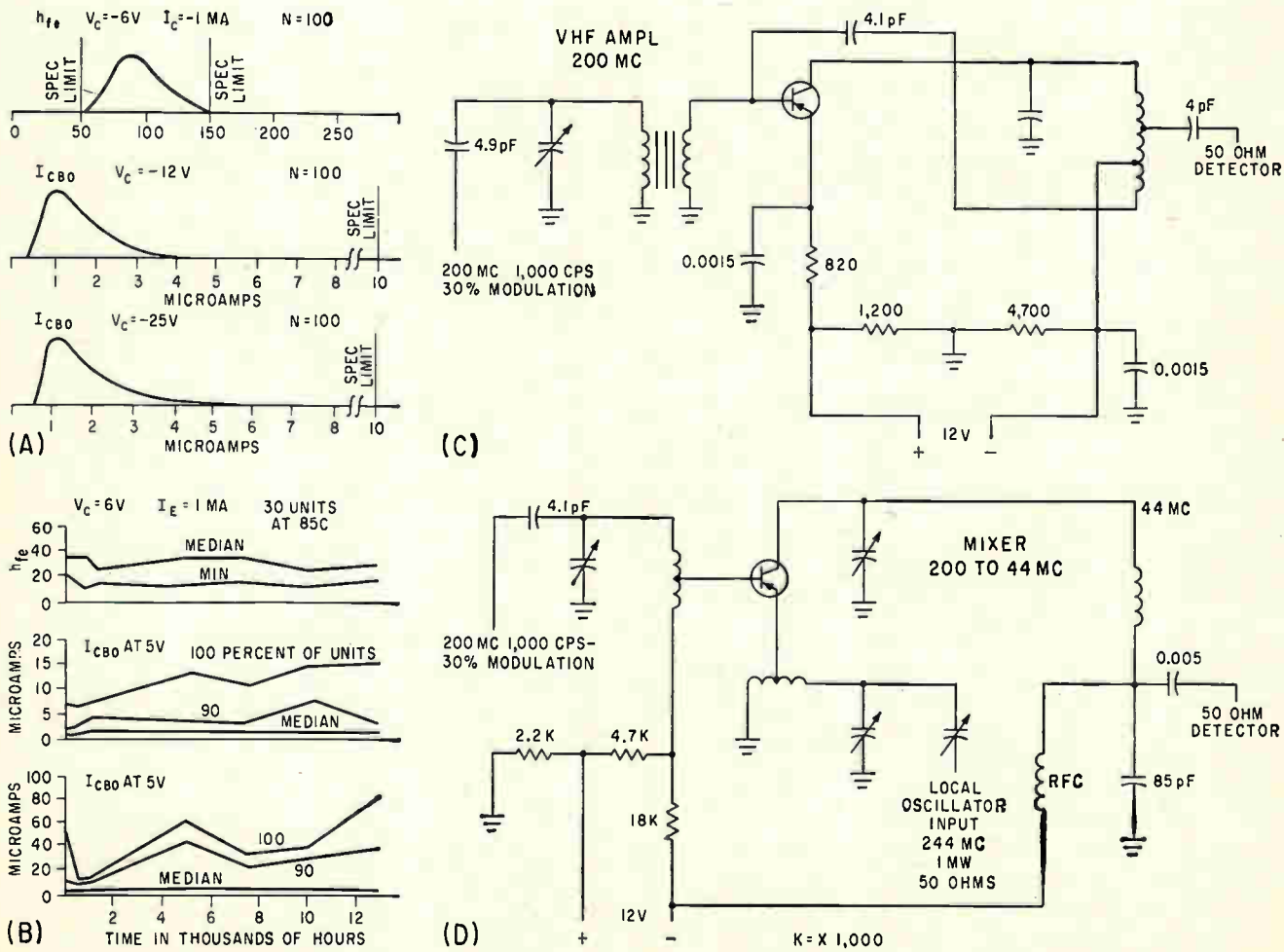


FIG. 3—Transistors optimized for entertainment functions can be held to specs (A), show good life expectancy (B). Functional test circuit for r-f amplifier transistor (C) and mixer transistor (D)

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[6].

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_{cbo} 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 noticable 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[7] of Fig. 5 was proposed as an alternative. The circuit uses a high frequency *pnp* 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.

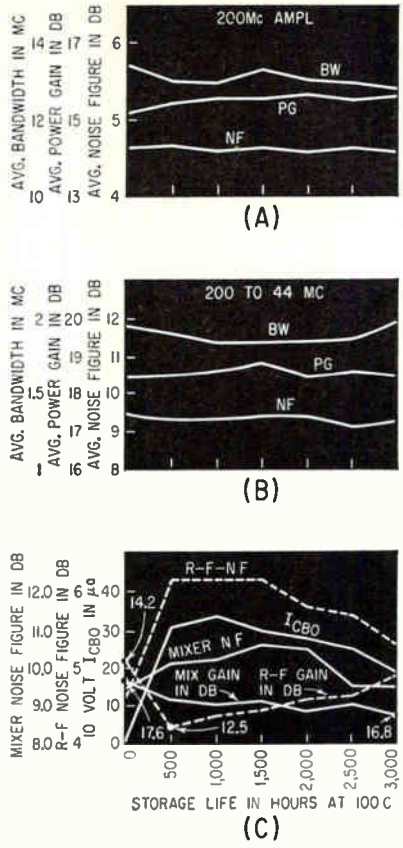


FIG. 4—Performance of 18 production line Madt transistors in special amplifier test circuit (A) and mixer circuit (B). One transistor indicated an early failure (C) but improved with age

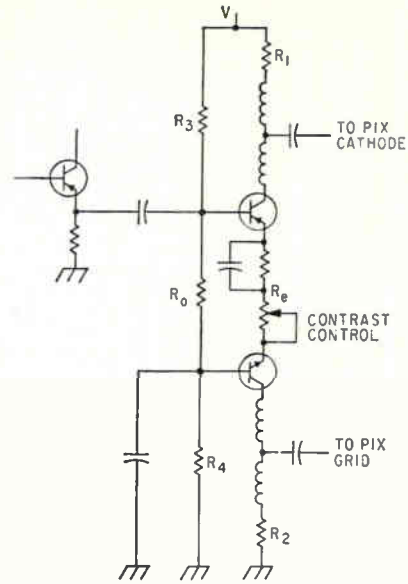
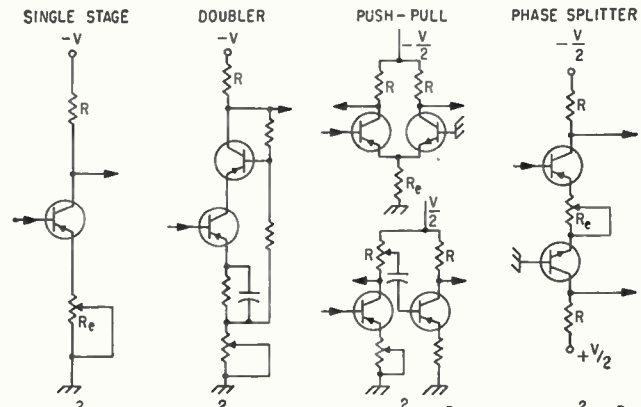


FIG. 5—Phase splitter for video amplifier with 80 v peak-to-peak output



	SINGLE STAGE	DOUBLER	PUSH-PULL	PHASE SPLITTER
MAX SUPPLY POWER	$P_o = \frac{V^2}{2R}$	$P_o = \frac{V^2}{2R}$	$P_o' = \frac{1}{2}\frac{V^2}{2R} = \frac{P_o}{2}$	$P_o'' = \frac{1}{2}\frac{V^2}{2R} = \frac{P_o}{2}$
MAX POWER DISSIPATION IN EACH TRANSISTOR	$P_t = \frac{V^2}{4R}$	$P_t' = \frac{1}{2}\frac{V^2}{4R} = \frac{P_t}{2}$	$P_t'' = \frac{1}{4}\frac{V^2}{4R} = \frac{P_t}{4}$	$P_t''' = \frac{1}{4}\frac{V^2}{4R} = \frac{P_t}{4}$
COLLECTOR-EMITTER BREAKDOWN VOLTAGE	$V_B > V$	$V_B > \frac{V}{2}$	$V_B > \frac{V}{2}$	$V_B > \frac{V}{2}$
TOTAL GAIN	$G_t = \frac{R}{R_e + re}$	$G < 2G_t$	$G < 2G_t$	$G < 2G_t$
INPUT Z	LOW	LOW	LOW	HIGHER
PHASE SHIFT	NO	NO	YES	NO

FIG. 6—Comparison of design parameters of different video output circuits

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(5) H. C. Bartels and C. B. Tague, Manufacture and Control of High Frequency Transistors for Consumer Products.

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(7) Z. Wiencek, Phase Splitter Video Amplifier for Transistor TV.

High-Temperature Resonant-Cavity

Equipment can measure dielectric constant and loss-tangent at temperatures encountered by space vehicles when they reenter the earth's atmosphere. Technique permits 1 percent accuracy in dielectric-constant measurements at 2,500 F

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 2,700F 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 TE_{01n} resonant cavity method[1] 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 2,700F 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 100F 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 800F, 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 TE_{01} mode and is tunable between the TE_{014} and TE_{015} 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 circumferential line describing maximum electric field for the TE_{01n} mode.

The slots are driven by two aluminum oxide filled platinum rectangular waveguides. Electrically, the guides operate in the TE_{10} 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 β_s.

$$(\tan \beta_s d)/\beta_s d = -\tan \beta_0 [M - M_4 - d]/\beta_0 d \quad (1)$$

where β_s is the phase constant in the sample, d is the sample thickness, β_0 is the phase constant in the empty portion of the cavity, M is the micrometer reading at resonance in the TE_{015} mode with the sample inserted and M_4 is the micrometer reading at resonance in the TE_{014} mode with the cavity empty.

Dielectrometer

By ROBERT W. SUTTON,
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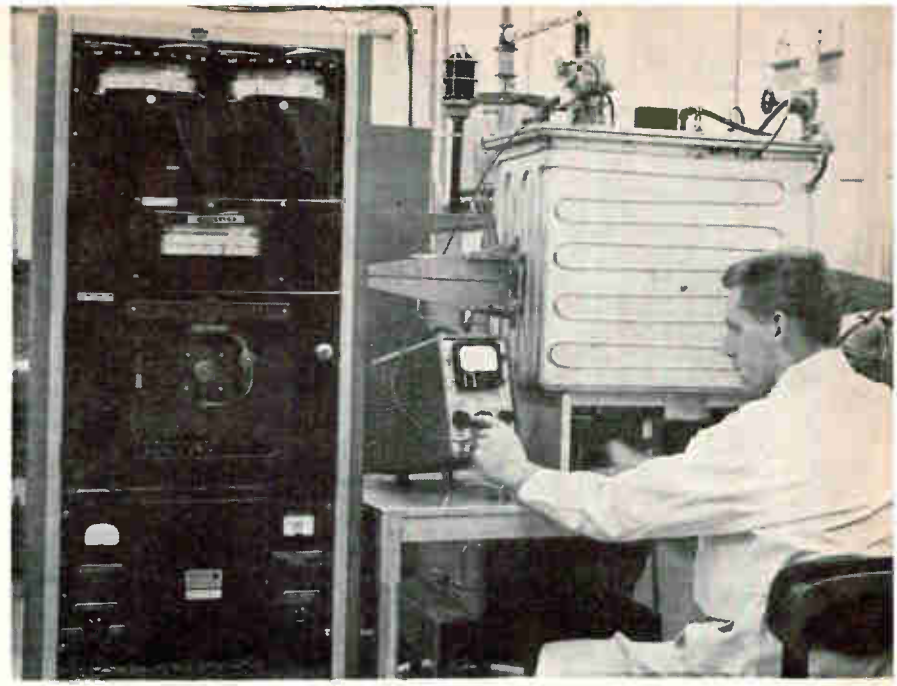
Physics Technology Department
Boeing Airplane Co., Seattle, Wash.



Using dielectrometer to measure dielectric constant of high-temperature resistant radome material

Then for medium and low-loss samples

$$\epsilon = (\beta_s^2 + K^2)\ (\beta_g^2 + K^2) \qquad (2)$$

where ϵ is the dielectric constant of the sample, $K = 3.832/a$ for the TE_{011} mode, and a is the cavity radius. Solution of Eq. 1 and 2 requires this data

M^+, M^- = the micrometer reading at the upper and lower half-power points, TE_{016} mode, sample inserted

M_4^+, M_4^- = the micrometer reading at the upper and lower half-power points, TE_{014} mode, cavity empty

M_5^+, M_5^- = the micrometer reading at the upper and lower half-power points, TE_{015} mode, cavity empty

d = sample thickness

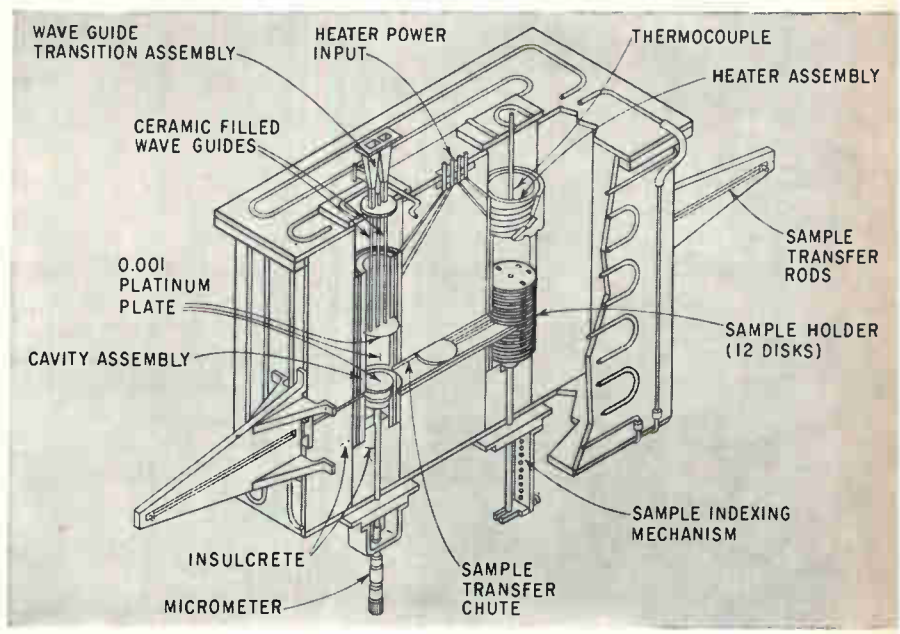
λ_0 = free space wavelength of the microwave signal.

These data are then used to find M, M_4, M_5, β_g and a: $M = (M^+ + M^-)/2$, $M_4 = (M_4^+ + M_4^-)/2$, $M_5 = (M_5^+ + M_5^-)/2$, $\beta_g = \pi/(M_5 - M_4)$, and finally

$$a = \{(\lambda_0^2 \times \lambda_g^2)/[2.6896\ (\lambda_g^2 - \lambda_0^2)]\}^{\frac{1}{2}},$$

where $\lambda_g = 2\ (M_5 - M_4)$. With the exception of λ_0, 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 TE_{014} or TE_{015} 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 a t3 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.



