ELECTRONIC DESIGN

MARCH 16, 1960

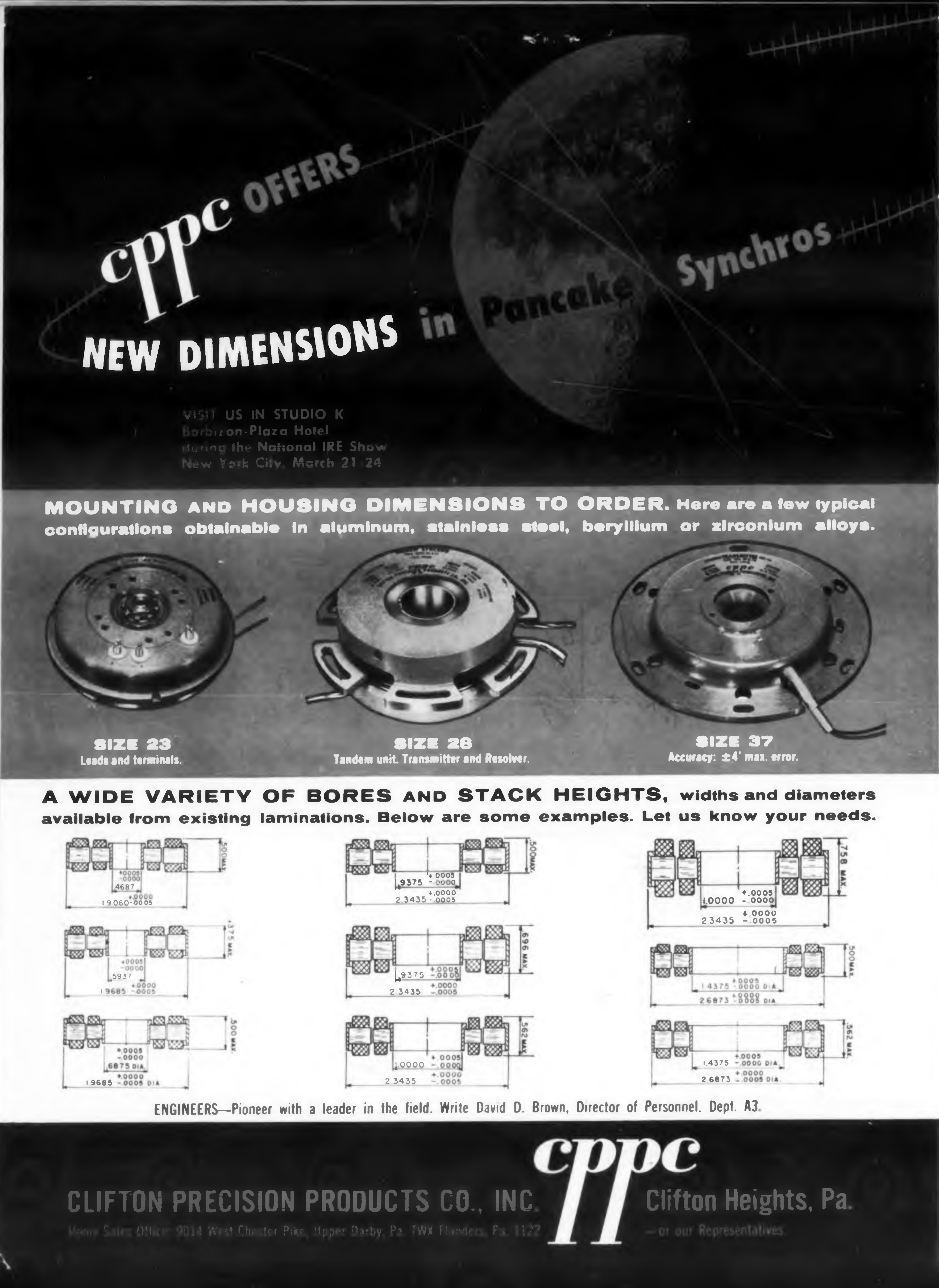
Preview of IRE Show Products

Comb Structure Transistor . . . p. 116

Cable Takes More Stresses . . . p. 124

Nuvistor Made Available . . . p. 118

ts on Dielectric Material . . . p. 122



A complexity of shapes symbolizes the maze of products found at this year's IRE Show. Included are: a comb structure transistor (p 116); a cable that takes more stresses (p 124); a Nuvistor that is now commercially available (p 118); and a new tube that prints on dielectric material (p 122). In addition, close to 300 products, most of which are being displayed at the IRE show, are described in this issue's New Products Department.

Selected Topics In This Issue

◀ CIRCLE 1 ON READER-SERVICE CARD

A
edito
cove
Conf
rivec
a wh
print
Tunn
top
ous
many
held
whic
hair
much
DESIG
nel D
On
envisi
feare
culty
tors.
gentle
imped
In
one
multi-
in Ge
quite
Per
those
unexp
Esaki,
fame.
any ex
visitor,
that, in
for the
speak
Of
the sce
were k
sions,
current
ELEC
tion co
of the
present
netic fi
microel
pleased
most th
A pr
exhibito
in this
them e
ELECTRO
lease b
in the
addition
you alw

Sidelights Of This Issue

A task force of ELECTRONIC DESIGN editors descended on Philadelphia to cover the recent Solid-State Circuits Conference. From the moment they arrived, six *ED* editors were kept busy in a whirl of activity . . . distributing reprints of an ELECTRONIC DESIGN Tunnel Diode Report . . . interviewing top engineers and physicists from various parts of the world . . . attending as many as five concurrent panel sessions held during the evenings, sessions at which the experts often let down their hair . . . and fulfilling requests for the much-in-demand exclusive ELECTRONIC DESIGN reprint, "Designing With Tunnel Diode."

One problem that the editors had envisioned failed to materialize. They feared that there would be some difficulty communicating with foreign visitors. It turned out that many of the gentlemen from other countries spoke impeccable English.

In a few cases, it was necessary for one ELECTRONIC DESIGN editor, a multi-lingual chap, to conduct interviews in German. Needless to say, he was quite successful.

Perhaps the most pleasant surprise for those attending the conference was the unexpected appearance of Dr. Leo Esaki, Japanese scientist of tunnel diode fame. The language barrier prevented any extensive interview with the smiling visitor, though it may be pointed out that, in his case his achievements speak for themselves. He certainly seems to speak the same language as IBM.

Of course, tunnel diodes dominated the scene at the conference. The editors were kept hopping at the evening sessions, many of which were held concurrently.

ELECTRONIC DESIGN's News Section contains a comprehensive round-up of the conference. Included are detailed presentations on tunnel diodes, magnetic films, and solid-state advances in microelectronics. The staff is indeed pleased to bring design engineers this most thorough coverage.

A preview of new products that IRE exhibitors recently announced appears in this issue. These products—some of them exclusive "firsts"—were sent to ELECTRONIC DESIGN on a special release basis. Over 200 of them appear in the New Products Department, in addition to the regular products that you always look for.

KAY . . . The Most Complete Line of High Frequency Attenuators

KAY
ROTARY SWITCHABLE
DRD®
(DIRECT READING DIGITAL)
Attenuators

Provides Digital Readout of Attenuation, 0-119 db

Standard Toggle Switch Models, 0-101 db

- Fixed Zero or 10 db Insertion Loss
- Choice of 50, 70, or 90 ohm Impedance
- Improved Accuracy—Reduced Maximum Error
- High Frequency Switches—Solid Silver Contacts Set in Teflon
- 1% Carbon Film Resistors

The three models of Kay *DRD Attenuators*, listed at the right hand side of the table, offer the convenience of a direct-reading dial. Attenuation can be varied from 1 db to 119 db in one-db steps by operating two rotary switches. The standard Kay *Attenuators* operated by six or nine toggle switches are listed at the left. All models are set in light-weight cast bronze housings and offer reduced maximum total error and a negligible insertion loss.

	STANDARD TOGGLE SWITCH MODELS						DRD MODELS	
	MODEL	CAT. NO.	MODEL	CAT. NO.	MODEL	CAT. NO.	MODEL	CAT. NO.
	20* 21† 22‡	430-B 440-B 450-B	20-0* 21-0† 22-0‡	431-B 441-B 451-B	30-0* 31-0† 32-0	432-C 442-C 452-C	40-0* 41-0† 42-0‡	433-A 443-A 453-A
Z_{in} Z_{out}	*50 ohms nom. †70 ohms nom. ‡90 ohms nom.							
DB Switched	41 db in 6 steps				101 db in 9 steps		119 db total in 1 db steps	
Steps	20 db, 10 db, 5 db, 3 db, 2 db, 1 db				Same as 41 db units, plus 3 extra 20 db steps		1 db and 10 db	
INSERTION LOSS	10 db		Zero db at low frequencies; approx. 0.1 db at 250 mc; approx. 0.2 db at 500 mc					
Maximum Total Error (includes insertion loss)	At full attenuation: 0.5 db at 250 mc; 1.2 db from 250 to 500 mc				At full attenuation: 0.9 db at 250 mc; 2.0 db from 250 to 500 mc			
	BETTER ACCURACY AT LOWER FREQUENCIES AND/OR USING FEWER ATTENUATION STEPS							
Frequency Range	DC to 500 mc; useful to 1000 mc							
SWR	1.2 max. up to 250 mc; 1.4 max., 250 to 500 mc							
Maximum Power	½ watt							
Connectors	BNC type UG-185/U							
Dimensions	2" x 7" x 2"				2" x 9¾" x 2"		5" dia. x 2¼"	
Weight	2 lbs.				3 lbs.		4¼ lbs.	
Prices	$75.00		$70.00		$100.00		$225.00	

All prices f.o.b. factory.

NOTE: Kay *Attenuators* can be made on special order in 0.5 db steps, and to customer's choice of insertion loss, attenuation range, and impedance ratings.

Write for New Kay Catalog

KAY ELECTRIC COMPANY

Dept. ED-3 • Maple Avenue • Pine Brook, New Jersey • CApital 6-4000

See us at the IRE Show—Booths 3512, 14, 16, 18

CIRCLE 3 ON READER-SERVICE CARD

CONTENTS FOR MARCH 16, 1960 VOL. 8 NUMBER 6

ELECTRONIC DESIGN

Hayden Publishing Co., Inc.,
830 Third Avenue, New York 22, N. Y.

ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N. Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation at Bristol, Conn. Additional entry, New York, N. Y. 34,400 copies this issue.

ELECTRONIC DESIGN
NEWS

Air Force Pushing Midas Satellite Project With Hopes Pinned on New Tests and Budget Increase

Midas satellite nears top of missile gantry shortly before unsuccessful test shot from Cape Canaveral Feb. 26. IR detection of hostile missile launchings is the satellite's mission. Planned system calls for a network of surveillance satellites in polar orbits at 100 to 200 mi altitude.

Despite the failure of an initial Project Midas satellite test shot from Cape Canaveral, the Air Force hopes to step up activity on this program. As planned, Midas would consist of a network of infrared surveillance satellites capable of spotting hostile missiles seconds after launching.

The unsuccessful shot was the first in a planned series of attempts to orbit an instrumented test satellite from Canaveral, and later from the Pacific Missile Range. If the Midas vehicle reaches orbit and successfully spots a subsequent missile launch from the Cape, the program will undoubtedly gain stature in the eyes of Government budget planners, industry observers believe.