Physical arrangement of the dielectrometer showing mechanical construction and location of dielectric samples

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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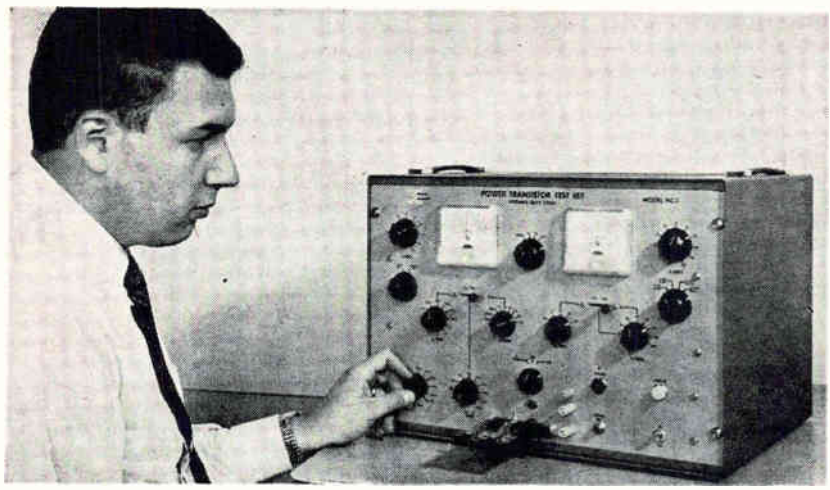
Measuring Parameters by



Author makes 250-w peak power measurement at average power level of 2.5 w. Pulse method minimizes requirements for heat sinks

By DONALD H. BRESLOW,
Baird-Atomic, Inc., Cambridge, Mass.

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_{FE}, 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_cI_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_B and I_c. 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 $P_c = (1/T)\int_0^T E(t)I(t)\,dt$ and for this example $P_c = V_cI_c/4$. This is ¼ 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_{FE} may be calculated as I_c/I_B. The average power is $P_c = V_cI_c\,\tau/T$ where τ is the pulse width and T is the period. By making τ/T small, the average power can also be kept small, typically one to two percent of peak.

The values of τ and T to obtain the duty cycle must be selected with care if optimum results are to be obtained. The minimum value of τ 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

time were required, the low reading of Fig. 1C would indicate too slow a gain and/or rise time. Pulse-type measurements are useful in evaluating switching devices as the current gain can then be measured under dynamic conditions.

The maximum pulse length and minimum repetition period are governed by the thermal time constant of the test transistor. The solution of the problem of calculating junction temperature as a function of time during pulsed excitation has been presented by Mortenson.[1] An alternate treatment is given by Morgan.[2]

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, τ 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 μsec. Thermal time constants are typically on the order of one to ten msec. Therefore, a range of rectangular pulse widths from 100 to 1,000 μsec will be electrically and thermally compatible with most available transistors. Repetition periods of several thousand msec, 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 μsec, the duty cycle τ/T is variable from 0.006 to 0.06. Thus, in the most favorable case 99.4 percent of the average power for a conventional d-c test is eliminated.

If power greater than maximum is applied, the final junction temperature will be greater than allowed. However, if the power is applied in pulses whose period is sufficiently short compared with the transistor's thermal time constant, then the maximum junction temperature at the end of the pulse may be kept at a safe level. Thus, tests may be conducted safely at peak powers many times rated dissipation without destroying the transistor.

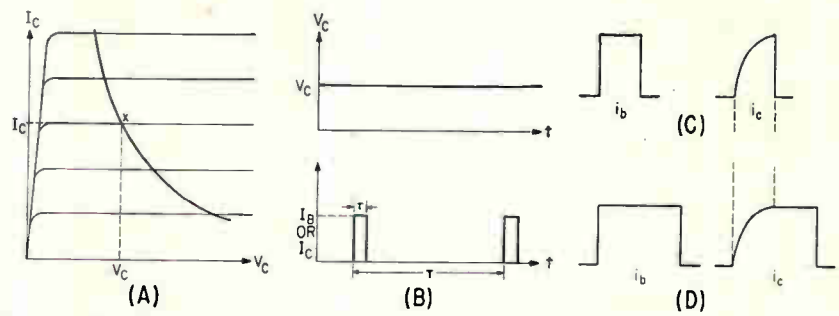


FIG. 1—Typical power transistor collector characteristics (A), pulse drive waveforms (B), and effect of response time (C) and (D)

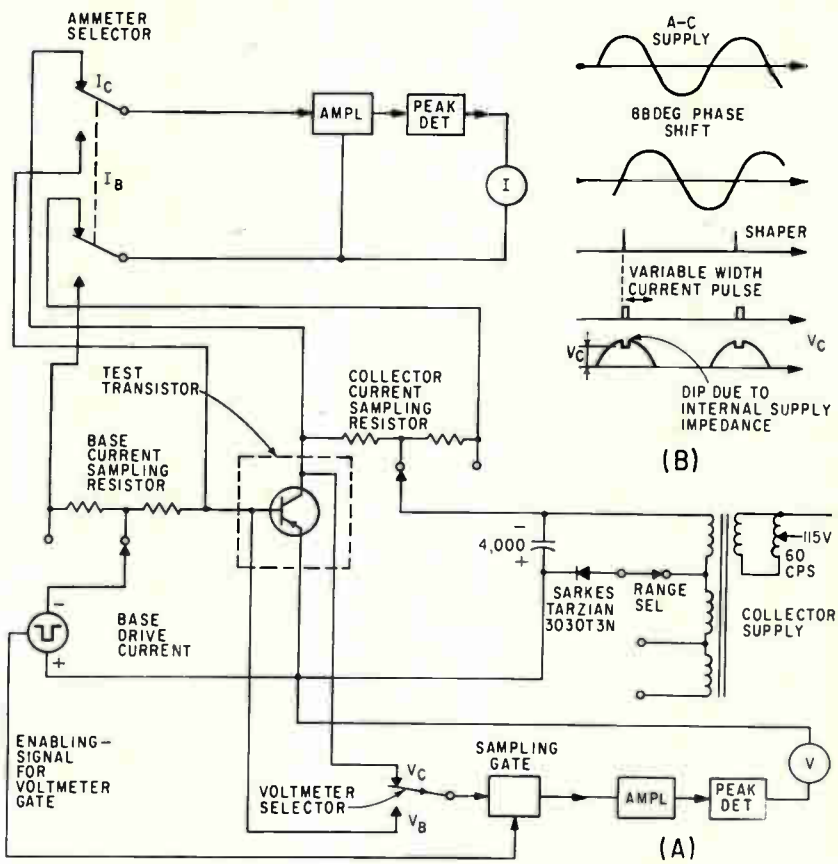


FIG. 2—Pulse tester (A) has transformer-operated, half-wave rectifier collector supply. Timing diagram and key waveforms are shown in (B)

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

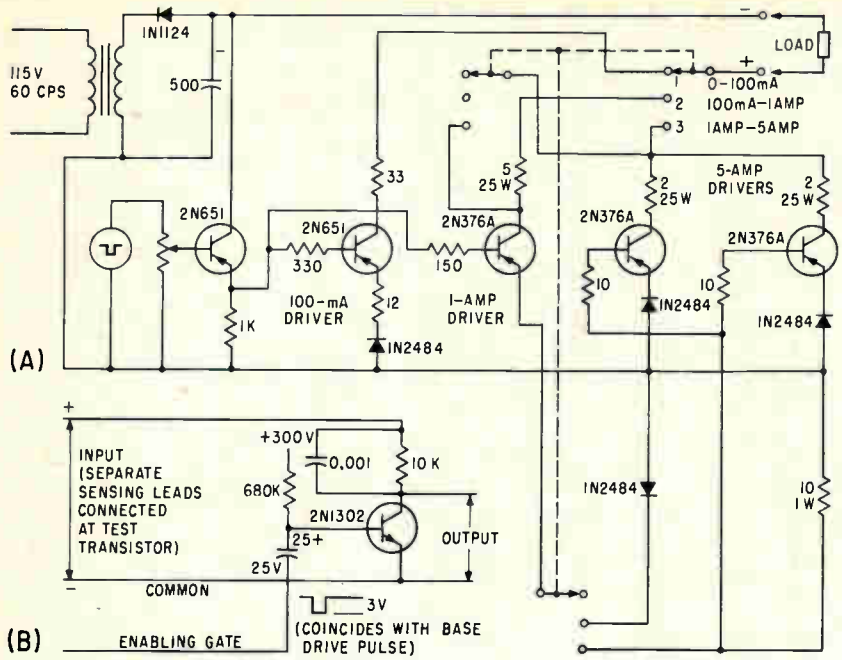


FIG. 3—Drive current generator simplified schematic (A) and voltmeter sampling gate (B)

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 milliohms, 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 I_{CO}, I_{EO} and other leakage parameters. Since these tests are conducted at low power levels, conventional d-c is used. A function-selector 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.

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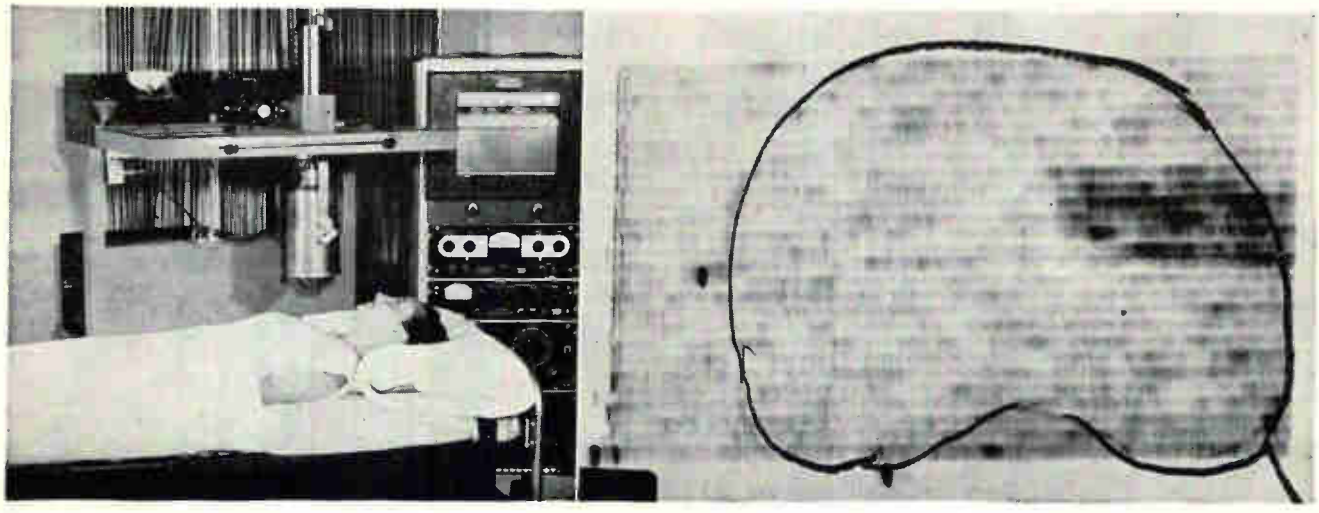


Apparatus performs front-to-back scan of patient's head (left). Side scan (right) shows tumor as dark area, with skull outline indicated roughly in grease pencil

Sensitive Amplifier Helps Locate Tumors

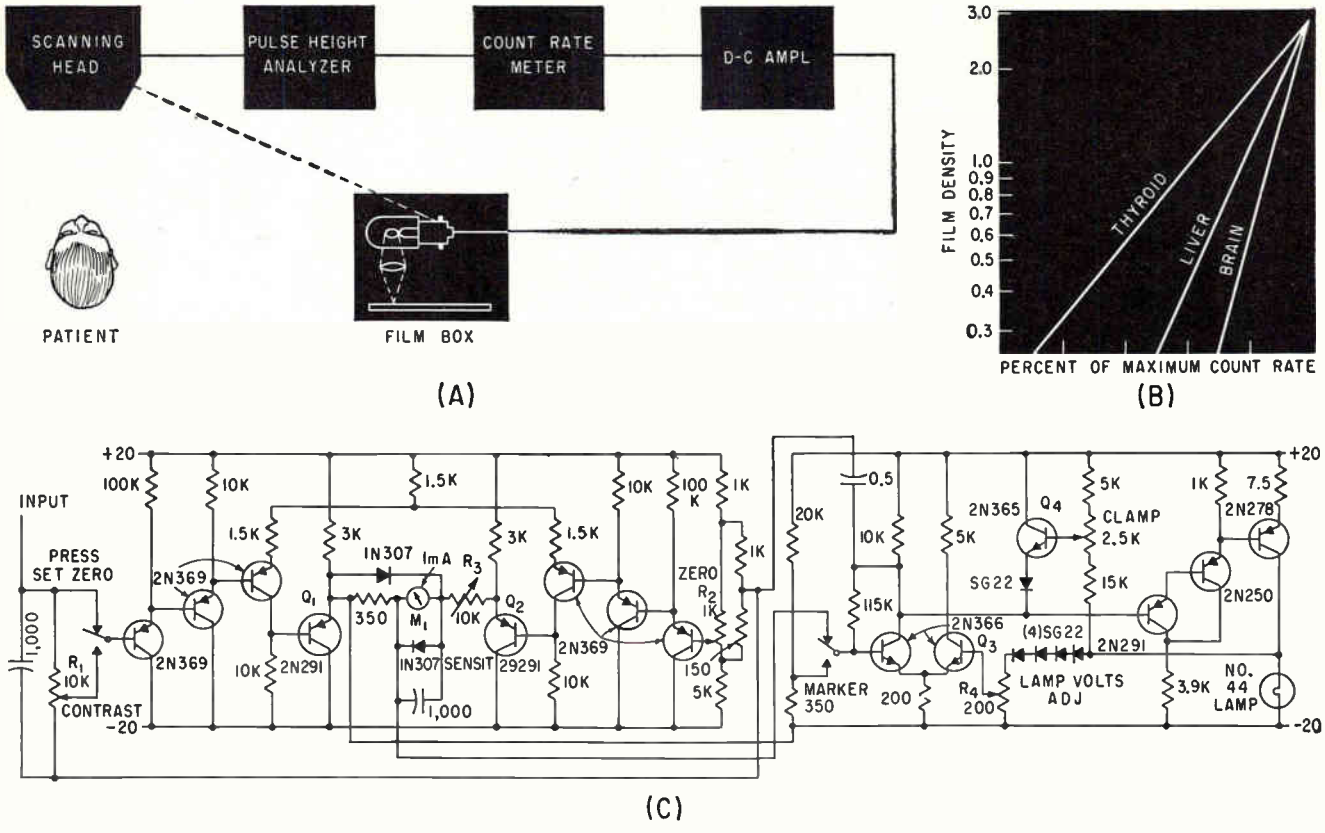
By EDWIN GORDY, M.D. and GEORGE SIEBER,
Roswell Park Memorial Institute, Buffalo, N. Y.

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^{131} iodinated albumin, the difference in detected count rate between normal and tumor tissue is only about 10 percent.[1, 2]

Working with this information,[2, 3] an instrument was developed that mechanically scans a body region, using a scintillation counter fitted with a lead focusing-collimator.[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.[2] 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 useable 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



Block diagram of tumor-scanning apparatus (A); graph showing relationship between film optical density and detected count rate (B); and circuit of d-c lamp-driving amplifier (C)

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[3] 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 Walsh[5], 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_1 and R_2 and scale expansion R_3, 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_1 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_3 through R_4. Transistor Q_4 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_2.

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.

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(5) J. W. T. Walsh, Photometry, 2nd Edition, appendix X. Constable and Co., London, 1953.

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Thyratron Monitors Line-Voltage Dips

Circuit senses and counts sudden line voltage dips below a preset level

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[1]. 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 electromechanical 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[2]. 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 reignites lamp *L*, and this indicates that a dip has taken place. The circuit is now disabled until the reset button is again operated.

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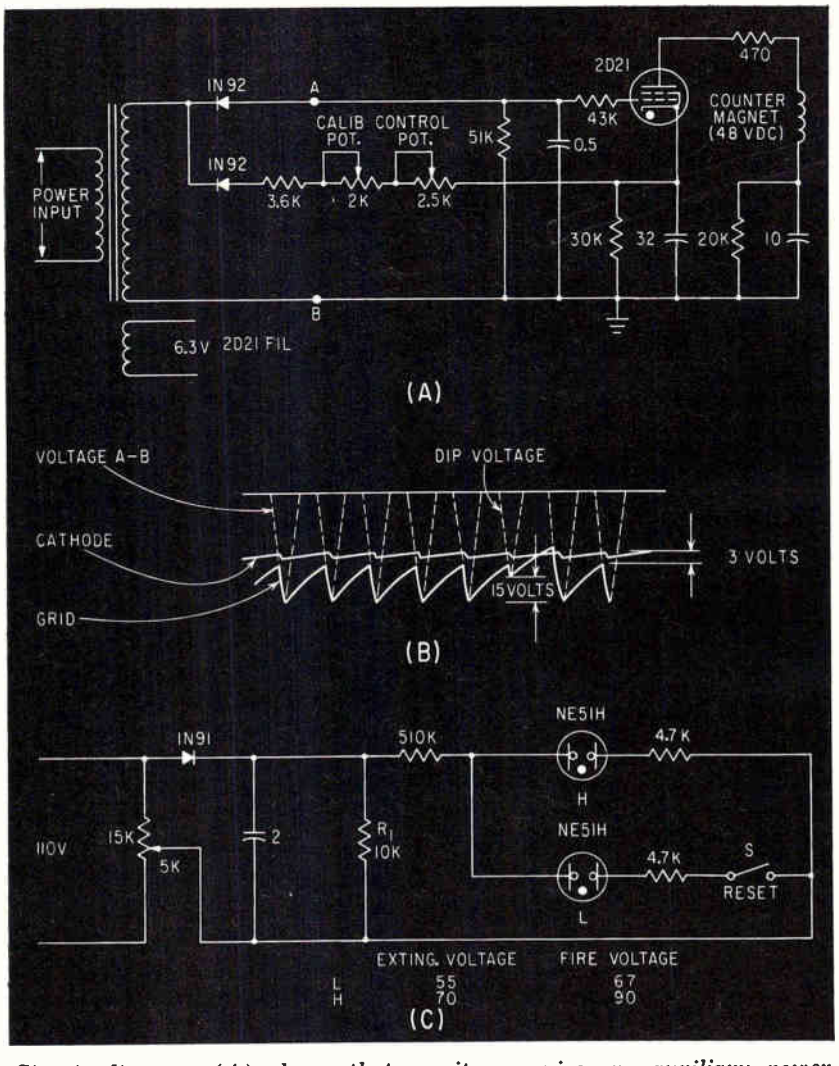

Circuit diagram (A) shows that monitor requires no auxiliary power source; it uses same source as voltage being measured. Waveforms (B) illustrate circuit operation. 4x3x3 in. box houses monitor. In the neon latch (C) lamp H is ignited by opening switch S, thus preventing lower voltage lamp L igniting until a dip in voltage turns H off. Lamp L then lights on restoration of input indicating that a dip has occurred

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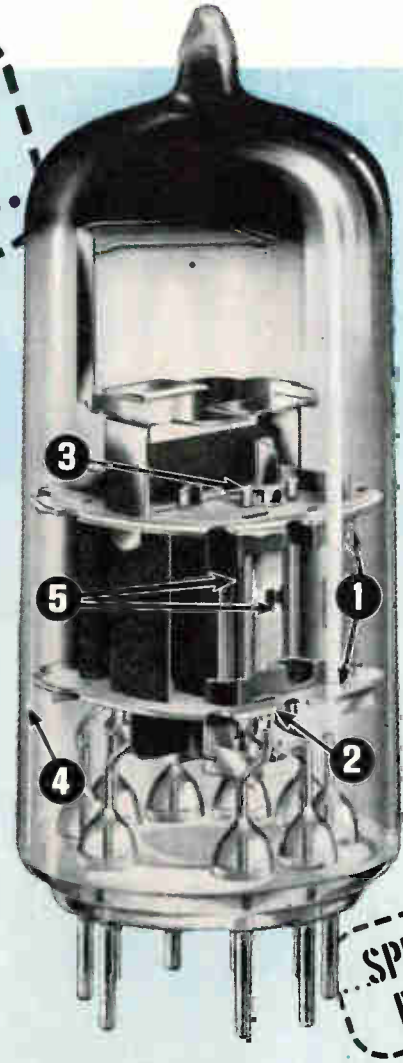

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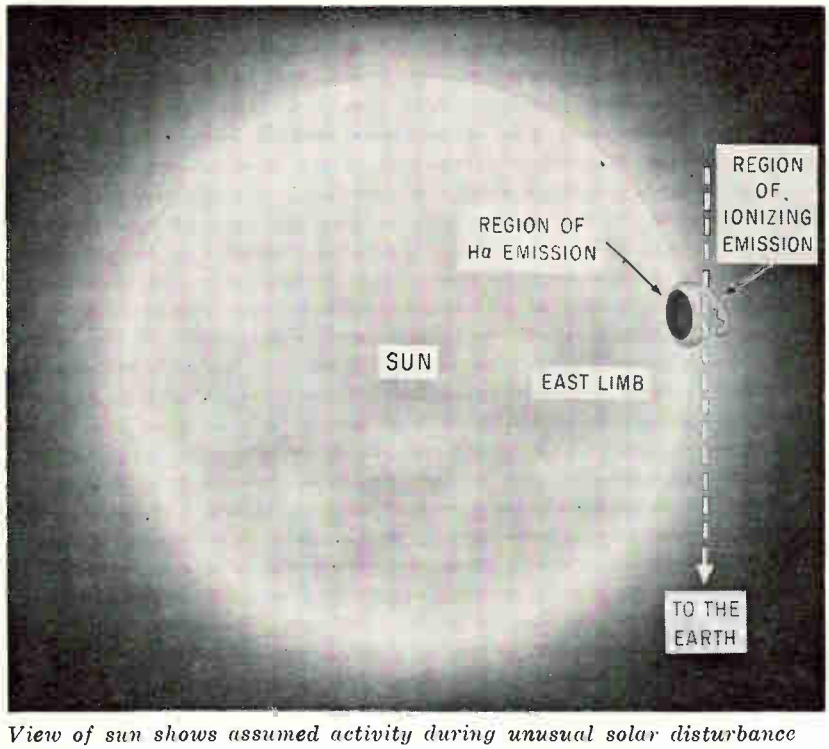
Solar-Radio Event Not Explained by Theories



View of sun shows assumed activity during unusual solar disturbance

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 1½ 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 terrestial 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 emission usually travel in straight lines. It then becomes necessary to assume a different trajectory for each type emission, which is at variances 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.

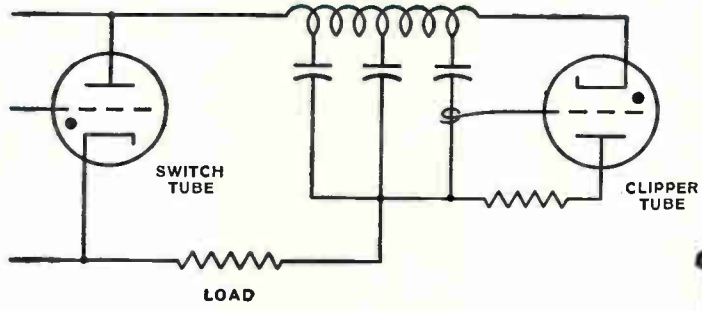
Getting More Data From Weather Radar

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 thyratron clippers 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" clippers or "tail biters".

Write for complete technical details on the new 7454 and 7455 Clipper Thyratrons. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193.

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Technical information available through ATLANTA, GA.; COLUMBUS, OHIO; CULVER CITY, CALIF.; DALLAS, TEXAS; DENVER, COLO.; DETROIT, MICH.; IRVINGTON, N. J.; MELROSE PARK, ILL.; NEWARK, N. J.; PHILADELPHIA, PA.; SEATTLE, WASH. IN CANADA: ABBEY ELECTRONICS, TORONTO, ONT.

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 observational 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-

versity of Chicago, MIT and Weather Services, Inc.

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 heartbeat (0.5 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.

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.

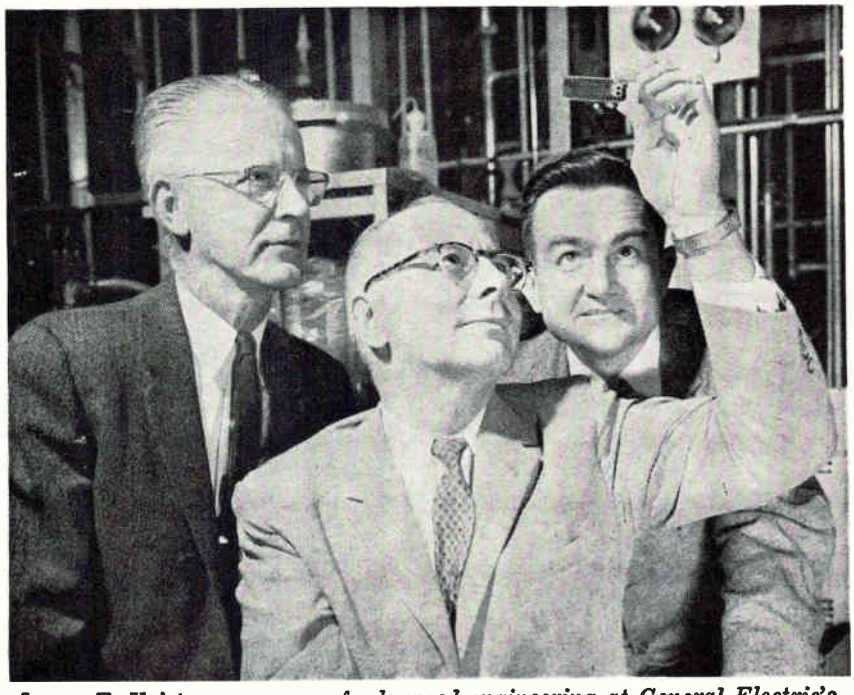
The key to this philosophy, which recognizes opportunity commensurate with the challenge, is that the business demands a customer-oriented approach that both fills the needs of current technology and anticipates what future products ingenuity will demand.

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."



James E. Keister, manager of advanced engineering at General Electric's Advanced Product Planning Operation holds a shift register, an assembly of cryotrons designed for operation under super-cold temperatures in potential computer applications. Martin A. Edwards, manager of APPO, and Joseph S. Quill, manager of advanced marketing, look on

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.

CDF **CONTINENTAL-DIAMOND FIBRE**

CONTINENTAL-DIAMOND FIBRE CORPORATION, NEWARK, DELAWARE • A SUBSIDIARY OF THE Budd COMPANY

by-product of the constant effort to "compact" equipment operating at sonic and supersonic speeds.

The latter problem, G-E feels, will require more complex vacuum-producing equipment than now exists, in order to make it possible to seal metal-ceramic combinations as a safeguard against ambient oxidation and corrosion.

While Advanced Product Planning is flexible, and can study and research problems for any of G-E's electronic-product components, the operation zeroes in on two major objectives. The first is to expand the company's participation into a larger segment of the electronic components business, both in this country and overseas.

The second objective is allied to the first: to provide information to management on fundamental problems.

L. Berkley Davis, a G-E vice president and general manager of the Electronic Components Division, defined the over-all problem in a recent issue of a company marketing publication.

Davis pointed to the 1949-59 period in which the American electronic components industry grew from a $2 billion business to a $9 billion enterprise, and to forecasts that see a further leap to $20 billion by 1965.

The executive discussed the perils of foreign competition and the growing rivalries of domestic entrants into the field, but then pinpointed on "innovation" as the basic nature of the business. He added:

"Marketing innovations can and will be developed as a result of careful integration of need, research, development and production in this fast-moving, fast-changing industry. Historically, a breakthrough in one area of the industry has always started a chain reaction of innovation in other areas. It is important to gear our organization, our outlook and our efforts to a concentrated and integrated search for innovation in all fields."

Created in part to implement this quest, the Advanced Product Planning Operation probes in a variety of areas but is reluctant to discuss in depth many of the facets, because of proprietary considerations.

Joseph S. Quill, manager of advanced marketing for the group, in a recent speech illustrated the

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 APPO. 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 (TIMM 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 challenge."

"The successful competitors," he adds, "will be those with the agressiveness, 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."

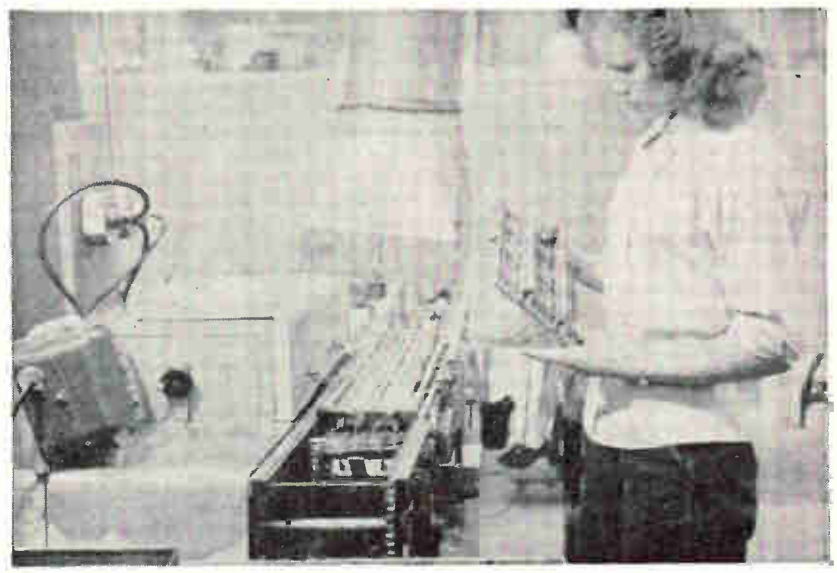
Silicone Price Decreases

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,
Manager of Engineering, Elgin Laboratories, Inc., Subsidiary of Erie Resistor Corp., Waterford, Pa.