The Air Force is pinning its hopes on such a success and on a favorable reaction from the House Space Committee, which has been looking into Midas. Lt. Gen Bernard A. Schriever, commander of the Air Research and Development Command, has commented that the Pentagon will decide soon whether to ask for increased funds for the program. Congressional reaction to testimony on Midas (which stands for Missile Defense Alarm System) will be a major factor in this decision, an Air Force spokesman told ELECTRONIC DESIGN.

"Less than $100 million," has been appropriated for Midas for the present fiscal year, according to General Schriever. Unofficial estimates place the figure at about $60 million, with $100 million more presently earmarked for fiscal 1961.

Midas critics have attacked what appear to be some weaknesses in the infrared surveillance concept. Burning flares on railroad cars might be used as countermeasures against the detection net, they say. Another comment is that too many satellites will be required for effective continuous surveillance of all possible launch sites.

The ability to launch missiles from submarines complicates this surveillance problem, because vast ocean areas become possible launch sites. Additional surveillance orbits may have to be added to the program to counter undersea launching capabilities.

Significantly the Polaris, this country's underwater-launched missile, was to be used as the first missile to be spotted by a Midas satellite in the unsuccessful test. But like the Midas, it also failed. The Midas shot failed presumably because the second-stage Agena-B rocket did not detach from the first-stage Atlas booster. The Polaris weaved erratically and was destroyed by the range safety officer.

Secrecy surrounds infrared developments for Project Midas. Engineers working on the project are unwilling to discuss the problems involved because of the security consideration.

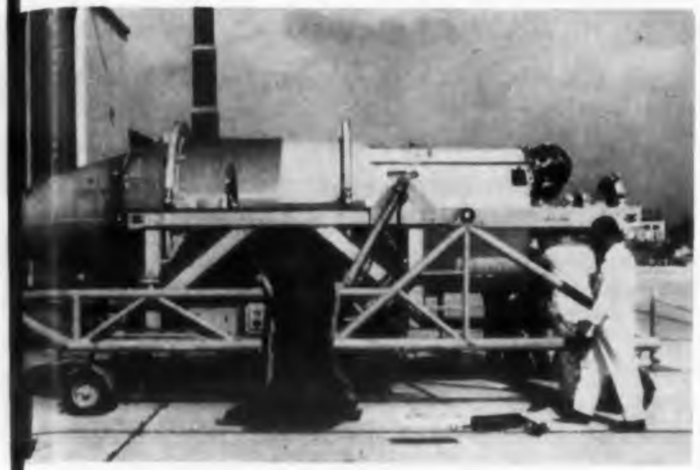
Other engineers and scientists working with infrared, however, explain that much of the work on Midas involves translating known principles into useful hardware. Although many tough problems face Midas instrumentation designers, the general approach to solutions is well-defined by the present state of the art, these IR workers feel.

Special Filtering Techniques Are Available

Various techniques are known for infrared surveillance of large areas with the ability to pinpoint intense heat sources. These spacial filtering methods include the use of mosaics, or groups of detectors, each covering a small portion of the angle of view. Scanning of the outputs of individual detectors, or selective cancellation of individual outputs from a total signal might be used to find a point of intense radiation.

Electronic scanning tubes are also a possibility for this purpose, although sources indicated that these are not planned for Midas satellites. Image orthicons are probably too fragile for launching shocks, but vidicons can be made very rugged, one engineer commented.

Positive identification of intense heat sources



Technicians check a Midas satellite which contains a 15,000-lb thrust engine and reportedly carries a 3,000-lb instrument payload.

is a much tougher demand. The satellite must distinguish between missile flames and other sources, such as blast furnaces, chemical explosions or power plants. Possible countermeasures, such as burning flares on railroad cars, must also be considered.

Burning missile fuels have unique wavelength signatures, or distributions of radiated energy by frequency, so that spectral analysis is a logical approach to this problem, engineers pointed out. A received infrared signal could be split with gratings or optical filters, one IR designer said, and the energy distribution by frequency analyzed. Data processing techniques could be used to compare the received signal with the known characteristics of burning missile fuels, so that data from suspicious targets could be selected for telemetering to ground stations.

Infrarimetry Promises Identification

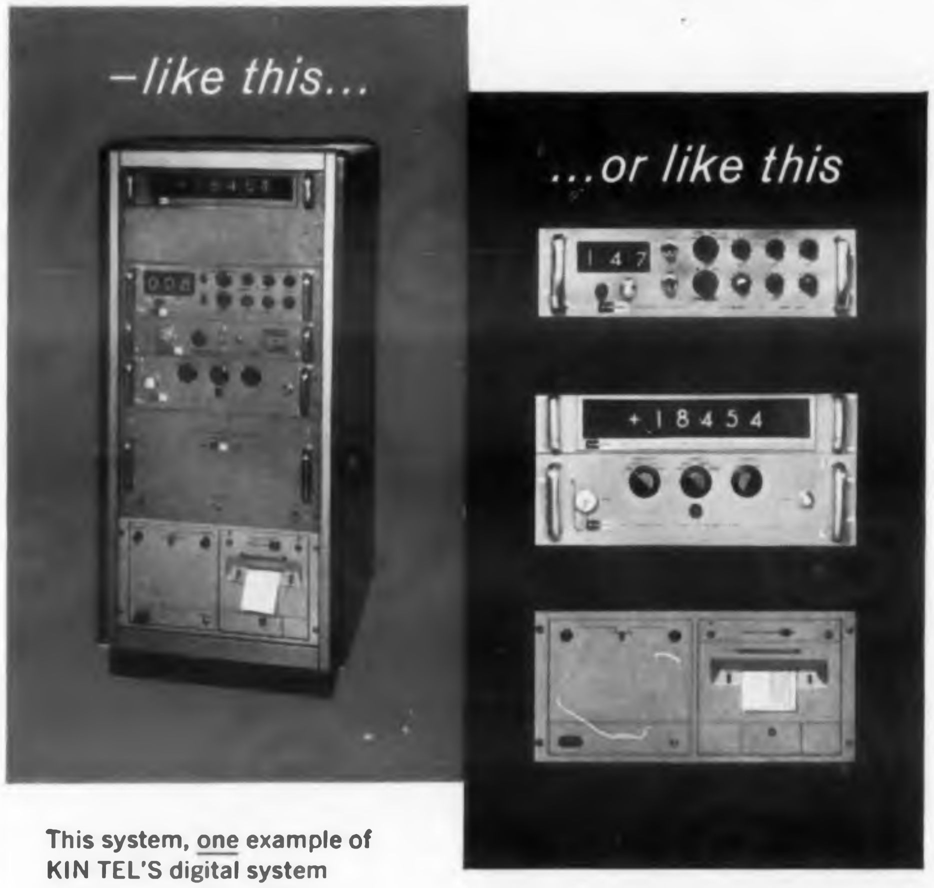
Very precise analysis of this type might result from work on a new technique, called infrarimetry, now being researched at General Electric Co. Principles of the well-developed science of colorimetry in the visible spectrum are being adapted to work in the infrared region.

In colorimetry a color being analyzed is broken up into three components, or color channels, with bandpass filters. The channels are chosen mathematically by means of tri-stimulus coefficients, which have been optimized for use in the visible spectrum. Variations in any one of these three channels can then be used to detect extremely minute changes in the color under analysis.

Infrarimetry has not been developed to this degree of precision, although GE researchers believe further effort will be fruitful. Practical optics, detectors and filters to meet specific requirements are not always available, so that work is now in the stage of finding the best compromises, according to one project engineer.

Precision distinctions, such as might be pro-

For high-accuracy data logging...to checkout missiles or meters, to test transducers or transistors...checkout a KinTel digital system



This system, one example of KIN TEL'S digital system experience, takes eight measurements at each of 7200 different data points. Outputs include visual readout, digital printer, X-Y recorder, and tape punch. Tape is perforated for direct entry into a digital computer. To provide 0.01% accuracy for low-level inputs, alternate channels scan calibration signals. These, with the unknown input signal, are fed to the computer and correction is made for any inaccuracy in the system itself.
Cost: about $20,000.

This data system consists of a KIN TEL 453M scanner and 501 DC digital voltmeter, plus a parallel entry printer. Briefly, the system will accept 400 one-wire, 200 two-wire, or 100 four-wire inputs, and will provide both visual and printed indication of the channel being scanned and DC input signals from ±100 microvolts to ± 1000 volts. Accuracy is 0.01% ±1 digit, and ranging and polarity indication are automatic. The complete system costs approximately $6850. At the present time, delivery is off the shelf.

KIN TEL DIGITAL SYSTEM CAPABILITIES

You can have any number of channels: A single 453M scanner ($2500) accepts 400 one-wire, 200 two-wire, or 100 four-wire inputs. Additional scanners can be added if more inputs are required.

You can measure DC from ±1 μv to ±1000 volts: The KIN TEL 501 DC digital voltmeter ($2995) measures from ±100 μv to ±1000 volts. Addition of a KIN TEL digital preamplifier increases sensitivity to 1μv DC.

You can measure AC from 10 μv to 1000 volts: Addition of a 452 AC converter ($850) to the 501 DC digital voltmeter permits measurement of RMS AC voltages from 1 mv to 1000 volts in the frequency range of 30 cps to 10 kc. A KIN TEL preamplifier can be added to increase AC measurement sensitivity to 10 μv from 30 cps to 2 kc.

You can measure DC/DC and AC/DC voltage ratios: The 507B digital voltmeter/ratiometer ($3835) measures DC voltages from ±100μv to ±1000 volts and DC/DC ratios from .0001:1 to 999.9:1. Accuracy is 0.01% ±1 digit. Addition of an AC converter permits AC/DC ratio measurements.

You can get 0.01% DC and 0.2% AC accuracy: The KIN TEL 502 AC/DC digital voltmeter ($3845) measures DC from ±100 μv to ±1000 volts with 0.01% ±1 digit of reading accuracy; and AC from 1 mv to 1000 volts, 30 cps to 10 kc, with 0.2% of full scale accuracy.

You can have 10,000 megohm input impedance: The KIN TEL 458A digital voltmeter preamplifier ($1225) has gain positions of 100 (for DC and 30 cps to 2 kc AC measurement) and +1 HI Z (for DC only). On the +1 gain position input impedance is >10,000 megohms and gain accurracy is 0.001%. Input range for +1 operation is 0 to 40 volts.

You can have visual, printed, or any other form of output: KIN TEL digital voltmeters provide visual indication of the measured quantity on a single-plane in-line readout. They are capable of directly driving commercially available 10-line parallel input digital printers. Converters are available for driving other types of printers, paper tape punches, typewriters, and IBM card punches.

To find out how a KIN TEL digital system can solve your particular data acquisition problem, send us an outline of your requirements, or contact your nearest KIN TEL engineering representative.

5725 Kearny Villa Road, San Diego 12, California

CIRCLE 5 ON READER-SERVICE CARD

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.

vided by infrarimetry, might be used to distinguish between actual missile launches and similar hot sources used as countermeasures against the satellite detection net. The technique might also provide precise data on fuels being used.