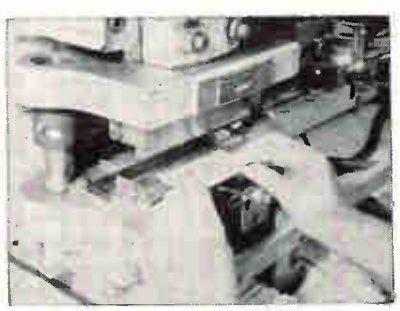


Strip package assembly fixtures go right onto soldering machine conveyor

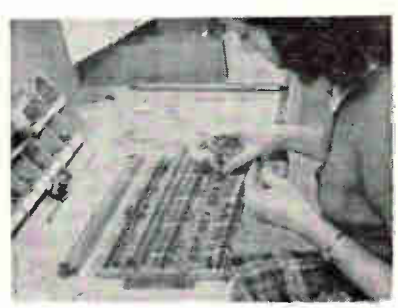
TERMINALS STAMPED in a continuous strip and mounted on prepunched boards are the basis of a strip packaging method designed to simplify design, production and testing of circuit modules. Many of the hand assembly steps usually needed for wired circuitry are avoided.

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 nonstandard dimensions.

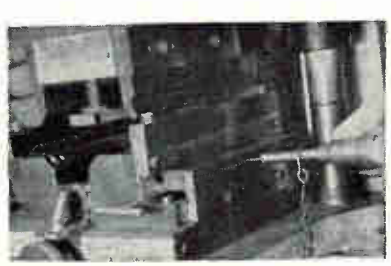
Primary operations, shown in Fig. 1, are inserting the terminal strips in the boards (A), cutting out unwanted connections between terminals (B) and placing components in a row between terminal pairs (C). The assembly is then machine-soldered.



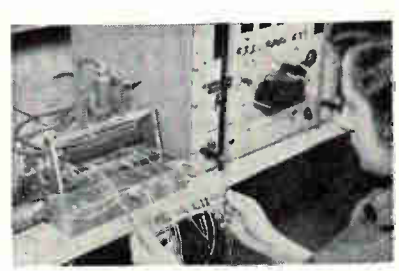
Terminal insertion in press starts assembly



Components are laid in place on fixture holding two rows of cards



Cutters are programmed to remove excess connections



Final tests are made on tape-programmed circuit tester

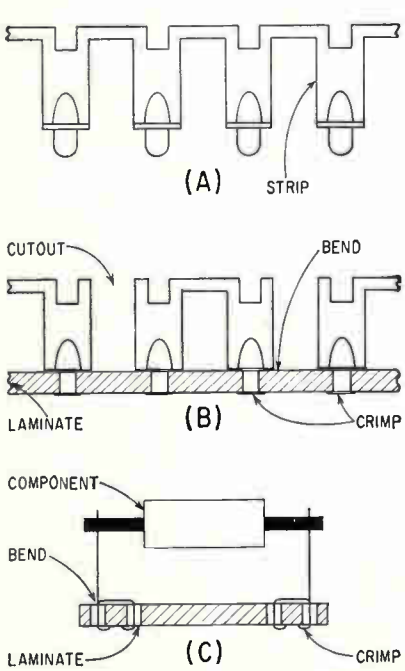


FIG. 1—Basic steps in assembly

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

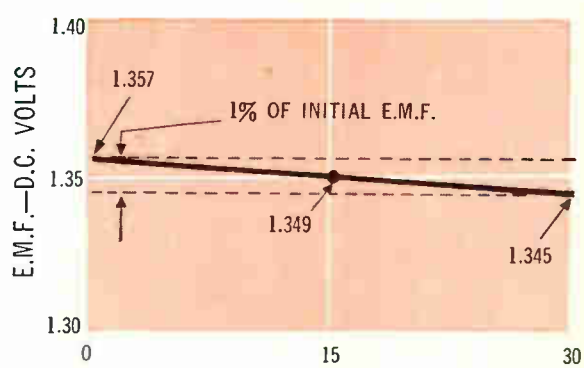
actual size

Another Mallory "First"

Mallory Voltage Reference Battery has 8 outputs, 0-10.8 volts in 1.35 volt increments; accuracy ±½%; internal impedance ½ 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.



Voltage Stability—Mallory Mercury Batteries maintain exceptionally constant voltage. After 30 months of storage, voltage is within 1% of initial E.M.F. and life tests of three years and more demonstrate voltages within ±½% of stated values. Output of production cells is within a range of 0.0005 volts over the past twelve year period.

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MALLORY

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.

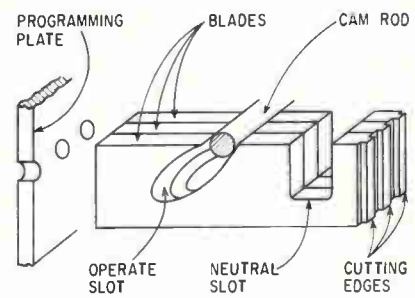


FIG. 2—Cam drives cutters in operating position

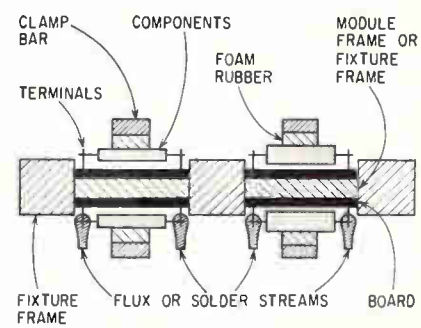


FIG. 3—Cross section of assembly and soldering fixture

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.

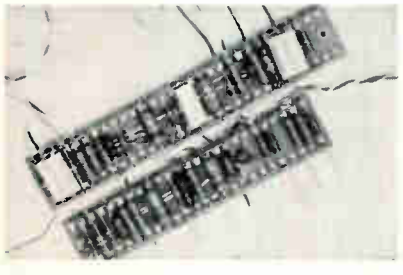
A press has been equipped for punched card programming. Miniature air cylinders, mounted on a manifold, substitute for the programming plate. The air lines go to individual holes in a platen mounted in the main air supply line. The card, placed on the platen, acts as a gasket, allowing the air to reach

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. 3).

Wiring is added first and wire ends are crimped to terminals at connection points. Wire is generally precut and stripped by machine. Component leads are also precut. 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.

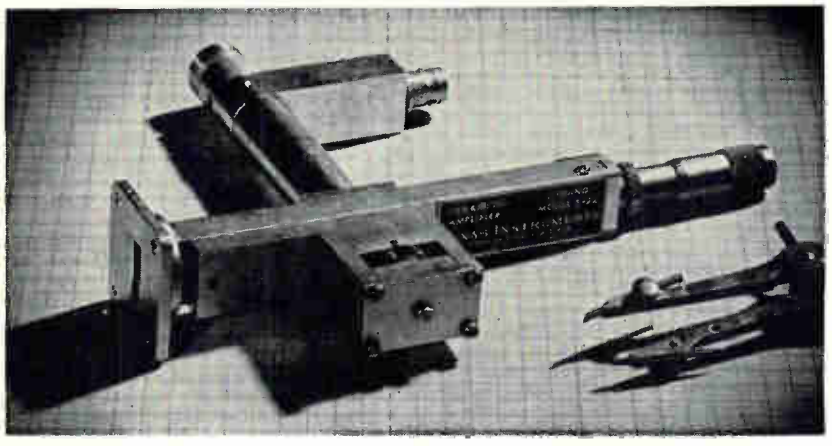
The assembly fixture is also the soldering fixture, fitting on the conveyor of a stream-soldering machine. The machine which Elgin uses was designed to allow flux and solder to touch only the terminal strips. Flux is pumped through small tubes spaced the distance of the terminal strips. As with other 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 vises. 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.

New On The Market



Parametric Amplifiers

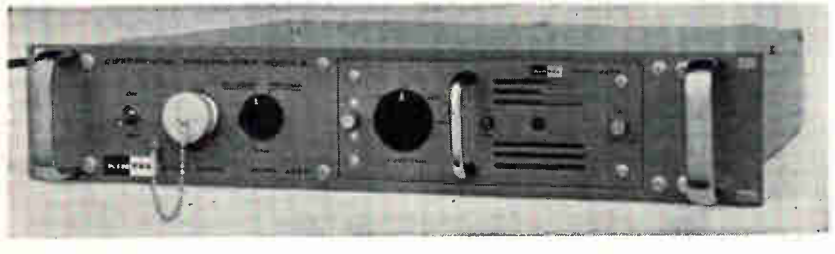
75 Mc BANDWIDTHS

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.

CIRCLE 301 ON READER SERVICE CARD



Differential Preamp

HELPS MEASURE TO 1uV D-C

RANGE of digital voltmeters is extended to 1 microvolt d-c with the 459B/N, a floating, narrowband, differential d-c preamplifier manufactured by Kin Tel Division of Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego, Calif.

Designed for general use, the preamp provides stable, accurate amplification of low level input signals. Common mode rejection is 180 db for d-c and 130 db for 60 cps with up to 1,000 ohms unbalance in either signal lead. The input, which is completely isolated from both output and chassis ground, may be floated up to ±250 volts with respect to ground. Small signals which would be masked by common mode hum and noise are isolated and amplified accurately.

Two units are used, the 459B amplifier and the 559N module. The amplifier has fixed gains of 10, 30, 100, 300 and 1,000 (the 300 and 1,000 settings are not to be used with tracking type voltmeters). A vernier control provides ±1 percent gain variation for system calibration and a zero control balances the amplifier and compensates for small d-c offsets at the input. Price is $1,475; delivery is one week.

CIRCLE 302 ON READER SERVICE CARD

Precision Recorder

THREE CHANNEL

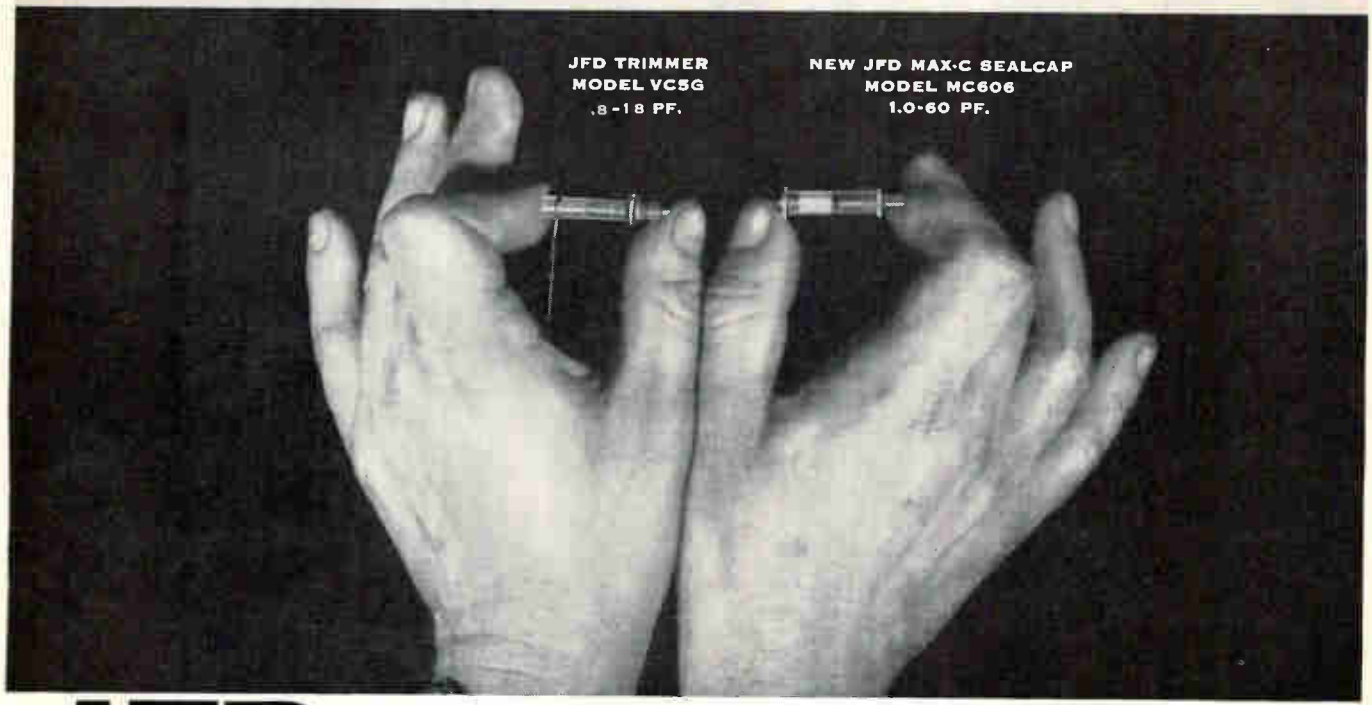
A 3-CHANNEL instrumentation quality magnetic tape recorder, 2 by 4 by 5 inches, weighing 31 ounces (including 7 ounces of tape), has been introduced by Precision Instrument Co., 1101 Commercial St., San Carlos, Calif. Designed for direct recording from 100 to 5,000 cps, the recorder can operate in any 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 ¾ watt, sup-

300% INCREASE IN RANGE NO INCREASE IN SIZE!



JFD

MAX-C®

MINIATURE TRIMMER SEALCAP®

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

Model	Min.	Max. (PF)	Distance Beyond Panel	Maximum Diameter
MC601	1.0	14.0	29/64"	5/16"
MC603	1.0	28.0	11/16"	5/16"
MC604	1.0	42.0	29/32"	5/16"
MC606	1.0	60.0	1 5/32"	5/16"
MC609	1.0	90.0	1 3/4"	5/16"

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	MINIATURE TRIMMER CAPACITORS
GLASS OR QUARTZ DIELECTRIC	LUMPED CONSTANT DELAY LINES
DISTRIBUTED CONSTANT DELAY LINES	PULSE FORMING NETWORKS
FILTERS	METALIZED INDUCTORS
LC TUNERS	

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.