Lead-sulfide detectors operating in the 3-micron range seem a logical choice for Midas satellites, according to one IR physicist.

This wavelength offers the least atmospheric attenuation of any of the infrared windows, he commented. The 8-to-13 micron range is a wider atmospheric window, but peak radiation from very hot sources occurs at shorter wavelengths, the physicist explained. A handy figure for use here is $2880/T =$ wavelength in microns of peak radiation, where T is the temperature of the source in degrees K.

Thus a radiation source at 6,000 K would transmit peak radiation at 0.48 microns. An ocean or ground temperature of 300 K, or 27 C, would give peak radiation at about 9 microns.

Optical materials are well developed for this wavelength range, so this would not offer a problem.

Getting as much radiation as possible to the detector is an important phase of the Midas program, a West Coast engineer commented. He pointed out that infrared sensors received much more radiation from the rear than they do from the front of a jet engine. Similarly, he said, a missile flame will be directed away from the detection satellite, and the body of the missile will block much of the radiation.

3,000-lb Payload Must Orbit

Instrumentation for meeting these requirements of the Midas program has to be heavy, engineers commented. That's why the payload for the Canaveral test shots adds up to about 3,000 lb and the Atlas booster, supplying about 360,000 lbs of thrust, is being used to put the Agena-B satellites into orbit. Reliability of the Atlas—with 20 straight successful shots—is another important consideration.

The Agena rocket, similar to those used as Discoverer satellites, is produced by Lockheed Aircraft Corp.'s Missiles and Space Div., Sunnyvale, Calif. It uses a 15,000-lb thrust engine produced by Bell Aircraft Co.

Operational Midas satellites will be launched into polar orbits from Vandenberg Air Force Base, Calif. A satellite test center, now being equipped by Radiation, Inc., Space Communications Div., Mountain View, Calif. under a $1.3 million contract from Lockheed, will be used to

Major Contractors—Project Midas

Military Control: Headquarters, Air Force Ballistic Missile division, Inglewood, Cal.

Prime Contractor: Lockheed Aircraft Corp., Missiles and Space division, Sunnyvale, Cal.

Ground-Space Communications: Philco Corp., Western Development Laboratories, Palo Alto, Cal.

IR Horizon Sensing System: General Electric Co., Light Military Electronics department, Utica, N. Y.

Satellite Test Center Instrumentation: Radiation, Inc., Space Communications division, Mountain View, Cal. (about $1.3 million)

coordinate tracking and telemetry equipment for the program. This test center is located near Lockheed's Sunnyvale plant.

Ground-space communications for the program will be handled by Philco Corp.'s Western Development Laboratories, Palo Alto, Calif.

An infrared horizon sensing system, developed by General Electric Co., will be used to establish a vertical from a satellite to the earth, so that the infrared detection system can be constantly directed toward the ground. This vertical reference, plus the precisely calculated orbit of a satellite, should permit missile launches spotted by the satellite to be located geographically by means of triangulation. A series of fixes on the hot source could establish motion and direction of the missile, engineers explained.

GE Horizon Sensing System Classified

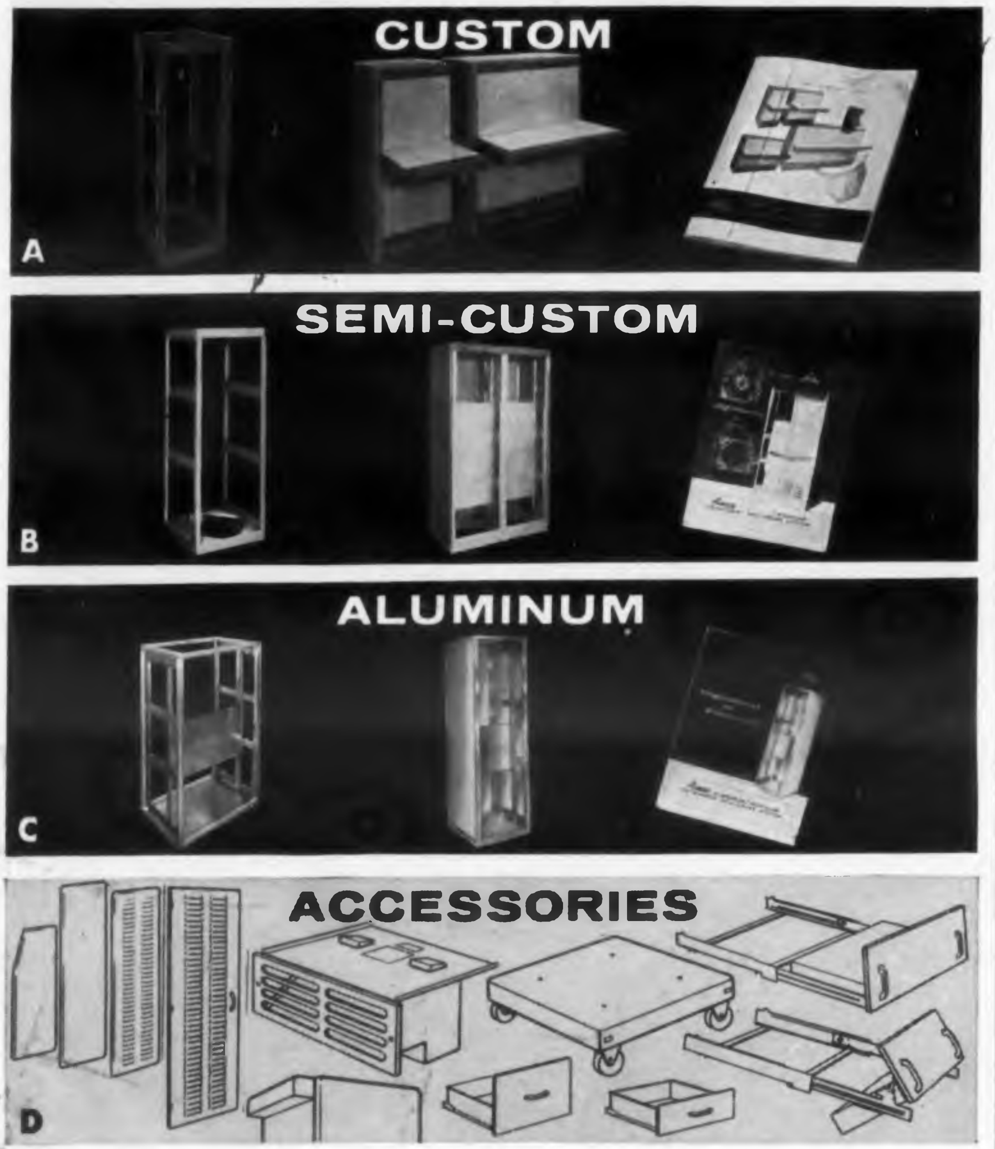
Although the GE system designed for Midas is still under security wraps, industry sources believe that the concept of operation is similar to that used in a previous infrared horizon sensing system developed by Barnes Engineering Co., Stamford, Conn.

Two IR horizon sensing units are used in a satellite to maintain stability with the Barnes system. One of the units contains a reference roll axis, and the other a reference pitch axis.

The infrared optics are set to scan conically a narrow field of view. The conical scan is directed so that the scanning "beam" is directed toward the earth during part of each cycle. At the point where the beam crosses from the atmosphere to the earth, a sharp discontinuity in received radiation is sensed by the infrared detector. When the beam crosses from the earth to the atmosphere, another distinct change in received radiation is sensed.

These two points in the scan establish an angle. This angle is bisected and the resultant compared with the built-in reference angle. Differences are used to trigger valving jets or reaction wheels to turn the satellite until it is again properly oriented. ■ ■

THE AMCO MODULAR INSTRUMENT ENCLOSURE SYSTEM



TWO COMPLETELY NEW LINES ADDED IN STEEL AND ALUMINUM TO GIVE 3 COMPLETE MODULAR FRAME LINES IN ONE OVER-ALL SYSTEM

A **Amco Custom Line.** Removable multi-panels and cowlings based on 19" increments of width. Custom, single-unit appearance for frames mounted in series—ideally suited for complex console arrangements. The 19 1/16" width of frame saves space in series mounting of frames. Constructed of double-channel 16 gauge cold-rolled steel. Conforms to EIA mounting standards.

B **Amco Semi-Custom Line.** Removable multi-width cowlings provide a semi-custom, single-unit appearance for frames mounted in series. Extra rugged, wide box-type channel frames provide greater internal mounting area. 19" wide panels of any thickness can be recessed—from a flush-mounted position to any desired depth. Box type channel construction of 14 gauge cold-rolled steel. Conforms to EIA mounting standards.

C **Amco Aluminum Line.** This system of aluminum box extrusions and cast corners allows easy assembly of cabinets in any size from 7" to 20' in height, width or depth. Corners and extrusions lock together by hand with built-in locking device. All sizes are standard. Ideal for stocking and odd-ball sizes. Cast and hardened corners of 356-T6 aluminum as described in Federal Spec. QQ-A-596a. Extrusions of 6061-T6 aluminum as described in Federal Spec. QQ-A-270a.

D **Amco Accessories.** A full line of Amco integrated accessories such as blowers, chassis slides and mounts, lighting, doors, drawers, dollies and many more available for A, B and C shown.

Cost savings. All the above—or any part thereof—may be ordered under one combined discount schedule base determined by order dollar value. Orders received at one time with one delivery date may also be combined. Free pre-assembly by Amco provides additional savings in time and installation.

3 week delivery on all standard parts. We welcome inspection of our plant and facilities. Send for your free literature now.

Amco
ENGINEERING CO.

AMCO ENGINEERING CO.
7333 W. Ainslie Street, Chicago 31, Illinois
Booth #4412 and 4414
CIRCLE 8 ON READER-SERVICE CARD

5 Companies Pool Efforts In New Micromin Program

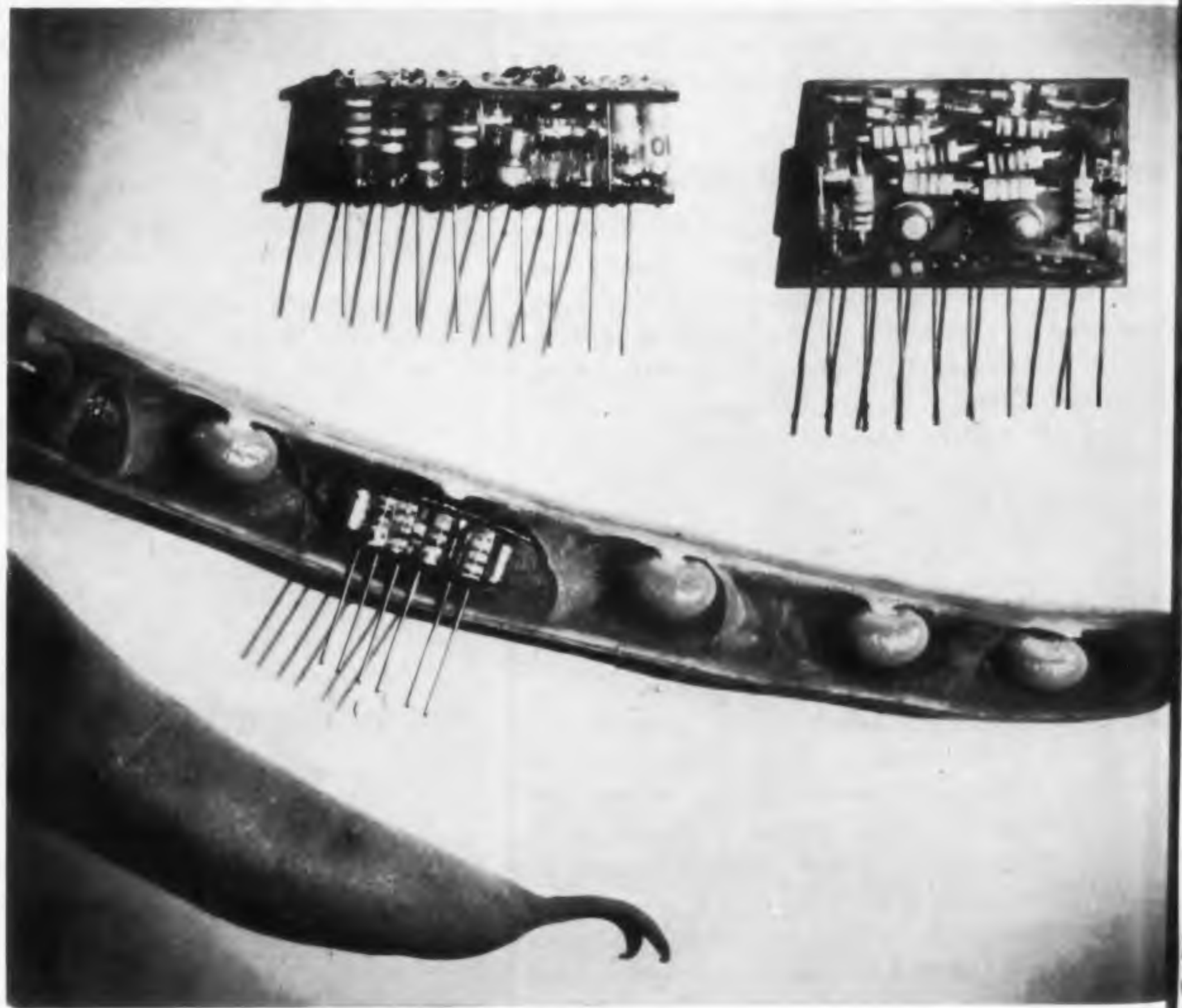
Microminiaturization, with component densities of up to 8 million per cu ft and reliable, off-the-shelf components readily available to industr —that's what five electronics companies are offering in a joint program called MICRAM. Th program will be unveiled at the New York IR show this month.

MICRAM means Microminiature Individua Component Reliable Assembled Modules.

All of the component parts used in the assemblies are standard production items. Price are "realistic," the companies report.

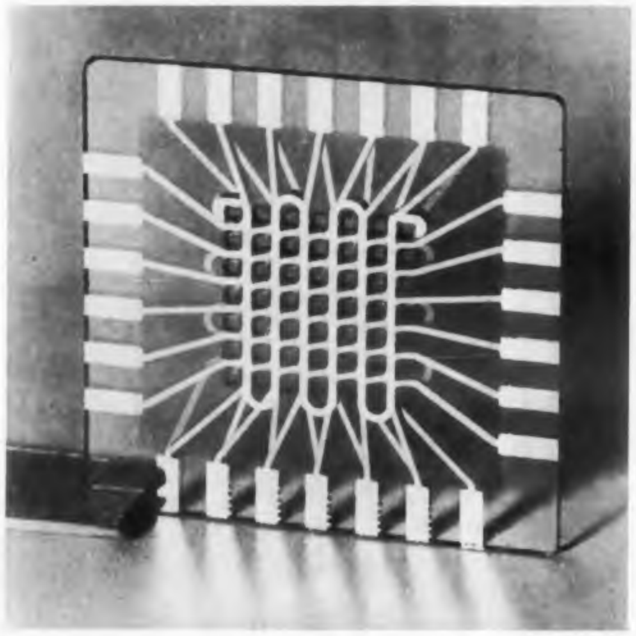
Raytheon Semiconductor Div. supplies th transistors. Pacific Semiconductors makes th diodes, and Aerovox Hi-Q Div. the capacitors. Sylvania Electric Products Lighting Div. supplies the microminiature lamps. Cleveland Metal Specialties assembles the modules.

Modules to be displayed at the companies' booths at the IRE exhibition include a flip-flop, a shift register, a binary divider and a multivibrator. The flip-flop modules have 18 components and occupy less than 0.015 cu in. This packing density can be translated into about 2 million parts per cu ft.



Pea-sized standard modules like these are being made available in a five-company program called *MICRAM*. Items will be in ready supply at "realistic" prices, the manufacturers say.

84-Bit Memory Plane For Airborne Computers



Thin film processes are used by CBS Laboratories to make this miniature memory plane for airborne computers.

Latest of a series of microminiature devices to come out of CBS Laboratories, Danvers, Mass., is a microminiature 84-bit coincidence memory plane. Using thin-film processing techniques, the memory plane is designed for airborne computers.

In this application, it achieves a 25-to-1 volume reduction, the company says. It makes possible a 100-to-1 volume reduction over present ground-based random access memories. Several of these memory planes can be grouped together to form a large unit. The unit is being made for a major electronics systems manufacturer.

Another CBS memory unit is a 2,500-word, 40-bit-per-word memory pack. About the size of a slice of bread, the device has a storage capacity in excess of 10,000 bits, CBS reports. These bits can also be stacked in multiple units.

CBS has developed a device called the Circuit-Dek. It consists of a high-temperature ceramic or glass substrate on which highly reliable electronic components are deposited photographically. A number of Circuit-Deks may be combined through an integral interconnecting method, thus requiring no hand wiring.

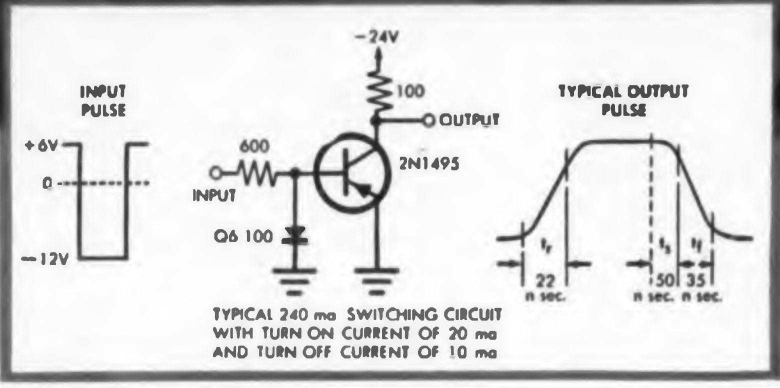
PHILCO ANNOUNCES

THE FASTEST HIGH-CURRENT SWITCHING TRANSISTORS!

MADT*

2N1495 • 2N1496
2N1204 • 2N1494

These Diffused-base Transistors are capable of utilizing the full speed of new magnetic film memory planes



TYPICAL 240 ma SWITCHING CIRCUIT
WITH TURN ON CURRENT OF 20 ma
AND TURN OFF CURRENT OF 10 ma

TYPICAL CHARACTERISTICS

TYPE	CASE	P_T @25°amb. (Max)	V_{CES} (Max)	$V_{CE}(SAT)$	V_{BE}	h_{FE}	f_T
				$I_C = -200$ma $I_B = -10$ma		$V_{CE} = -1$v $I_C = -200$ma	$V_{CE} = -10$v $I_E = 25$ma
2N1495	TO-9	250mw	−30v	0.35v	0.60v	60	320mc
2N1496	TO-31	*0.5w	−30v	0.35v	0.60v	60	320mc
2N1204	TO-9	250mw	−20v	0.35v	0.60v	60	320mc
2N1494	TO-31	*0.5w	−20v	0.35v	0.60v	60	320mc

*At 25°C case temp.

These new Philco MADTs are the result of a revolutionary new development of the Precision-Etch process, which gives high switching speed at high currents. *They are capable of switching 400 milliamperes of current at a 10 mc clock-rate . . .* and are the only transistors available today that permit full utilization of high-speed magnetic film memory planes. The typical f_T of 120 mc at 100 ma makes these units particularly suitable for video drivers, pulse line drivers and other high-current switching circuits. The ultra high-frequency response at the levels normally encountered in current-switching logic circuits, coupled with high dissipation capabilities, makes these units desirable for this class of circuit application.

Both the 2N1495 and 2N1204 are available in studded versions for higher power applications. Typical characteristics are shown in the accompanying table. For complete application data, write Dept. ED-360.

*Reg. U. S. Pat. Off.

IMMEDIATELY AVAILABLE

In Design Quantities through your Philco Industrial Semiconductor Distributor

PHILCO®

LANSDALE DIVISION • LANSDALE, PENNSYLVANIA

SEE US AT IRE...BOOTHS 1302-1308

TRANSISTOR CENTER U.S.A.

Sees Manhattan at Night

Infrared photograph of Manhattan taken at night from 4,000 feet with a Reconofax camera, designed by HRB-Singer, Inc. White spots on photo pinpoint intense heat sources. Detection of ships' wakes and sensing of small temperature differences are also possible with the IR equipment.

◄ CIRCLE 10 ON READER-SERVICE CARD

1960 IRE Convention to Mark Centennial of Signal Corps

The 100th anniversary of the founding of the Army Signal Corps will be marked at next week's IRE International Convention by manufacturers of military equipment. They plan to emphasize in their displays the steady development of military electronic equipment.

Products developed for the military will bear stickers at the convention citing the Signal Corps centennial. This is one of several new features of the meeting, which will be held March 21 through 24 in New York City.

Another change has resulted in the addition of the word "international" to the convention title. This is to emphasize that IRE has 22 sections and 6,000 members outside the United States.

This year's show will have more than the usual educational flavor. Many exhibiting companies have announced plans to increase the number of technical personnel who will dispense engineering advice at the booths.

The conference will be in New York,'s Coliseum and at the Waldorf-Astoria Hotel. The 275 papers planned for delivery at both sites will cover developments in all of the IRE's 28 professional groups. The papers will be delivered in 54 sessions. (See program index on p. 68)

About 850 exhibitors will fill four floors of the Coliseum and display an estimated $15 million worth of the latest electronics equipment.

Planar-Structure Transistor Developed By Fairchild

A diffused planar-structure transistor, type 2N1613, will be introduced at the IRE show by Fairchild Semiconductor Corp. The device differs from mesa types in that both the collector-to-base and base-to-emitter junctions are embedded in the top surface of the planar structure.

A significant advantage of the planar structure, the company reports, is reduced reverse leakage: 0.0005 μa I_{cbo} typically at 60 v. A typical noise figure of 5 db is said to allow it to be designed into infrared amplifiers, character recognition preamplifiers, and low-noise video amplifiers. Guaranteed minimum beta of the device is put at 15 at 100 μa.

Fairchild has begun production on a line of transistors that incorporate the planar structure. Detailed information will be presented in a subsequent issue of ELECTRONIC DESIGN.

new transistors from Sprague*

SUPER HIGH-SPEED SWITCHING TRANSISTORS TYPE 2N501

	Typical	Maximum	Units
Rise Time (t_r)	9	18	mμsec
Storage Time (t_s)	9	12	mμsec
Fall Time (t_f)	7	10	mμsec

In circuit with current gain of 10 and voltage turnoff.