Pioneers in electronics since 1929

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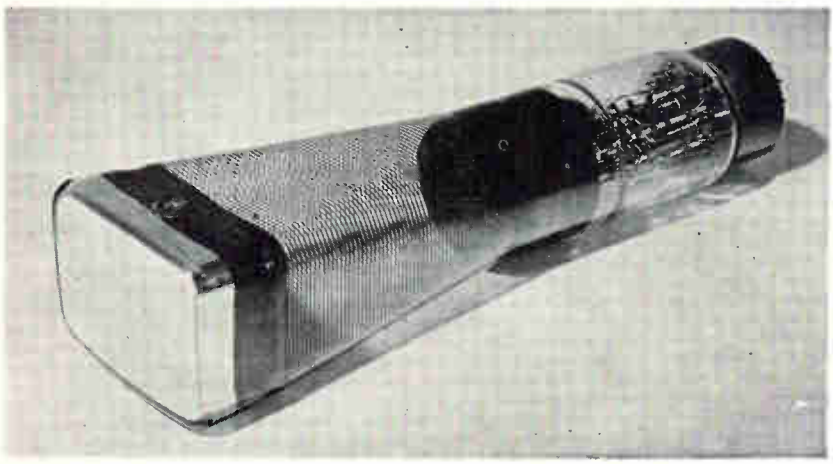
plied by mercury cells or other low-impedance source. Recording time is one hour at 1⅞ ips; frequency response is 3 db from 100 to 5,000 cps, with negligible flutter and wow, and signal-to-noise ratio better than 30 db.

CIRCLE 303 ON READER SERVICE CARD



Three-Beam CRT

ELECTROSTATIC DEFLECTION

TRIPLE BEAM 4 x 6-inch rectangular cathode-ray tube, registered as type 7BFP, 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 three 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 304 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 3⅜ 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.

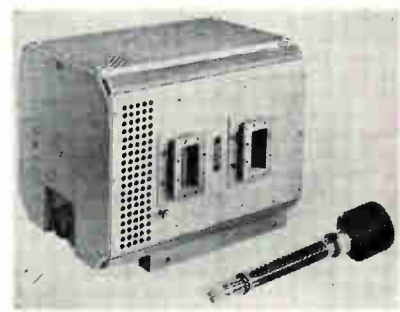
CIRCLE 305 ON READER SERVICE CARD

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.



Production refinements now under way are expected to make it possible to replace tubes with no adjustments. Low level gain at 5,000 Mc, with output power at 100 mw, is better than 34 db; with output power at 2.5 watts, gain is better than 32 db; noise figure is less than 30 db.

The tube is free air, convection cooled, and operates at 1,150 volts. It is being manufactured by Amperex Electronic Corp., Microwave Tube Dept., 230 Duffy Avenue, Hicksville, L. I., New York.

CIRCLE 306 ON READER SERVICE CARD

Electrostatic Printer

10^5 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

CIRCLE 143 ON READER SERVICE CARD→

RELIABILITY

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.

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

AMERICAN LAVA CORPORATION

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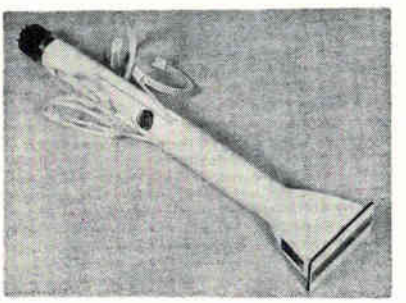
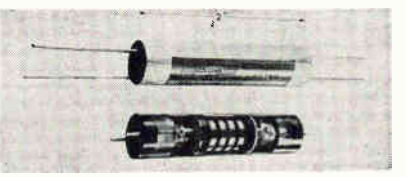
composed of a dense series of conductive elements embedded in a thin field of glass. The conductive elements transfer electrons directly from the electron beam to the printing medium, thus establishing an electrostatic charge which can be made visual by adding a precharged powder.



The Printapix B3C2 tube features 500 conductive elements per linear inch, or a conductive element density of 250,000 elements per square inch, allowing the printing of high quality characters.

Supplementary electrostatic deflection plates generate alphanumeric characters, increasing the character generation capability of this type of tube. The tube is compatible with available character generators and can print characters directly on nonsensitized paper at 100,000 characters per second.

CIRCLE 307 ON READER SERVICE CARD



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 ⅞ 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.

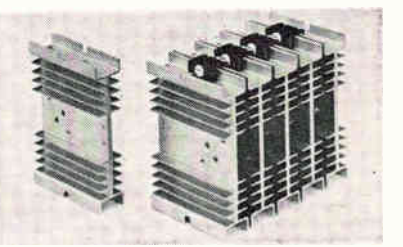
CIRCLE 308 ON READER SERVICE CARD

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 Kv 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.

CIRCLE 309 ON READER SERVICE CARD



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

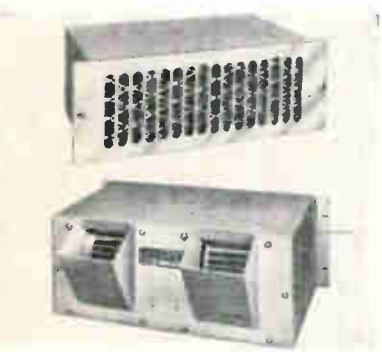
heat sinks provide a large heat dissipating surface while maintaining a minimum overall size. The units were specifically designed to be used singly or in multiple arrays and are furnished with holes for mounting the power transistor, for mounting or "stacking" the heat sinks in a compact array, and 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-

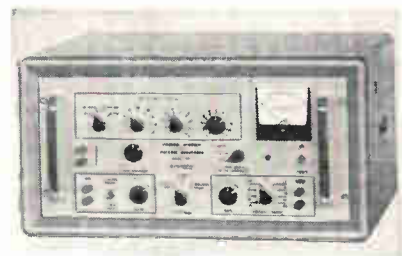
istics of all units are thoroughly checked and tested in the company's air-flow test chamber.

CIRCLE 316 ON READER SERVICE CARD

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.

CIRCLE 317 ON READER SERVICE CARD



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

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 50 Kc. 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, vtvm'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

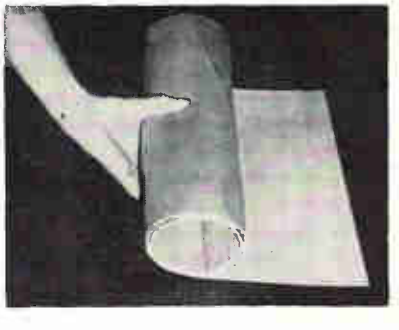
gain of 25 db minimum. Other electrical characteristics include a 1-mw minimum saturation power output and a saturation gain approximately 6 db below small-signal gain. The HA-82, without solenoid measures 15¾ in. long, 1⅛ in. in diameter, and weighs 1¾ lb.

CIRCLE 320 ON READER SERVICE CARD

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

MCMILLAN 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.

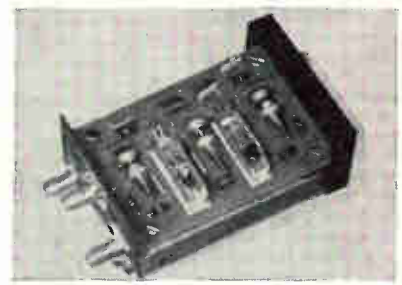
CIRCLE 323 ON READER SERVICE CARD

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

only 2 seconds on the electronic Dermitron instrument, which operates on eddy-current principles. The probes can measure a wide variety of metallic and non-metallic coatings such as plating, anodizing, paint, plastics, ceramics, and so forth.

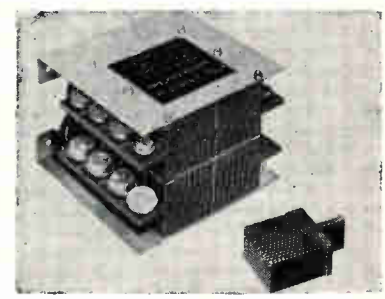
CIRCLE 324 ON READER SERVICE CARD



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

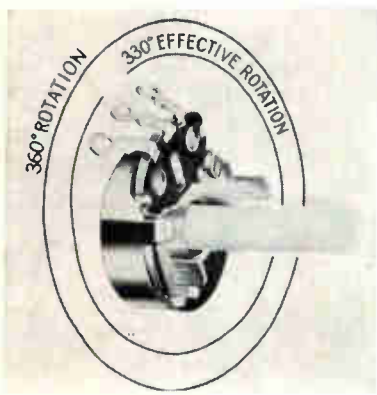


Modular Heat Sink
USES INTEGRATED BLOWER

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

high pressure fin assembly process which produces a strong metal to metal bond and extremely high thermal conductivity, the company can vary size and spacing of fins to match specifically the requirements of a wide variety of systems and blowers. Additional flexibility is provided by assembling the modules in incremental combinations for greater cooling capacities. Model 2401 heat sink module weighs 0.31 lb.

CIRCLE 326 ON READER SERVICE CARD



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 330 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 $\frac{13}{16}$ in. diameter and the same $\frac{27}{32}$ in. depth as the standard series 45. Resistance range is 250 ohms through 10 megohms with linear resistance gradient. Rating is $\frac{1}{4}$ to $\frac{1}{2}$ 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

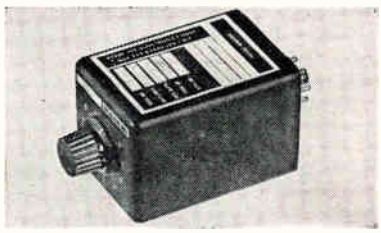
Converter

DIGITAL-TO-ANALOG

DATEX CORP. 1307 S. Myrtle Ave., Monrovia, Calif. Digital-to-analog converter generates an analog out-

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.

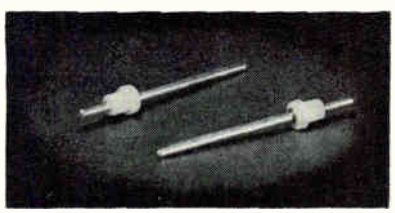
CIRCLE 328 ON READER SERVICE CARD



Electronic Timer
TRANSISTORIZED

SYRACUSE ELECTRONICS CORP., P.O. Box 566, Syracuse 1, N. Y. A new rugged subminiature (2 by 2 by 2¾ 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

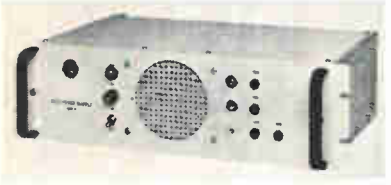


Tiny Feedthrough
EXTRA-LONG PIN

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.

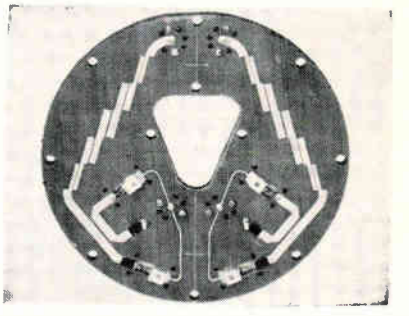
CIRCLE 331 ON READER SERVICE CARD

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

consists of a modulator type calibrated d-c microvoltmeter, with ranges from 0.2 μv per dial division to 1,000 v full scale. Price is $1,300.

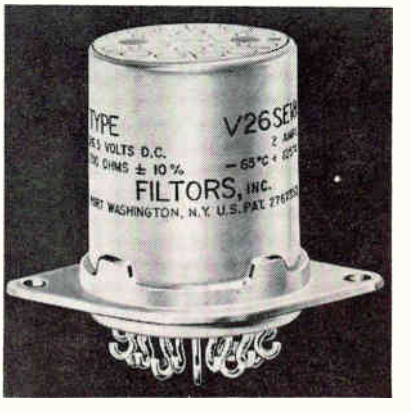
CIRCLE 332 ON READER SERVICE CARD



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.

CIRCLE 333 ON READER SERVICE CARD



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 Filtors' 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 Cienga 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-

works to obtain delay on operate time ranging from 5 millisec to 120 sec; also available for slow release applications. Contact arrangements up to 4pdt rated up to 10 amperes resistive. Meets high environmental conditions.

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

strain gage indicator. Designed for maximum versatility as a research tool, the instrument provides features and adjustments to accommodate all commonly used gage factors, gage resistances, and transducer bridge configurations. Eight calibrated sensitivity ranges cover all normal requirements. Maximum resolution is better than 1 μin., per in. Accuracy of panel meter indication is 1 percent of scale. A-C operation with regulated internal excitation source eliminates need for batteries. Electrical output is provided for operation of standard potentiometer recorders, cathode ray and recording oscillographs.

CIRCLE 338 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.

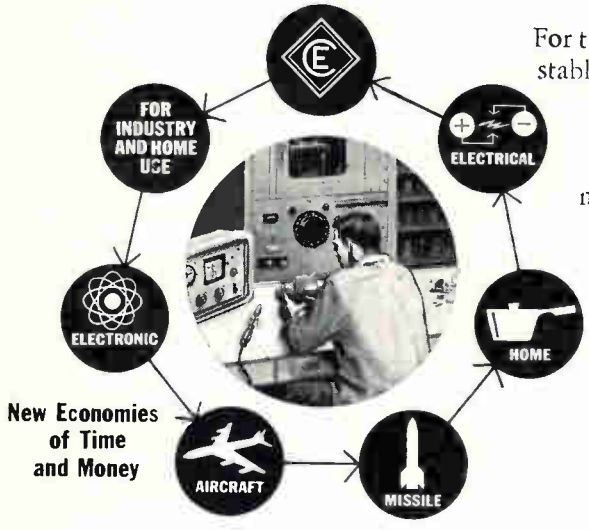
CIRCLE 339 ON READER SERVICE CARD

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.

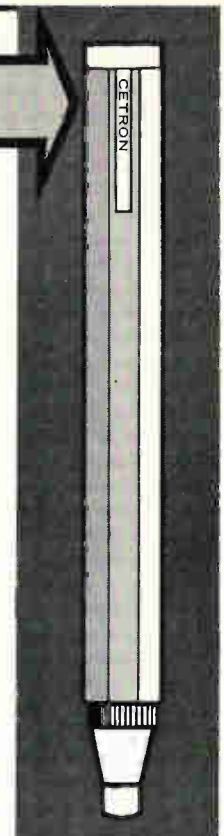
CIRCLE 340 ON READER SERVICE CARD

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.



Supplied in handy pencil-type holder ready to use.

WRITE FOR FURTHER INFORMATION

CETRON ELECTRONIC CORPORATION
Plastics Division
2265 E. Foothill Blvd., Pasadena, California

CIRCLE 217 ON READER SERVICE CARD

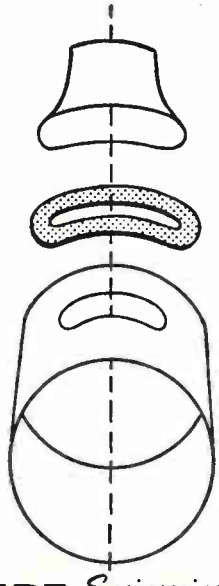
NEW CURVED

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.



Write for FREE 20 page "PREFORM BRAZING HANDBOOK"

LUCAS-MILHAUPT *Engineering Co.*
5051 South Lake Drive, Cudahy, Wisconsin

NOW! NEW LOWER PRICED COIL FORMS

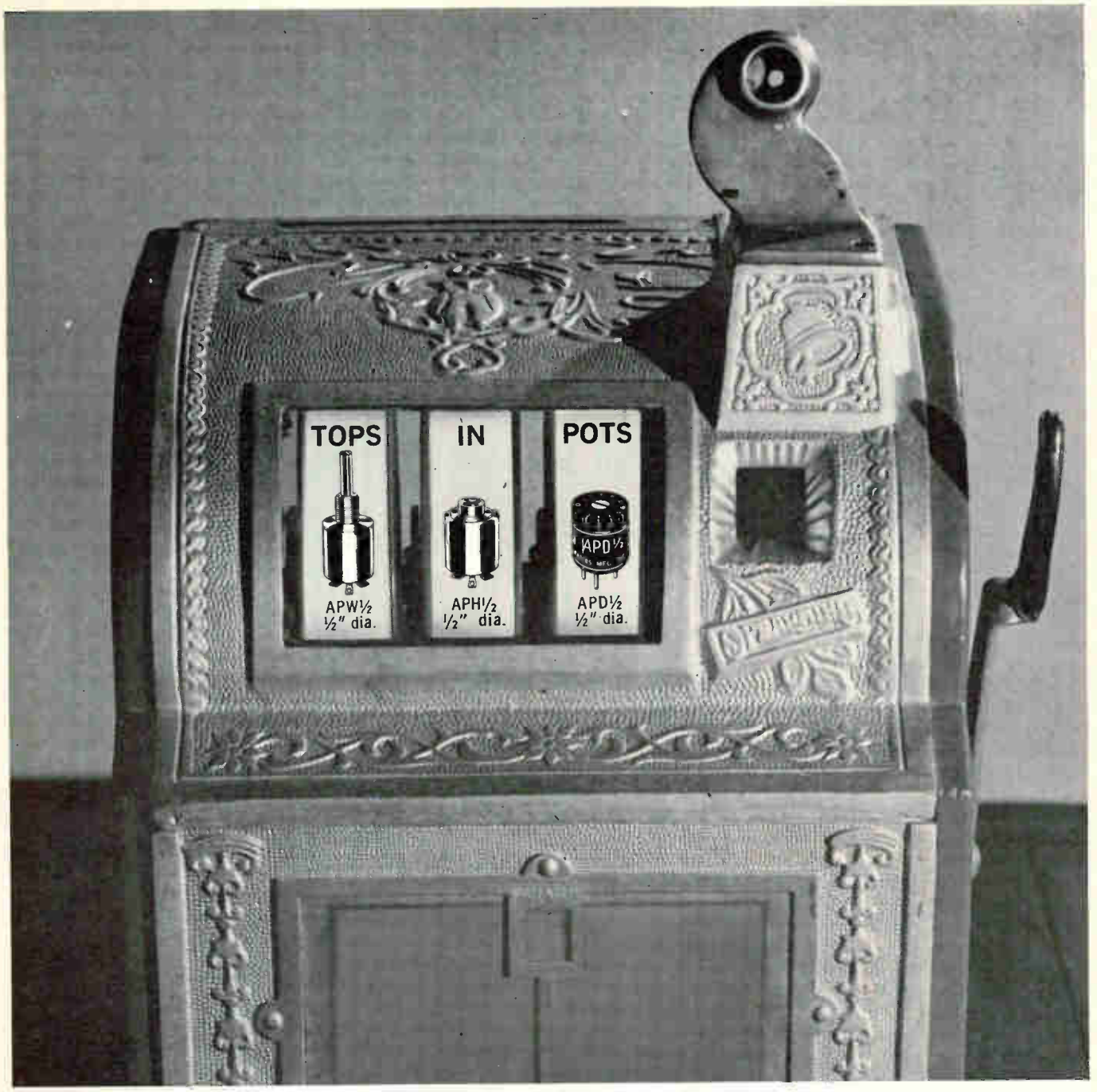
Interchangeable with industry standards

Thermosetting epoxy cement permanently positions collars and lugs to withstand severe shock under high temperature (250°C). Available in any lug configuration. Completely rustproof and moisture resistant. Ceramic conforms to Grade L5 JAN-1-10 silicone impregnated. Lightweight aluminum bushing. Silicone fibre glass washers. Unique built-in dependable tension device guarantees vibration-proof, smooth tuning. Nickel-plated parts conform to MIL-P-5879 QQ-N-190. Diameters: .205, .260, .375, .500. Frequencies: .1-1.5 mc, .5-10 mc, 10-30 mc, 30-50 mc, 30-150 mc, 50-200 mc, and brass slugs. Write for quotes and bulletin CF-860.

Waters
MANUFACTURING, INC.
WAYLAND, MASS.

ALSO AVAILABLE IN EXCLUSIVE RIBBED DESIGN

CIRCLE 218 ON READER SERVICE CARD



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 x 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.

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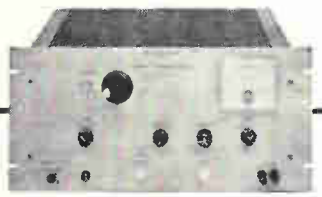

THE AIL TYPE 132

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.

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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.

EASY TO MOUNT AND STACK

TPB-20-S

Barriers across both faces increase creepage path; elongated holes facilitate mounting; nesting projection and recess aid stacking. Brass receptacles provide low contact resistance. 14 lbs. min. pull out with standard solderless taper pins. Molding compound is MAI-60 (Glass Alkyd) of MIL-M-14E.

Gen-Pro boards have passed Navy 2,000 ft. lb. high shock requirements as specified by MIL-S-901B.

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• GRC's complete line of high quality, close tolerance molded screws and hex nuts include screws in standard commercial heads—Phillips or slotted types—in sizes from #4 thru ¼"; hex nuts in ten sizes (#2 thru 5/16") GRC molded miniature machine screws—half the weight of aluminum—in sizes as small as #0 make more compact designs possible. GRC's single cavity molding technique adds exceptional uniformity, accuracy, economy to Nylon's & Delrin's high strength-to-weight ratio, built-in electrical insulating qualities, stability, resilience and elasticity. GRC's molded fasteners are available from stock in a wide range of types, sizes and lengths.

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INERTIAL ENGINEERING INGENUITY

Litton's LN-3 Inertial Navigation System for the NATO F-104, now in production, owes its excellent performance to Litton-designed technical features such as:

Integrators with linearity of better than 1 part in 10,000.

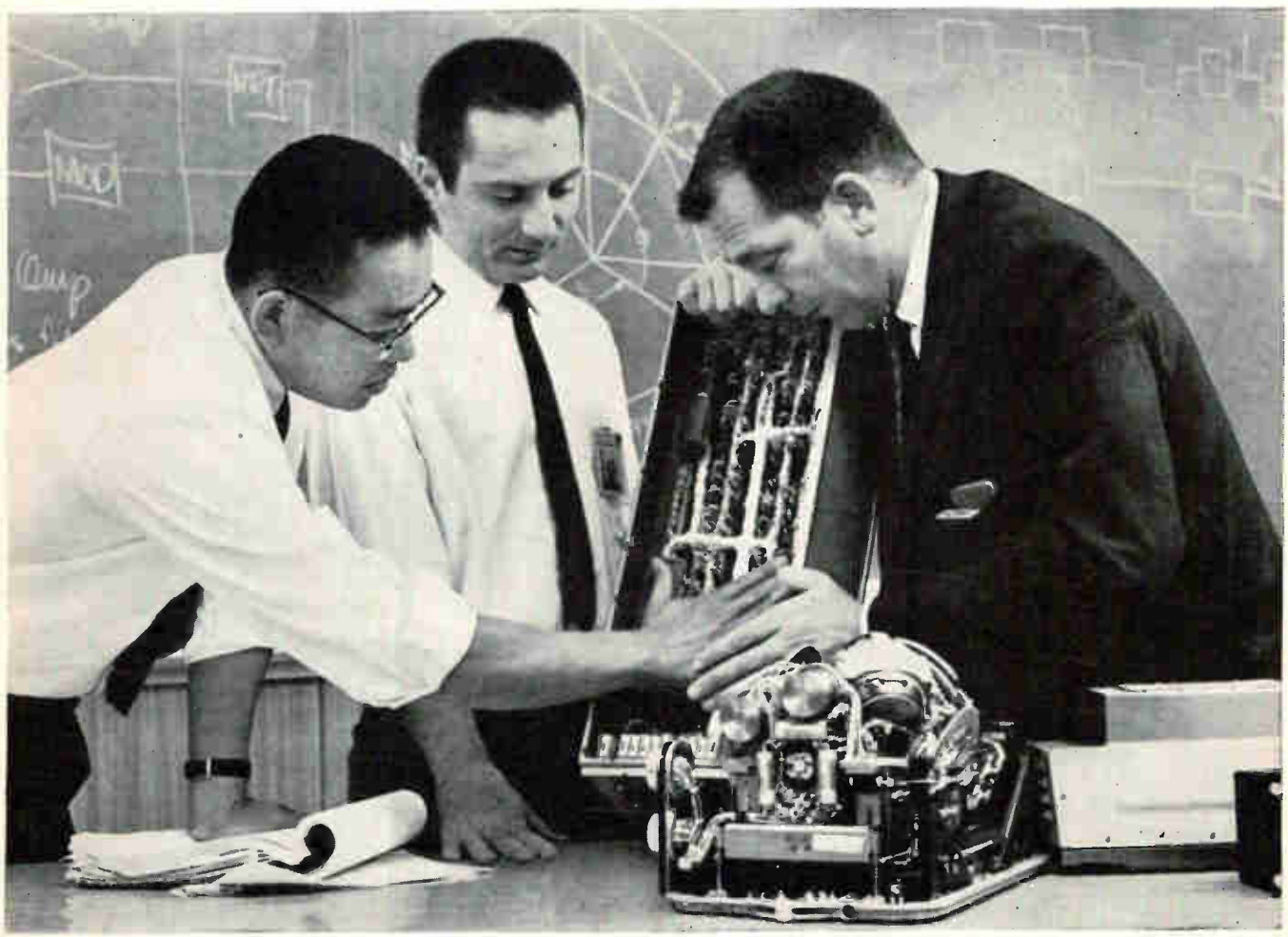
Fully transistorized d.c. amplifiers with internal gain better than 10^7 with offsets, referred to the input, of 20 microvolts maximum. Operational characteristics are constant between —55°C. and 85°C.

The next generation of inertial systems will require engineers with experience applicable to the improvement of computer performance and the performance of other system units such as miniature inertial platforms. If you have experience in fire control, analog, servo, or gyro systems, you may find unusual satisfaction in applying your talents to the development of fresh concepts in inertial systems.

Contact Mr. Donald B. Krause of our Research & Engineering Staff. You can share in generous employee benefits, including stock purchase and tuition-paid education plans. Relocation assistance is provided.

LITTON SYSTEMS, INC.
GUIDANCE & CONTROL SYSTEMS DIVISION
Beverly Hills, California

John Tamura and Robert Ebner discuss the optimization of the LN-3 Computer Integrator design with Dr. Harold Bell, assistant director of the Guidance Systems Laboratory



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Reeves-Hoffman transistorized, proportionally controlled ovens *do* give almost miraculous service—in providing closer frequency control. These highly reliable ovens have no mechanical contacts. There are no spark-producing gaps. Radio interference is eliminated. Although it is difficult to measure temperature excursions beyond ±.01°C, it is reliably estimated that Reeves-Hoffman ovens provide control in the order of ±.001°C. If you have a problem involving reliable temperature control, contact Reeves-Hoffman for additional information.

REEVES HOFFMAN

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Price 102.25% and accrued interest

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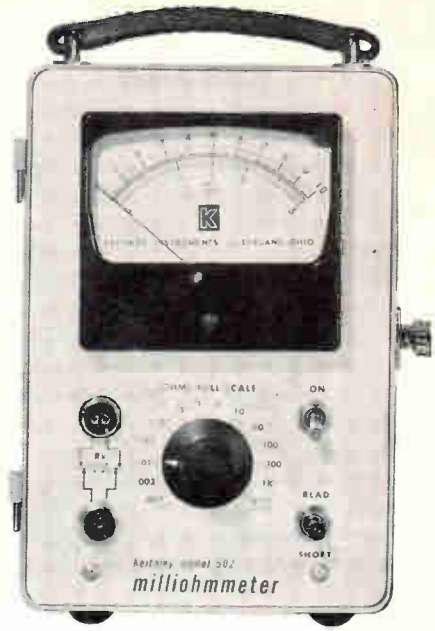
Model, Roland & Stone

December 15, 1960.



a good way to measure 0.00003 ohm

The Keithley 502 Milliohmmeter offers speed, ease, and accuracy in the measurement of low resistances. Typical uses are corrosion tests, checking resistivity of metals, semi-conductors, printed circuits, switch and relay contacts.

Battery operation, a ruggedized meter, and protective cover make the 502 ideal for field tests of squibs, carbon bridges and other explosive devices. Features include:

- **13 overlapping ranges** from 0.001 ohm to 1000 ohms full scale.
- **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 Milliohmmeter are available in Keithley Engineering Notes, Vol. 6 No. 3. Write for your copy today.

K

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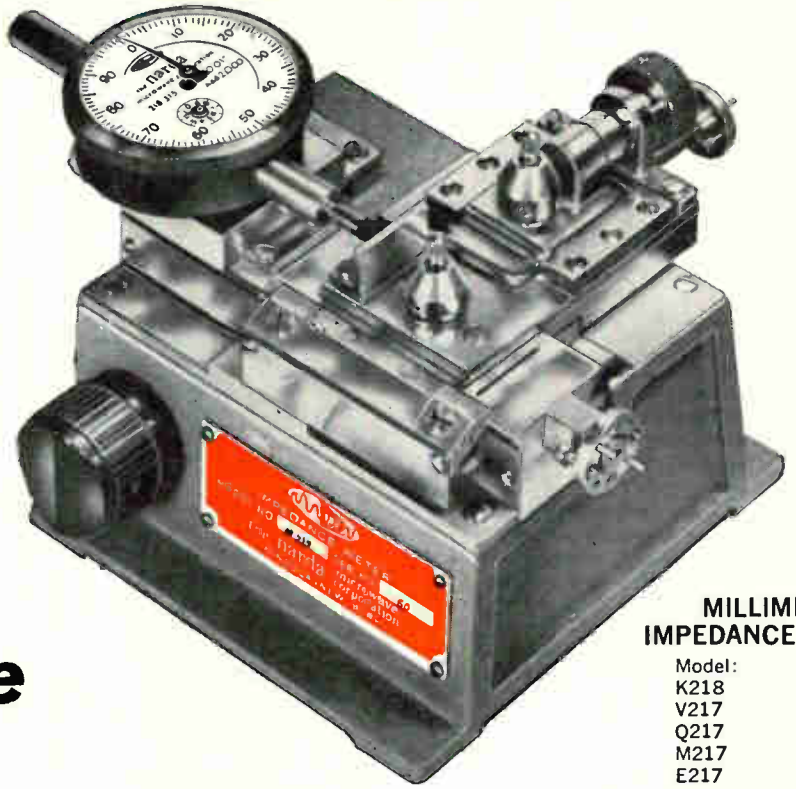

MILLIMETER IMPEDANCE METERS

Model:	Price:
K218	$ 500.
V217	600.
Q217	1100.
M217	995.
E217	1650.