Also available as special type 2N501A for 100° C. maximum storage and junction temperatures.

This table tells the story. Sprague Type 2N501 germanium micro-alloy diffused-base transistors are the fastest mass-produced transistors available anywhere! They are unexcelled for high-speed computer applications. The ultra-low rise, storage, and fall time cannot be matched by any other transistor.

Ultra-precise process control in manufacture results in superb and consistent high quality. The basic electrochemical process of fabrication takes the guesswork out of transistor manufacturing. The result is outstanding uniformity of product.

Because of the electrochemical process, Sprague is able to fabricate a graded-base transistor with no intrinsic base region. The Type 2N501 can thus maintain its super high-speed switching characteristics right down to its saturation voltage, providing all the advantages of direct-coupled circuitry with no impairment of switching speeds.

Type 2N501 Transistors are available from Sprague now at extremely reasonable prices. They are transistors you can use today! You need not delay your development work for the future when you design high-speed switching circuits with Type 2N501 Micro-Alloy Diffused-Base Transistors.

Write for complete engineering data sheet to the Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

* *Sprague micro-alloy, micro-alloy diffused-base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable.*

SPRAGUE COMPONENTS:

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

SPRAGUE®
the mark of reliability

SEE US AT THE IRE SHOW BOOTHS 2416-2424
CIRCLE 11 ON READER-SERVICE CARD

NEWS

Gavin Bids Nation Fill Perilous Gap In Basic Research

Gen. J. M. Gavin, new president of Arthur D. Little, Inc. believes that a new method of cooperation between government and industry for the sponsorship and use of basic research is needed.

"This country is not using its innovative potential in the most efficient way today —a concentrated attack on this problem would pay important dividends," said Gen. James M. Gavin in an ELECTRONIC DESIGN interview. The general, recently appointed president of Arthur D. Little, Inc., added that the long period necessary before we can realize the pay-off on basic research does not fit the short-term planning in effect in industry.

"This," he said, "suggests that a new method of cooperation between government and industry for the sponsorship and use of basic research is indicated. The first steps in this direction are already apparent in such fields as space and nuclear technologies. But many problems still exist for more effective use of our brainpower. Until we can solve some of these problems, we are handicapped in our competition with monolithic state economies that can concentrate national efforts on centrally chosen objectives."

When asked how large an effort electronics companies should expend on basic research, Gen. Gavin said that only by constant additions to our scientific knowledge can the industry produce new ideas and radically new products.

"Basic research," he continued, "is not necessary to bring out a different combination of currently known devices, but a new device like the crybtron, diode, or maser must be preceded by new knowledge.

"Percentage of sales is not a satisfactory measure of the level of basic research, nor, even, as a rule, of research and development programs. A more useful approach, and one used by some companies today, is to undertake enough basic research to keep new ideas flowing into the development groups to maintain a steady flow of new products. This must be determined pragmatically, and errors on the high side are probably more desirable than the reverse.

"Without more basic research and the rapid conversion of its results into civilian products, our economy will not be able to grow fast enough to support the demands of this nation's role as leader of the free world."

In commenting on whether higher government expenditures for basic research should be made at the expense of items already in the military budget, Gen. Gavin said that such expenditures are not an alternative to the other activities covered by the military budget. "By its very nature, basic research is looking five to twenty years ahead. Most of the military budget is concerned with shorter-range needs such as the maintenance of adequate forces to deal with threats to our national security in the next three years. The one is not a substitute for the other, they are complementary parts of a total national plan."

Gen Gavin's answers to other questions of interest to the electronic industry are printed below.

In what areas would you say electronic research money is most needed and can be best spent?

"Research money is needed in all areas of electronics to improve efficiency, increase miniaturization, and develop new and better techniques. In the area of defense needs, electronic research in anti-missile requirements and development of more sophisticated tracking techniques would prove especially useful."

Can the military electronics systems needed in the 1960's be developed within the existing state of the art, or will research "breakthroughs" be needed?

"As far as the needs of the coming decade can be foreseen (and they might change rapidly with the swift pace of technology today), an "economic breakthrough" for more research and development can produce hardware within the present state of the art that will meet these needs."

Do you think electronic equipment is accounting for a dangerously high proportion of total military equipment cost?

"The same question could have been asked during World War I of the internal-combustion engine. When a new technology assumes great importance, as is true of electronics today, the proportion of cost for it will increase in new proportions."

How can designers reduce the costs of military electronic equipment?

"Standardization, better methods of production, increased knowledge from research."

Do we need a new approach to the design of military electronic equipment?

"Industry and government are learning to coordinate simultaneous development of carrier and system to produce a single weapon. Such cooperation has come a long way. Similar developments in the management of R&D of teams associated with a project from the beginning will increase efficiency."

In your opinion, are the armed forces getting their money's worth in electronics, both in the price they pay for the equipment and the use it is put to?

"Yes, the Government is scrupulously careful in checking into such matters."

Are you in favor of military or civilian control of our space program?

"Civilian."

Would civilian control of our space program assure adequate development of military space hardware?

"Unquestionably, yes."

What military needs could be achieved by satellites within the next five years?

"To name a few: quicker communications, elimination of line-of-sight limitations on radar, worldwide surveillance, weather knowledge and control, and perhaps anti-missile or retaliatory stations.

(continued on following page)

after routing, clip and save

a continuing series on technical topics of specific interest to engineers

Folio 60-9

REFERENCE DATA FILE

SANGAMO

capacitor characteristic designation

. . . . . . and the story is told that Pelops was the son of Tantalus and the grandson of Jupiter. He was slain and served up beforc the gods by his own father, who wished to test the omniscience of the Olympians. They were not deceived, however, and would not touch the cannibal feast. But Demeter (Ceres), absorbed in grief for the loss of her daughter, Proserpina, tasted of the shoulder before she discoverd what it was. Jupiter restored Pelops to life, and replaced his shoulder with one of ivory, whence the ivory shoulder of the sons of Pelops became a proverbial phrase for the distinguishing or distinctive mark of anyone, since all the descendants of Pelops bore this characteristic. — Greek Mythology

The word "Characteristic" can mean many things in the description of capacitors. This article is aimed at removing some of the jargon associated with the term and clarifying its meaning and application to various capacitor types.

An indicator for "characteristic" is found in the nomenclature of many types of capacitors. It does not mean the same "distinguishing or distinctive mark" for all types. This is sometimes a source of confusion for equipment design engineers.

Typical examples of product nomenclatures including a "characteristic" identifier are:

1. SBA1**H**04104
2. CB11N**D**101K
3. SMDA1**K**04104K
4. CE34**C**101E
5. CM15**E**101K03

Items 1 and 3 are Sangamo nomenclatures for impregnated kraft tissue dielectric capacitors. Item 2 is a MIL type designation for a button style mica capacitor. Item 4 is a MIL type designation for an electrolytic capacitor. Item 5 is a MIL type designation for a plastic encased, axial wire lead mica capacitor.

The important information meant to be conveyed by the characteristic letter is shown below for Paper, Electrolytic and Mica capacitors.

PAPER CAPACITORS In the case of Sangamo products, this letter tells us:

1. The specific impregnant used in the dielectric. "H" is Sangwax, and "K" is Etherm. Detailed information on these impregnants is set forth in Sangamo Reference Data File—Folio 59-2.
2. High and low ambient test temperatures.
3. Minimum insulation resistance at 25°C., and at the high ambient test temperature.
4. Maximum capacitance change (in per cent of the initial value) from 25°C. to the low ambient test temperature.
5. Voltage (in per cent of rated) that can be applied to establish accelerated life performance capability.
6. Maximum and minimum allowable service operating temperatures consistent with normal life expectancy.

ELECTROLYTIC CAPACITORS The identifier letter spells out the working temperature range of the product as maximum and minimum values in degrees Centigrade. The inherent capability to perform is adjusted by:

a. Selection of insulating separators.
b. Formulation and control of the conductive electrolyte.
c. Selected processing techniques.

The performance parameters affected are:

I. At reduced temperature:
   a. DC leakage current.
   b. Capacitance change (in per cent of the initial room temperature value).
   c. Equivalent series resistance.
   d. Impedance.
II. At high temperature:
   a. Capacitance change (in per cent of the initial value).
   b. Equivalent series resistance.

MICA CAPACITORS The characteristic letter defines the capacitance stability of the unit during one "round trip" excursion from room temperature to minimum and maximum temperatures specified for the capacitor, although it does not specify the operating temperature range. It further defines the maximum temperature coefficient of capacitance. In the case of transmitting types, certain characteristic letters will also be associated with a required fifty per cent derating of radio-frequency current specified for that type.

The design factors affecting the "characteristic" performance of mica capacitors are:

a. The physical configuration (style) of the product. Button style capacitors are most stable in the family of mica dielectric units.
b. The relative nominal capacitance value in the design range. High capacitance values are inherently more stable than low values.
c. The electrode design. Styles using electrodes of deposited metal bonded to the dielectric plates (silvered) are more stable than styles using independent metallic foil electrodes.
d. Selection of mica quality.
e. Processing techniques.

It has been the purpose of this article to explore the meaning of the word "characteristic" as it applies to describing capacitor differences. While the term is used in a specific rather than a general sense, it serves its purpose to describe the "Ivory Shoulder" of the capacitor industry.

SC60-1

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

-designing toward the promise of tomorrow

CIRCLE 13 ON READER-SERVICE CARD

Is our electronic technology adequate to meet these space needs?

Yes, we have the manpower with sufficient training to solve the problems involved. Realization of the need, courage to make the economic breakthrough, and the creativity to improve social systems for more efficient research management are what we need."

IR Electronic-Scan TV Pictures Produced by Two Methods

TV pictures from infrared images, using electronic rather than mechanical scanning methods, have been produced independently by Philco Corp. and Westinghouse Electric Corp.

The systems, using different approaches, both scan at 30 frames a sec compared with 1 frame a sec using mechanical scanners.

A novel selective signal cancellation principle allows the Philco system, called Filterscan, to operate at room temperatures with conventional sensitive, small-area IR detectors. The tube does not have the memory capability of a vidicon, however.

The phothermionic image converter developed by Westinghouse uses a new IR detector-photoemitter sandwich element, said to be sensitive and fast enough to reproduce moving objects differing from room temperature by about 20 F.

Semiconductor Window Used

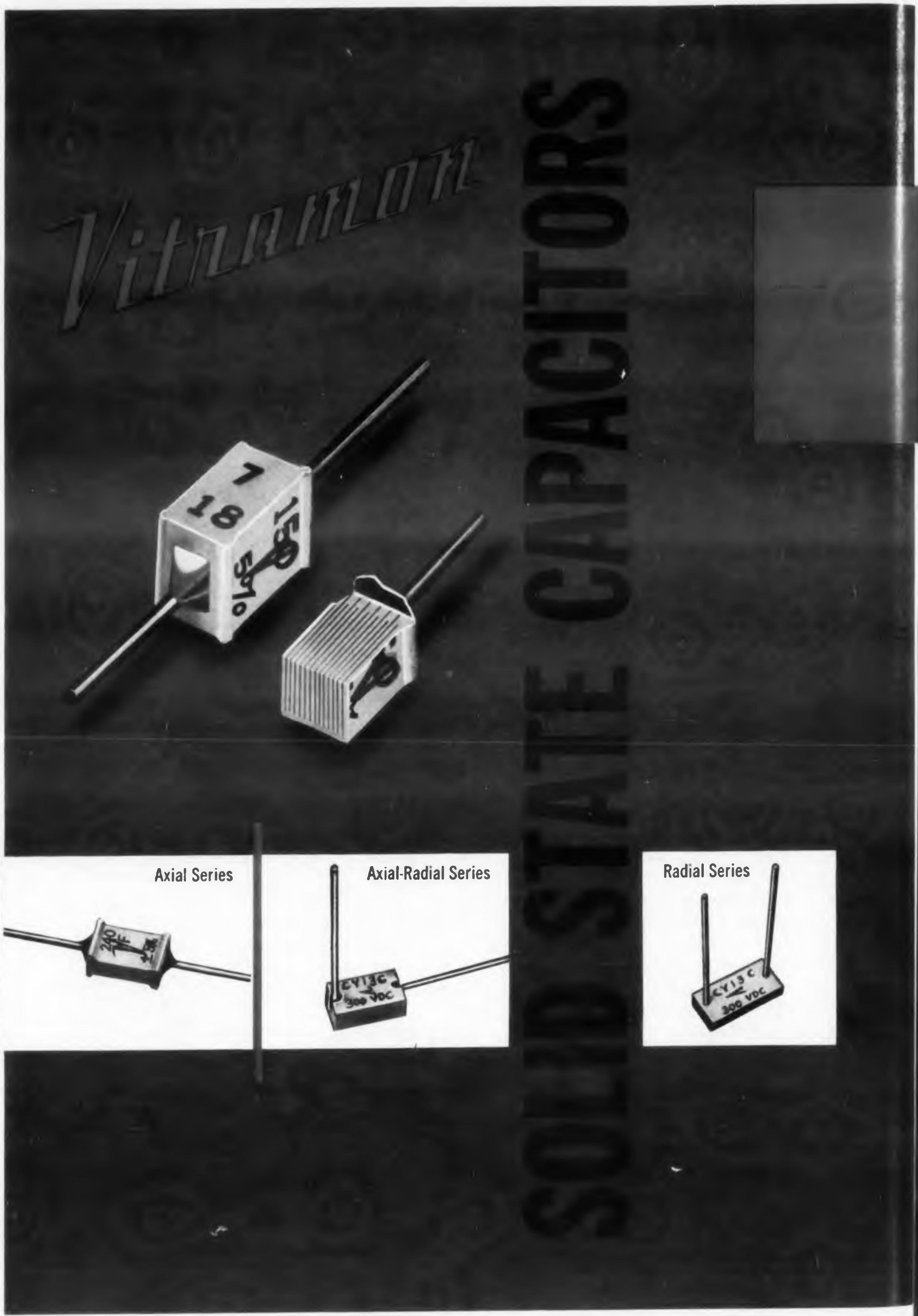
Scanning of the infrared image in the Filterscan takes place in a tapered tube with a semiconductor window at one end and any suitable IR-transparent material as a second window at the other end. From this end the image is focused onto a detector.

An electron gun is placed in the tube at an angle to the optical path between the two windows, so that an electron beam can be scanned over the surface of the semiconductor window.

When this electron beam is off, the entire IR image is passed by the window. When the beam is directed at a particular point on the semiconductor, however, it partially cancels the IR image at that point. This causes a decrease in the amplitude of the voltage from the IR detector at this instant.

Scanning of the cancelling spot causes this amplitude decrease to vary with time in proportion to the amount of IR radiation at each point in the scanned image. This varying voltage decrease can be used to modulate the beam of a TV monitor, operating in synchronism with the cancelling spot to reproduce the IR image.

The cancellation takes place in the semiconductor because of the release of free carriers in-



TV picture produced from infrared image of the letter M with Philco's Filterscan system. The image was formed by placing an M-shaped aperture in front of a plate heated to 125 C above ambient. Thirty frames a sec can be electronically scanned with the detector at room temperature in this system.

side the material at the point struck by the electron beam. This changes the conductivity and thus the absorption coefficient at that point, partially cancelling the transmission of the image, according to M. E. Lasser, P. H. Cholet and R. B. Emmons of Philco.

An operating Filterscan tube was built, using beam current of 0.5 ma with 25-kv anode potential to produce the cancelling spot. A 150-line TV image was produced, although a standard 525-line picture could be used if desired, according to Philco.

New Detector Developed

A new three-layer IR detector was developed for the Westinghouse phothermionic image converter. In operation this element is cooled to about −180 F.

A layer of nickel, less than a millionth of an inch thick, is used as an infrared absorbent surface. The center supporting layer, about a millionth of an inch thick, is made of aluminum oxide. It is produced by chemically dissolving the aluminum away from a suitably treated piece of aluminum foil.

The third surface is a layer of cesium bismuth. Photoemissivity of this surface varies with temperature.

When an IR image is focused on the front surface of the detector, the resulting temperature pattern is transmitted to the photoemissive layer through the thin supporting film. Then this surface is scanned with a beam of light, causing electrons to be emitted in accordance with the temperature pattern on the surface. The emission variation is used to modulate a TV monitor beam in synchronism with the motion of the light beam, according to Dr. Max Garbuny, head of the Westinghouse research team that developed the system.

Accessible Local Centers Needed, Measurements Symposium Hears

The electronics industry needs regional standards and measurements laboratories that are open to all companies in the industry—those making commercial products as well as those producing military equipment. This need was described at a standards and measurements symposium by one of the leading participants, I. G. Easton, engineering manager, General Radio Co.

In telling other symposium participants that the National Bureau of Standards has too great a load of routine measurements work, Mr. Easton asked whether "the present strong interest in standards is being overdone."

"We must be careful that standards do not become an end result rather than a means to an end," Mr. Easton said. "The present hysteria about traceability to NBS is disturbing . . . The concept that all calibrations be based ultimately on NBS certification is a commendable one, but the means of achieving this result requires scrutiny," he added. "It is clearly the responsibility of a manufacturer of standards to maintain the value of units with which he is concerned—but the end result is not assured by a simple statement regarding date of NBS certification of a particular standard in his possession. Little or nothing is gained by a traceability statement since it is already implicit in the manufacturer's warranty."

Mr. Easton added that "clarification and proper interpretation of traceability requirements is a problem for the immediate future at the commercial and operational level of our national standards program."

At the symposium, which was held at the Arma Div. of American Bosch Arma, Garden City, N.Y., the keynote speaker, Dr. James Thomas, section chief of the National Bureau of Standards reviewed the state of the measurements art and revealed that the bureau has developed a standard capacitor that is expected to lead to an absolute determination of frequency in terms of capacitance, the bureau also expects soon to measure resistance to an accuracy of 1 part per million, Dr. Thomas reported.

The traditional accuracy framework was compared to a transmisison line by W. M. Goodhue, of the Arma standards laboratory's technical staff. The transmission line in the standards structure terminates at NBS, said Mr. Goodhue, and it is exhibiting attenuation and phase-shift characteristics. Space-age requirements are imposing a transient condition on the transmission line and

Three participants in standards and measurements symposium current problems. Left to right, I. G. Easton, General Radio, John Cammarata, American Bosch Arms, and Dr. James Thomas, National Bureau of Standards. Representatives from 16 organizations attended the symposium.

threatening the traditional measurements organization. Evidence of change are quasi-accuracy in products and the abandonment of the traditional 10:1 accuracy attenuation occuring between the labs and the production line, Mr. Goodhue said.

Among other opinions expressed by Mr. Easton at the symposium were these:

- The standards situation is well under control at dc for resistance, and at audio frequency for inductance and capacitance. But "as we move up in frequency, the situation deteriorates rapidly, and at the still relatively low frequencies measured by tens of megacycles, we find ourselves talking in terms of parts per thousand or even of parts per hundred rather than parts per million or parts per ten thousand.
- "In the frequency area characterized by coaxial transmission lines, there is a definite need for improved methods of connection. Of the dozen or more different types of coaxial connectors in common use today, none is really suitable for precion measurements.
- "There is a growing recognition of the need for a precise, coaxial connector of the flange type using a tube diameter that is reasonably compatible with widely used connectors. The use of a coaxial connector with a flange, which provides a clearly defined reference plane for measurement purposes is also a valid and practical solution in the vhf range.
- "The status of the standards of frequency and resistance suggest quite obviously the challenge in our field. When all of our electrical standards have been brought up to the level of these two, we can perhaps say that the problems of tomorrow have been solved—but then only temporarily."

Ideal for critical infrared and microwave applications

Looking for ways to improve infrared or microwave systems designs? The unique advantages offered by these Alite-Sapphire assemblies may be just what you want!

Up to now, synthetic sapphire window units of this type required difficult, and often unreliable, metallizing methods. We've developed a high temperature *non-metallic* bonding technique that simplifies design problems, while assuring a high strength, vacuum-tight seal capable of withstanding extreme environmental conditions.

The similarity of the Alite body to sapphire (both are essentially aluminum oxide) offers distinct advantages. Since Alite and sapphire are nearly identical in composition, they have virtually the same dielectric constant, loss factor, coefficient of expansion, mechanical strength, and other superior characteristics. Excellent design flexibility is achieved with Alite, too. For in addition to the Alite-Sapphire bond, if desired the Alite body can be metallized and brazed to metal components to make hermetic assemblies with integral feed-throughs. Likewise, sapphire-to-metal seals can be provided where required.

Possible applications include infrared domes for missiles, infrared spectrometry, fire detection equipment, microwave windows, ultraviolet devices. We offer our technical assistance on any applications where Alite-Sapphire assemblies may prove of value. Write for details.

Visit ALITE at the IRE Show—Booths 2205-2207

ALITE
DIVISION

U. S. STONEWARE
BOX 119 ORRVILLE, OHIO

New York Office
60 East 42nd St.

381F

CIRCLE 17 ON READER-SERVICE CARD

NEWS

Pure Fluid Amplifier Joins Tubes, Transistors as Basic Element

A new principle of amplification, replacing vacuum tubes and transistors in some applications, has been developed at Diamond Ordnance Fuse Laboratory, Washington.

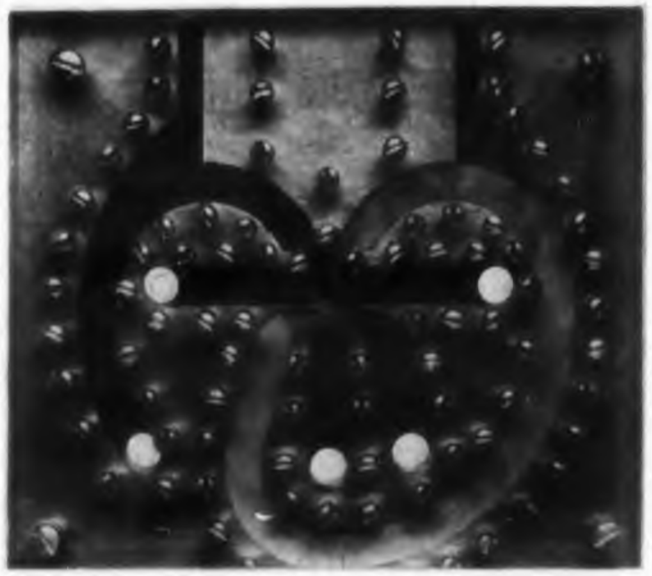
The basic amplifier is nothing more than a block of metal or hard plastic, with passages for the flow of a fluid. There are no moving parts. Operation is possible in temperatures ranging from near cryogenic to white heat. Shock, vibration, shelf-like, humidity and operating life should be minor problems, the laboratory says.