Just because you're working in millimeter bands is no reason to "make do" with lesser specs than you get from L to KU Bands. It's true that it's more difficult to maintain top specs at 90,000 mc than at X Band, for example, but in most cases Narda does it! And especially, in our slotted lines!

Precision instruments in every way, Narda millimeter Impedance Meters give you these important benefits: Smooth, stable carriage travel, absolutely parallel to the transmission line axis, with complete freedom from backlash. Imperceptible slope (0.01 max.), thanks to precision milling of tellurium copper main transmission line, followed by a silver plate of molecular thickness and a rhodium flash.

Residual VSWR is under 1.01 for K and V Bands; 1.02 for Q, M and E. Position of the built-in probe is measured with a precision dial indicator having a least count of 0.001". And as an added advantage, the probe is usable with any waveguide detector.

All in all, an exceptionally fine instrument — and yet, typical of all Narda millimeter products. For complete information on the entire line, write for a free catalog. Address: Dept. E-1.

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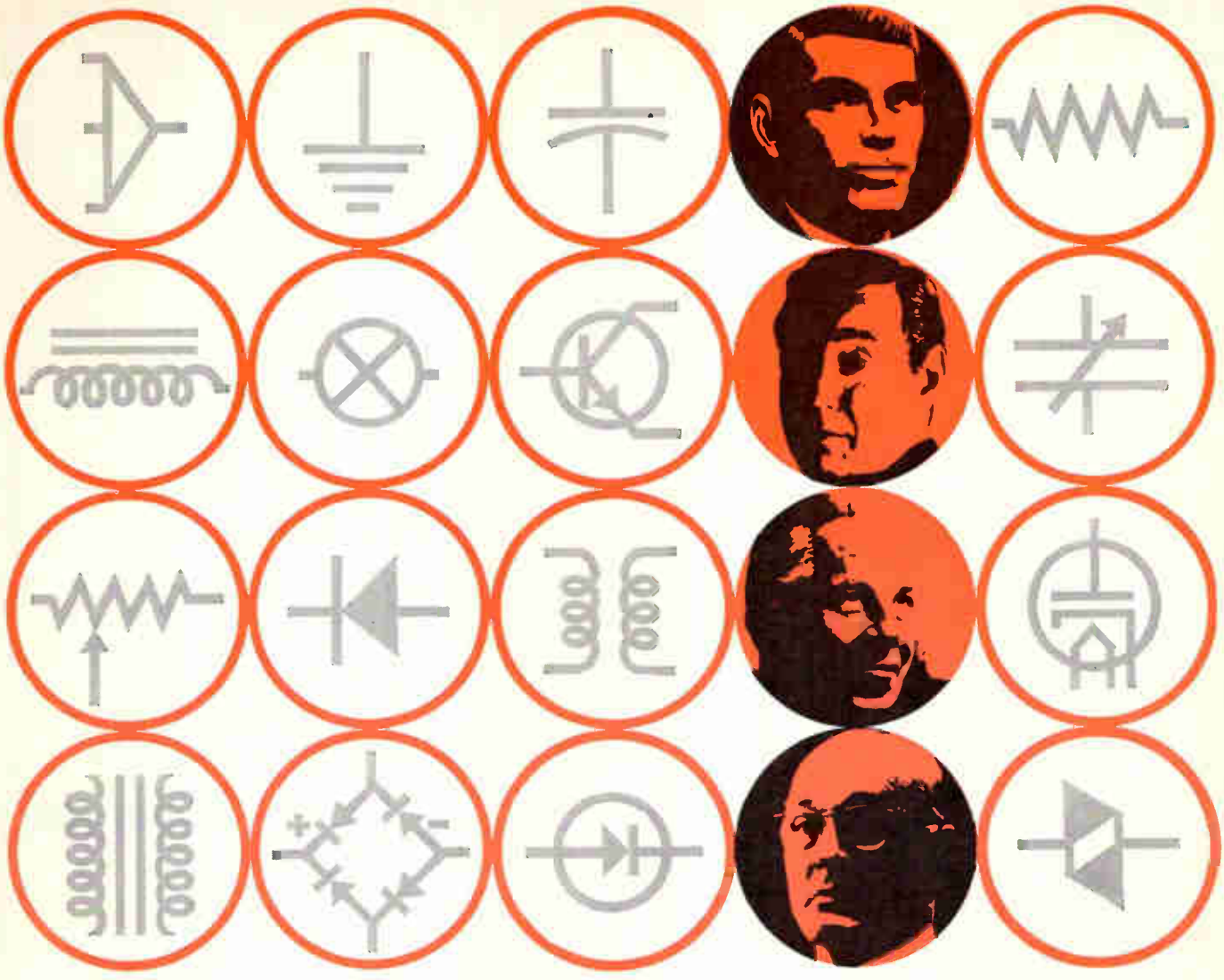

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4 Vital, Rewarding Positions

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RCA offers electronics engineers truly creative assignments on the most complex and challenging radar/data processing system ever undertaken—BMEWS. Engineers capable of meeting the challenge of this prime defense effort will find these opportunities both stimulating and rewarding.

FIELD-STRENGTH MEASUREMENT ENGINEER—Implement a complete monitoring and measuring program for BMEWS forward sites. A minimum of three years' experience in microwave and X-ray measurement techniques, and ability to analyze and write technical reports are required. BSEE, plus some supervisory background preferred. Frequent travel to forward sites.

QUALITY CONTROL ENGINEER Develop quality control program on the component and assembly level, in support of an operating BMEWS system. Minimum of 3 years' quality control engineering; familiarity with quality control inspection techniques, statistical sampling, and evaluation. Ability to provide self direction and leadership to a quality control operation. Location: Rome, N.Y.

DIGITAL ENGINEERS—Liaison and project level responsibility for site engineering activities on missile impact prediction computer, radar data take-off, and switching systems. Experience in digital logic design and transistor techniques on computer and on-line data handling equipment, plus degree is required. Locations: Riverton, N. J. with periodic trips to site; Van Nuys, Calif., with subsequent extended assignment to Thule, Greenland.

DETECTION AND TRACKING RADAR SYSTEMS ENGINEERS Supervise installation, checkout and integration of detection and tracking radar equipment. Intensive formal or on-the-job training on equipment, systems acceptance, and performance evaluation. Three to ten years' experience on long range radar (transmitters, receivers, and data processing systems) is required. Location: Riverton, N. J., with 3 months site rotation; or extended site assignments.

There is special site compensation for positions requiring extended site assignment.

To arrange a confidential interview, send your résumé to:

Mr. J. P. Thatcher, Employment Mgr.
RCA Service Company, Dept. BM-4A
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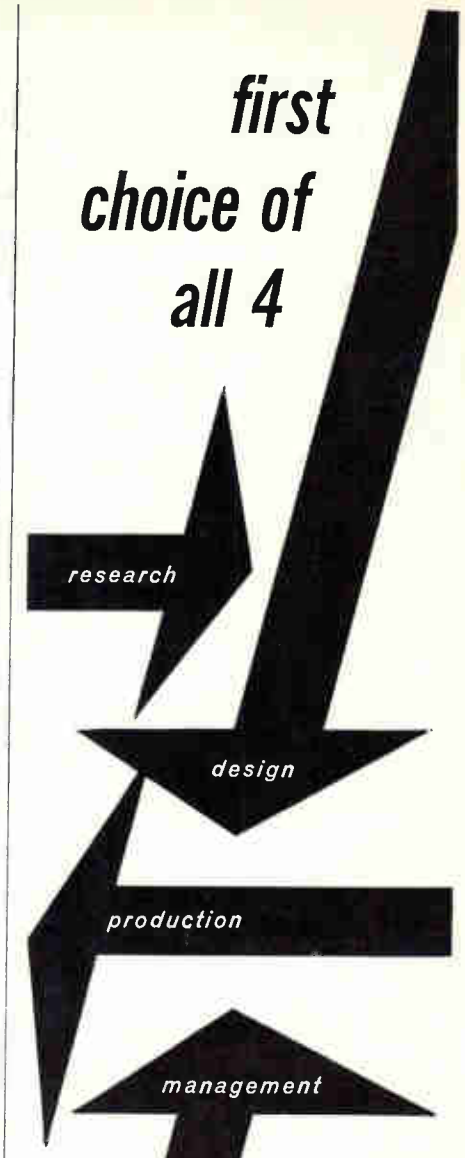

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ARMOUR RESEARCH FOUNDATION
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Technical sessions of invited and contributed papers on the present state and future potential of organic semiconductors in the electronics, chemical, and semiconductor 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 Filtors, Inc., Port Washington, N. Y. An engineering bulletin on the series "V" 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 116960.
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 28-29 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 Electomic 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 — 10 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 Atronics 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

POWER SUPPLIES Computer Engineering Associates, Inc., 350 North Halstead, Pasadena, Calif. Bulletin PT214.1 lists specifications and features of six new models of power supplies for strain gages.

CIRCLE 353 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.

Tensor Company Appoints Sutton

STRAIN "TIM" SUTTON has been named national sales manager of the newly-created commercial division, Tensor Electric Development Co., Inc. He was formerly sales manager of Acoustica Associates and Narda Ultrasonics.

Tensor maintains facilities in Brooklyn, Flushing, and Manhasset, L. I., N. Y.

Bonini Attains Post Of Chief Engineer

PROMOTION of Caesar J. Bonini from chief project engineer to chief engineer has been announced by Communication Measurements Laboratory, Inc., Plainfield, N. J. He joined CML's engineering department in 1951.

Schaevitz Hires Louis D'Angelo

APPOINTMENT of Louis D'Angelo, engineering projects administrator, is announced by Schaevitz Engineering, Pennsauken, 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-

facturing companies, including Olympia, AEG, Grundig and C. Lorenz, A.G.

CML Names Lavine Vice President & G-M

EDWARD L. LAVINE, formerly Eastern regional sales manager of Ling Electronics, Inc., has been named vice president and general manager of Communication Measurements Laboratory, Inc., of Plainfield, N. J. CML, manufacturer of electronic generators, d-c supplies and precision test equipment, is a subsidiary of Tenney Engineering, Inc.. Union, N. J.

McCarthy Moves To New Position

ELECTRONIC TRANSISTORS CORP., North Bergen, N. J., announces the appointment of Jack W. McCarthy as vice president in charge of manufacturing.

McCarthy was previously associated with General Transistor Corp. and with Johnson & Hoffman Mfg. Corp.

Magnetics Inc. Ups Four to V-P

ARTHUR O. BLACK, president of Magnetics Inc., Butler, Pa., has announced the promotions to vice

president of the company's four operating directors.

The new vice presidents are J. C. Brandon, Jr., engineering; Robert W. Olmsted, marketing; Charles B. Wakeman, research and development; and Elmer B. Kaelin, manufacturing.

John Oster Advances Melvin Kohner

JOHN OSTER MFG. CO., Racine, Wisc., 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 50,000 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

with Technical Development Corp., North American Aviation and Douglas Aircraft.

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.

SANDERS ASSOCIATES INC. Announces the opening of 2 NEW FACILITIES

ADVANCED SYSTEMS LABORATORIES
(on famed "Electronics Row" in suburban Boston)

NEW ENGINEERING OPERATION
(on suburban Long Island near New York City)

To meet the recent increase to $50 million in contract commitments, Sanders Associates of Nashua, 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.

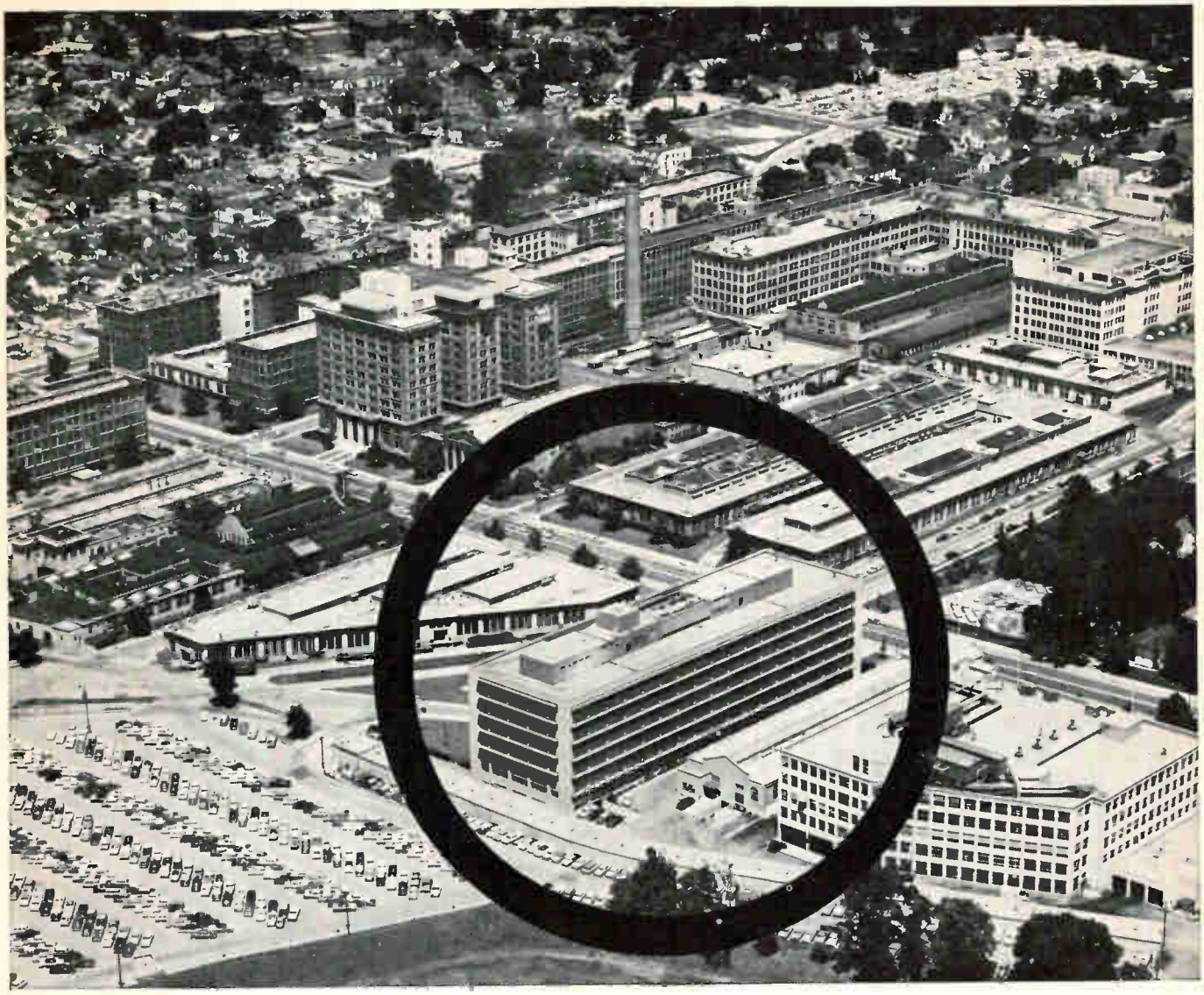
Positions in Plainview, L. I.