Operates On Jet-Deflection Principle

The basic amplifier comprises a power jet input, corresponding to a tube cathode; output jets, corresponding to plates; and control jets, corresponding to control grids.

The operation is based on the ability to deflect the high-power, fluid stream by directing low-power control jets at right angles to its flow. Amplification from 10 to 100 has been achieved.

Suitable design of feed-back passages yields bi-stable or tri-stable flip-flop units as well as



Pure fluid flip-flop of the momentum-exchange type acts like an Eccles-Jordan Circuit. Power jet (center) is directed up into either of two output paths by the control jets (horizontal). Feed-back paths (curved) reinforce the control jets, lock flow in one of two stable paths.

oscillators. One flip-flop design, called the momentum-exchange type, is strictly equivalent to an Eccles-Jordan circuit. A second, or boundary layer type, depends on flow patterns within the passages themselves. A wide variety of control and computing devices are possible.

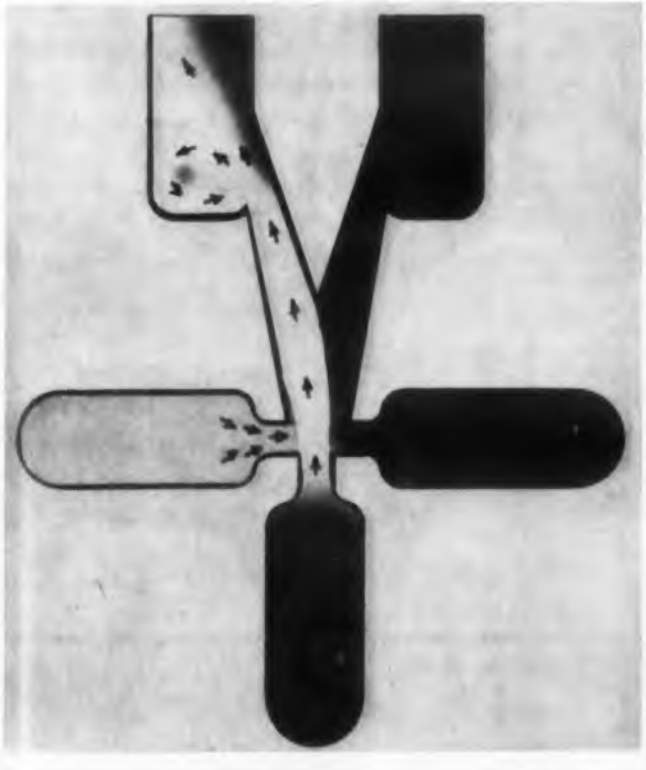
Frequency Limited to 20 kc

Frequencies as high as 5 kc have been achieved, using air as the fluid. Use of helium would extend this to about 20 kc.

This frequency limitation bars the device's use in large-scale digital computers, where only data are handled. However, in the many control-computer applications, where relatively large masses must be moved, these frequencies are more than adequate. The probable cost in quantity is less than a tenth that of tubes or transistors.

Applications are vast. They include hot-gas servos powered by rocket exhausts; pitometer and altimeter computers (where no transducers would be needed); aerodynamic control-surface servos, where the power supply could be ram-air; machine-tool control; and many others.

The three inventing scientists are Dr. R. E. Bowles, B. M. Horton and R. W. Warren.



Boundary-layer flip-flop depends on flow-patterns within the passages themselves. Low pressure between the side wall and the power stream is used to help deflect the power stream, which constitutes inherent positive feedback.

A real heel might test a Fusite Terminal like this

. . . but he won't make it leak!

The adherence between glass and metal in a Fusite Hermetic Terminal is an easily demonstrated fact. There are several theories as to *why* our exclusive V-24M glass actually chemically bonds to the metal components. Cobalt and certain other metallic oxides in the glass oxidize the iron in the metal which is taken into solution. It is believed that through the solution of iron, a gradual decrease of the difference of thermal expansion between the glass and metal takes place at the glass-metal interface. This inter-fusion of the two dissimilar materials gives Fusite Terminals their ability to withstand great mechanical and thermal shock and still pass Statiflux tests for glass cracks, hydrostatic pressure tests and helium mass spectrometer leak detection.

This fusion is reinforced by a strong compression of the metal ring around the glass made possible by a favorable thermal expansion balance of the glass, pins and housing.

The combination of fusion and compression provides a terminal so rugged that leaker rejection rate of components into which our terminal is fabricated is practically nil, even when roughly handled and subjected to extreme temperature changes.

Samples for your own testing are yours for the asking.
Write Dept. C-2.

INSULATE ELECTRICALLY GLASS TO METAL FUSITE TERMINALS PROTECT PRODUCT PERFORMANCE SEAL HERMETICALLY

THE FUSITE CORPORATION
6000 FERNVIEW AVE., CINCINNATI 13, OHIO
Woodford Mfg. Co., Versailles, Kentucky.
In Europe: FUSITE N. V. Konigsweg 16, Almelo, Holland

CIRCLE 18 ON READER-SERVICE CARD

Army Missile Work Continues Despite Facilities Shift to NASA

Several missile programs will continue to be directed by the Army Ordnance Missile Command despite the shift of some Redstone Arsenal facilities and personnel to the National Aeronautics and Space Administration.

Nike-Zeus, that anti-missile missile, is the major missile project remaining under Army control. Test-firing facilities being built in the Pacific will be used to test the Nike-Zeus against the Jupiter, an Army-developed intermediate range ballistic missile now under Air Force control.

The Army still has responsibility for the Redstone, a short-range, liquid-fuel ballistic missile scheduled to go out of production next year. It will be replaced by the Pershing, a solid fuel missile with similar capabilities, which will be under Army supervision.

Other Army missile systems, mainly tactical and short range types, are:

Missile "A," a new type of projectile now under study.

A weapon system known only as T-273. It is being developed jointly by the Army, the Chemical Corps and the Ordnance Weapons Command.

Redeye, an anti-aircraft missile, in the early development stage.

The Mauler, another anti-aircraft missile.

Two French anti-tank missiles, SS-10 and SS-11.

The Shillelagh anti-tank missile. It is being developed for the Ordnance Tank Automotive Command, and will be used in a vehicle mounted tactical system.

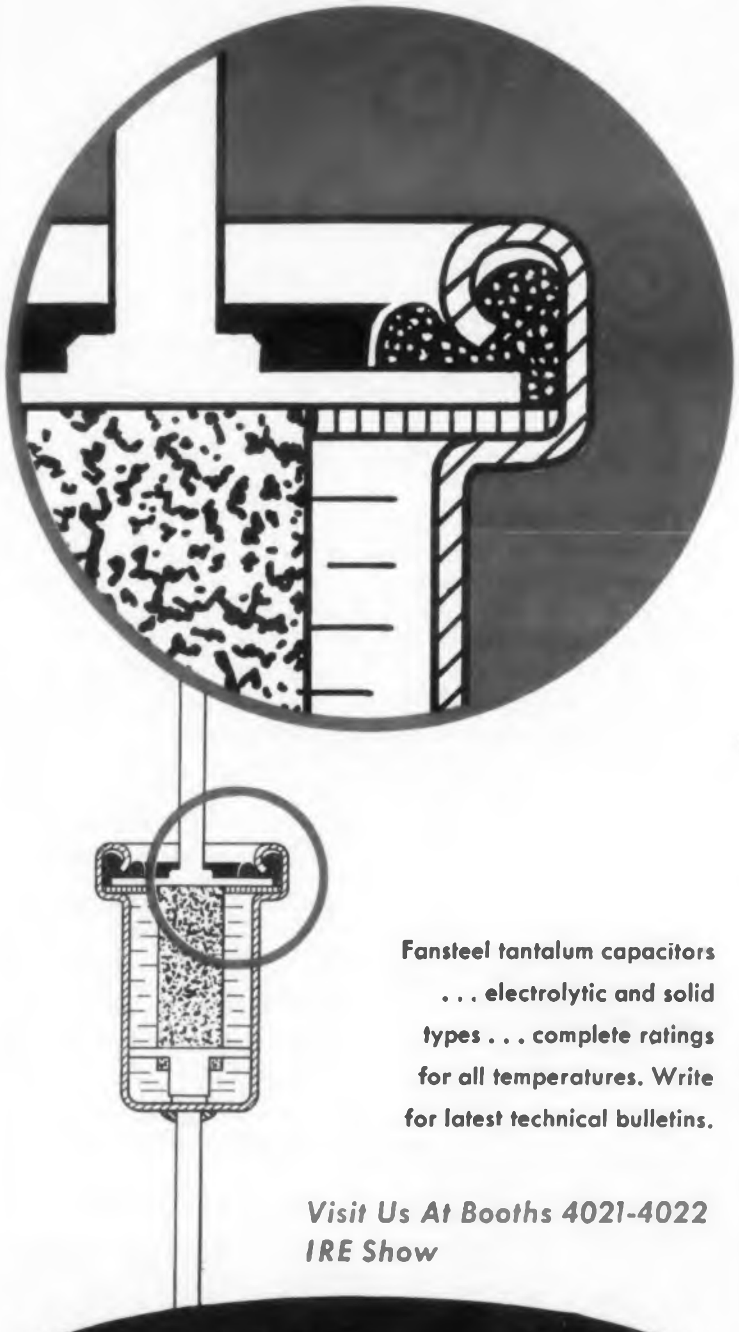
Little John, a surface-to-surface missile. It is scheduled to enter production this year. Other surface-to-surface weapons already in production under Army Supervision are the Corporal, Sergeant, LaCrosse and Honest John.

Three air defense missiles under Army responsibility are now in production. They are the Hawk, Nike Ajax, and Nike Hercules.

Go-Ahead Decision Made on Joint Communications Net for Military

A policy decision to integrate the military's upper-echelon communications system has been taken. So far the Defense Department has decided where it wants to go in organizing its world-wide telecommunications, but it has not mapped out the route for getting there.

Traffic load of the new system apparently



would be only a fraction of total military communications. Only long-distance high-level communications would be involved. The proposed all-Service communications net would get down as far as, but not below, a field army. The great bulk of military communications is handled at lower levels. These would be affected only indirectly, if at all, by the superimposition of the new agency.

Apparently, inter-service politics is still working against the eventual establishment of the new communications agency as an operating entity. The Army at first urged that its Signal Corps be given the huge communications job as a single manager. This met with opposition from both Navy and Air Force. The independent communications agency has the earmarks of being a barely acceptable compromise—individual services will continue to control communications terminals, subject to over-riding priorities of use to be laid down by the new agency.

One goal of the new group will be to avoid duplication of research projects.