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.

SANDERS ASSOCIATES, INC.
NASHUA, NEW HAMPSHIRE

CIRCLE 384 ON READER SERVICE CARD



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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 resumé 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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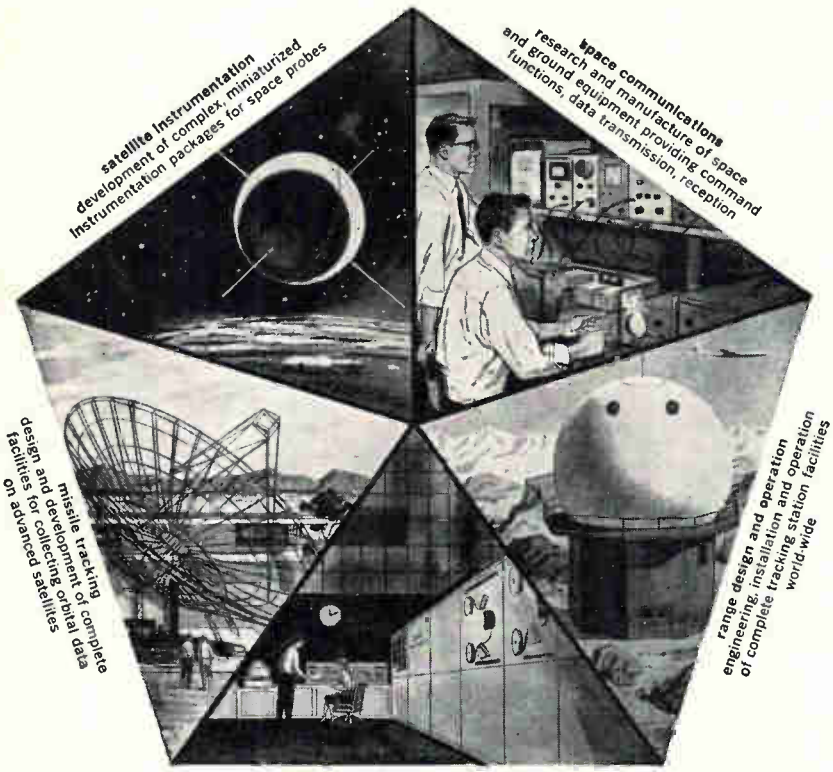

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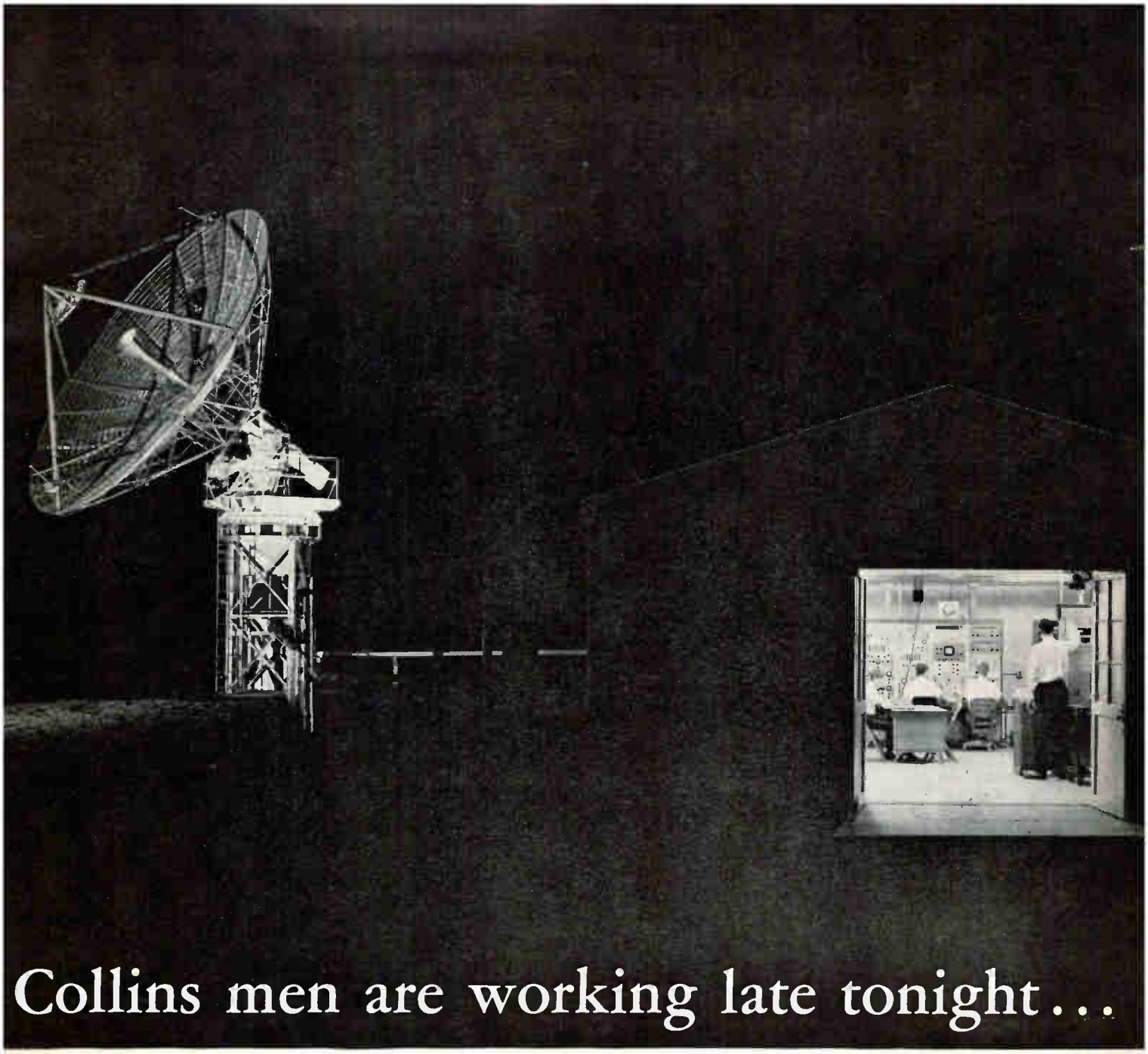

Collins men are working late tonight...

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
- ...transmitted and received a wirephoto
- ...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.

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Development & Design Engineer. Aemco Div. of Telex Inc. in Mankato, Minn. offers unusual opportunity to man with 5 years or more experience in relays and switching devices. BSME or equivalent experience required. Friendly small town environment in beautiful Southern Minnesota offers contentment for the family as well as a career opportunity for individual selected. Write in confidence to Mr. E. Pitzl, Aemco Division, Mankato, Minnesota. Phone 2580 or 5153.

Teaching and Research. Opening for Electrical Engineer with Ph.D. to supervise graduate research and do some teaching. Research experience in microwaves or semi-conductors desirable. Private research or consultation encouraged. Excellent salary and rank arrangements. Department offers work leading to Ph.D. Position available September 1961 or sooner. Apply to Chairman, Electrical Engineering Department, Vanderbilt University, Nashville 5, Tennessee.

Sales Manager. Career opportunity exists at Aemco Div. of Telex Inc. in Mankato, Minn. for serious capable sales manager experienced in sales of relays, timers, time switches. Handle both industrial & military accounts which presently gross $3,000,000. Small town environment plus unique exploitable sales opportunity. Write in complete confidence to Mr. E. Pitzl, Aemco Division, Mankato, Minnesota. Phone 2580 or 5153.

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Representatives desired by manufacturer of Industrial Electronic Instruments and Controls. P.O. Box 8246, Tulsa 15, Oklahoma.

Agent Required to cover entire U.S.A. for the sale of a new universal wiring board, meeting with great success in Europe. For full particulars apply RW-5744, Electronics, PO Box 12, New York 36, N. Y.

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.

Wanted Electrical or Electronic Engineering

Graduate, between 25 and 32 years of age for sales engineering work by manufacturer of electronic components, including High Speed Relays, Choppers, and Pressure Switches.

Location: Chicago or Cleveland
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ELECTRICAL

Machinery, Equipment and Supplies

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.

Coincidentally, 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 synonomous 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.

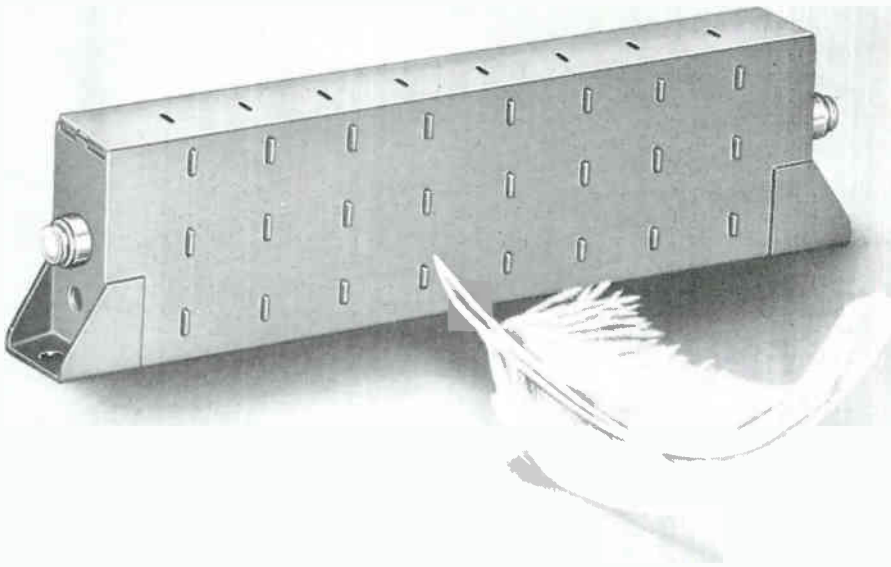
This is the time to check the quantity and, more particularly, the quality of equipment ranging all the way from instruments needed for research and development, through production, to equipment needed for efficient installation and maintenance of products in the field.

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.

James Givlewood

PUBLISHER



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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.

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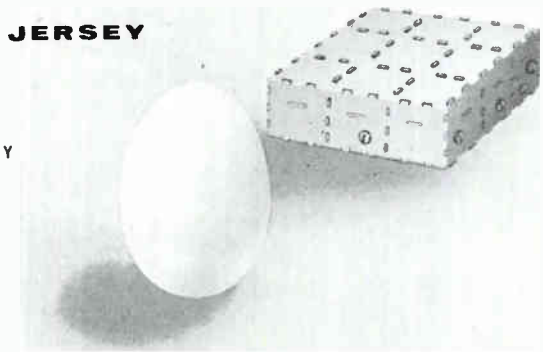

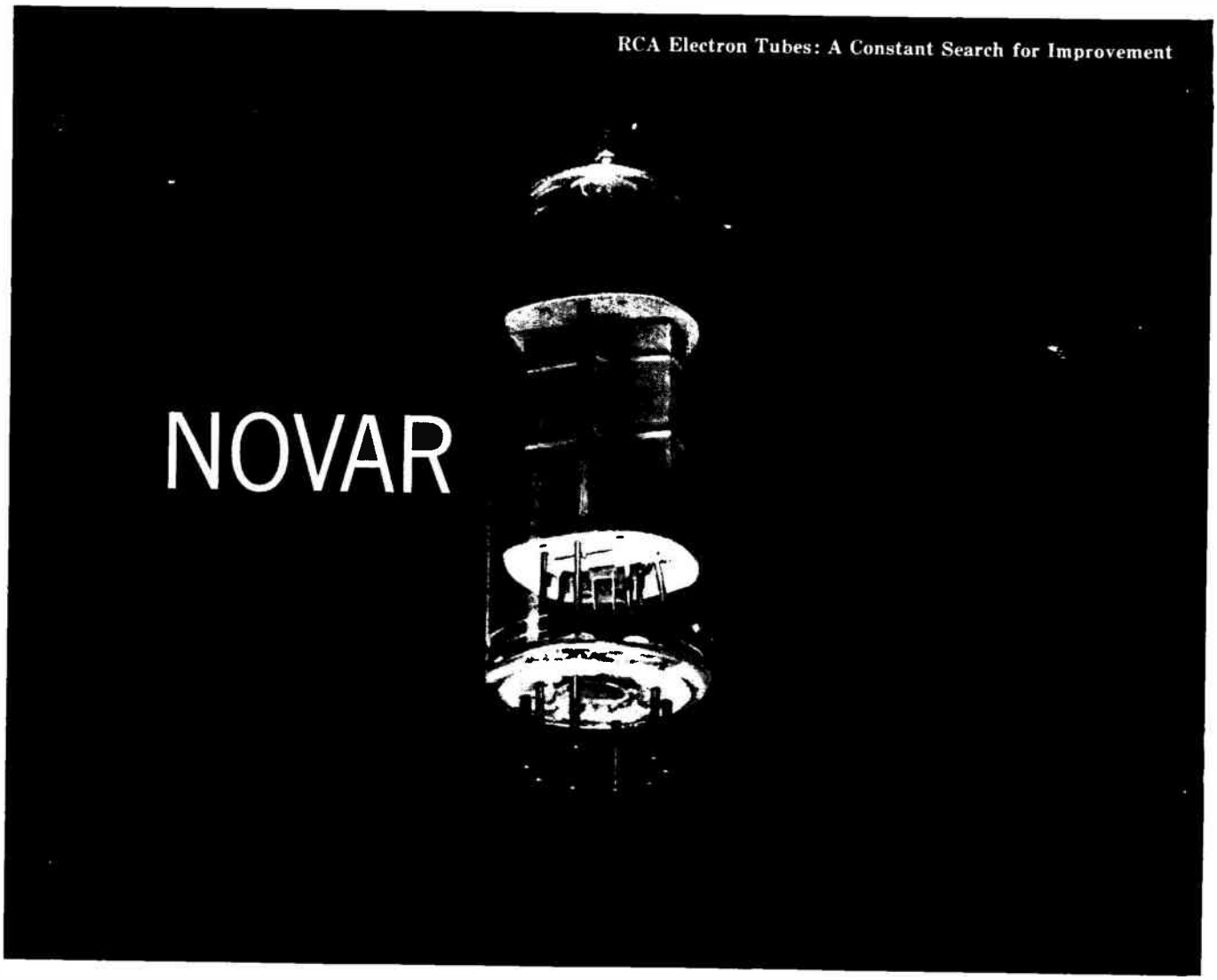

A STATEMENT TO THE INDUSTRY

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.

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