300 KW Average Power Delivered By 150-pound VHF Tube

Producing a 5-meg pulse of vhf power, type A-2346 super-power triode is reported the most powerful electron tube in its frequency range. Under development at RCA's Lancaster, Pa., plant, the tube is one of a family of super-power tubes designed by the Electron Tube Div.

Even more impressive than the multi-meg peak power is the average power output of 300 kw, which the company says, is generated by the 17-inch high, 14-inch diameter tube. This figure results from the 0.06 duty cycle at which the 2 millisecond pulse is generated.

Developmental super-power triode generates a 5-meg pulse of vhf power. Rated at 300 kw average, the tube is reported the most powerful in this frequency band.

Technical Education Assailed As Deaf to Industry Needs

"Schizophrenic" and "split-level" were among the labels pinned on technical education by speakers at the Control System Engineering Education Symposium in New York.

Too much to learn, too little time to learn it in and a failure to recognize the specific needs of industry were cited as the main reasons for the current shortage of adequately trained personnel.

Educators complained about the vague boundaries between professional and semi-professional requirements and between technicians and skilled workers. There was much doubt as to what type of education and educational institution would fill the need in each area.

'Over-Promoting' Charged

Some educators accused industry of "over-promoting" technicians and then complaining about a shortage. "A good technician is often promoted to engineer but continues doing laboratory work," the head of one technical institute said. "Some personnel man studies the figures and decides that there's a shortage of technicians because engineers are doing lab work."

Speakers included Lloyd Slater, head of the Foundation for Instrument Education and Research; Prof. Henry Summer of Auburn University, and Prof. John G. Truxal of Brooklyn Polytechnic Institute. Over 200 delegates representing education and industry attended.

Industry spokesmen, on the other hand, complained that the technical schools were turning out "TV repairmen, mostly."

As in many such conferences, the most valuable interchange of ideas came during the coffee-klatches with day's speakers.

"In view of the rapid growth of technology," Prof. Summers commented, "the only thing we can teach are fundamentals. Equip the student with the capacity to learn the minutae of his industry after graduation."

The symposium was the first in a series on education planned and sponsored by Servo Corp. of America.

Loran-C Found Precise At 1800 Miles for Ships

An experimental Loran-C navigation system has furnished position fixes of "fantastic" accuracy for ships at daytime ranges up to 1800 nautical mi, according to a report to the Office of Naval

Research. At night the range of accuracy extended to 2300 mi.

The system is an outgrowth of Loran developed during World War II and currently used by ships and transoceanic aircraft to determine their positions.

The principle is the same. Radio pulses are transmitted by strategically situated radio stations known as "master" and "slave" stations. The pulses are synchronized by a timing signal generated at the master station and transmitted to the slaves. With special receiver equipment aboard ships or aircraft, the navigator measures the time lag between the radio signals of three or more stations, giving him an accurate fix.

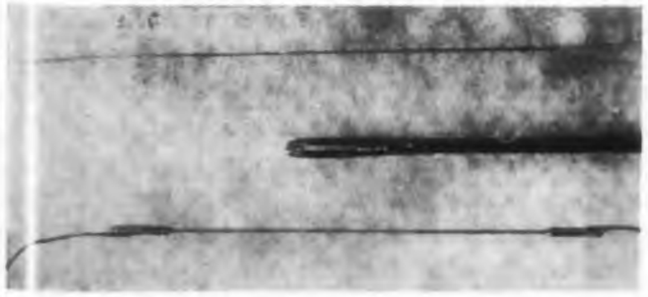
The major advantage of the new system is its use of low frequency. Conventional Loran operates at about 2 mc. Loran-C transmits at about 100 kc. Low-frequency transmission makes it possible to synchronize much more widely separated master-slave pairs. Low frequency also allows transmission of signals over large land masses, extending service to areas that cannot be covered by conventional Loran.

Jansky & Bailey, Inc., independent consultants of Washington, studied the Loran-C installations at Coast Guard stations in Massachusetts, North Carolina and Florida and reported the results to the Navy.

Using the North Carolina station as the master and Massachusetts and Florida stations as slaves, Jansky & Bailey bounced off the ionosphere. At points 900 mi from the most distant of the transmitters, 95 per cent of the fixes were found accurate to within 800 ft of the correct geographical position.

Silicon Strain-Gage Elements Said To Have High Sensitivity

Silicon strain-sensing elements claimed to be 50 times more sensitive than metallic strain wires have been produced by Electro-Optical Systems, Inc. Top element is a vapor-grown silicon whisker with leads attached. Bottom element is a sliver of silicon that has been lapped and etched. The company says the ultimate gauge factor is 175 for the low-impedance elements, shown here with a needle for size comparison. Metallic elements are said to have a gauge factor less than 5.



ADVERTISEMENT

Higher-Temperature Capacitors:

New Dielectric Materials Help Break the Heat Barrier

By Marc F. Warmuth, Staff Engineer, Airborne Accessories Corporation

Special Mylar*, Teflon† and mica constructions permit continuous operation up to 600°F

Three new types of special high-temperature motor-starting capacitors, utilizing Mylar, Teflon and mica dielectric respectively, have been developed recently by Airborne. The Mylar and Teflon types are wound of very thin metallized film for greatest possible miniaturization. The mica type is wound of a sandwich of aluminum foil and thin, pure mica ribbon, metallized mica not being procurable. All are encapsulated with thermoplastic polyamide or thermosetting epoxy resins (depending on temperature range) in sealed, cold-drawn steel cans with fused glass terminals. This construction provides low inductance units of exceptional mechanical sturdiness and environmental resistance.

As an alternate construction for less demanding applications, encapsulation in epoxy sleeves, with leads brought out through potted ends, is also available.

Mica for highest temperatures

The great advantage of mica as a dielectric is its ability to maintain its physical and electrical characteristics at temperatures up to 1000°F. All dielectric materials undergo severe reductions in insulation resistance at high temperatures, but with mica the critical value is reached around 600°F. Full voltage ratings up to this point are thus permitted. And with the right epoxy resin impregnant, mica capacitors are well able to withstand overtemperatures without damage . . . if not simultaneously subjected to full rated voltages.

Mica capacitors are three to four times larger than Mylar or Teflon units of comparable capacitance and voltage rating. This is because a greater thickness of dielectric must be used, as well as a separate layer of aluminum foil.

Mylar and Teflon for intermediate high temperatures and small size

Mylar can be worked continuously up to 300°F (derated to 250°F for a-c applications) and Teflon up to 400°F. For applications below these limits, but above the normal 185°F limit of more conventional insulating materials, metallized Mylar and Teflon offer high dielectric strength. They make possible wound capacitors of very small size with good voltage ratings and excellent capacitance-to-volume ratios.

A further advantage of metallized Mylar and Teflon capacitors is their self-healing characteristic. The short occurring when the dielectric is ruptured instantly burns the thin metallic coating back from the edges of the rupture, making further flashover impossible. Yet the amount of metallic coating burned away is so minute that hundreds of such self-healings have little effect on capacitance. Resistance to overvoltages can thus be considered excellent. Resistance to over*temperatures*, on the other hand, is not an outstanding characteristic of Mylar or Teflon—a design factor to keep in mind.

Summary

MYLAR: For intermediate high temperatures, high voltage and smallest size. Continuous operation at 300°F with ratings up to 1000 WVDC. Capacitance variation with temperature good, but not as good as that of Teflon or mica types.

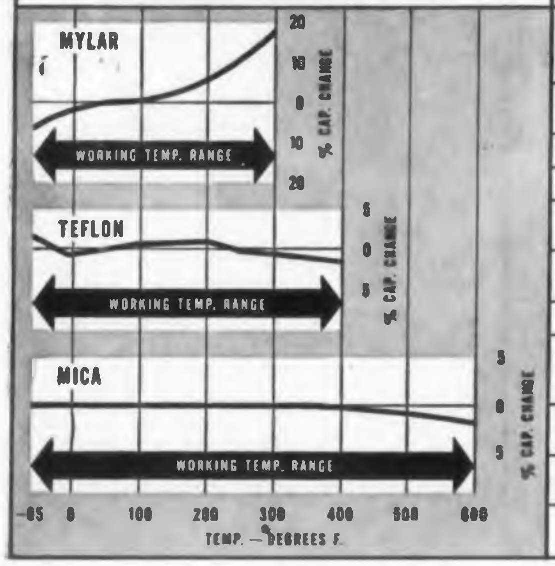
TEFLON: For intermediate high temperatures and small size. 600 WVDC up to 400°F without derating.

MICA: For highest temperatures. Continuous operation, 600 WVDC without derating up to 600°F. Higher temperatures possible with derating. Larger in size than equivalent Mylar or Teflon capacitors.

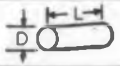
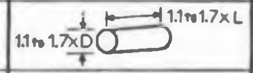
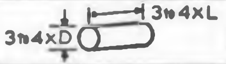
For further information, request Product Bulletin PS-6A from AIRBORNE ACCESSORIES CORPORATION, Marketing Dept., HILLSIDE 5, N.J.

**DuPont's tm for its polyester film*
†DuPont's tm for its tetrafluoroethylene resin

CAPACITANCE VARIATION WITH TEMP.



TABULATED CHARACTERISTICS—AIRBORNE SPECIAL HIGH-TEMPERATURE CAPACITORS

TYPE	MYLAR Wound, Metallized Mylar Film	TEFLON Wound, Metallized Teflon Film	MICA Wound Alum. Foil with Mica Ribbon
Working temp. range	–65 to + 300°F (–55 to + 150°C)	–65 to + 400°F (–55 to + 205°C)	–65 to + 600°F (–55 to + 315°C)
Voltage ratings	200–1000 WVDC	200–600 WVDC	200–600 WVDC
Capacitance range	.01 mfd up	.01 mfd up	.01 mfd up
Capacitance variation with temp.	Very good to 150°F Good 150–300°F	Excellent to 250°F Very good 250–400°F	Excellent to 350°F Very good 350–600°F
Insulation resistance	50,000 meg x mfd at 78°F 10 meg x mfd at 257°F	500,000 meg x mfd at 78°F 75 meg x mfd at 300°F	10,000 meg x mfd at 78°F 4 meg x mfd at 600°F
Dielectric strength	4000 v/mil	1500 v/mil	1000 v/mil
Size	 L D	 1.1 to 1.7×L 1.1 to 1.7×D	 3 to 4×L 3 to 4×D
Capacitance change vs time at max. working temp.	–5% or less after 250 hr	–5% or less after 250 hr	–5% or less after 250 hr
Overvoltage resistance	Excellent (Self-healing)	Excellent (Self-healing)	Non-self-healing
Short-time exposure to overtemperature	Poor	Poor	Very good with derating

CIRCLE 22 ON READER-SERVICE CARD

NEWS BRIEFS . . .

. . . **TUNNEL DIODE SAMPLES** for use at vhf frequencies are available from the transistor division of Standard Telephones and Cables, Ltd., Footscray, England. These are believed the first sample tunnel diodes available from European sources.

. . . **A 900-SAMPLE-PER-SEC** commutating switch has been developed by Instrument Development Laboratories, Inc. The high-speed switch, installed in ICBM's that were test-fired as far as 6,300 mi, samples temperature and passes the data in serialized form to a telemetering system. The system transmits the signals at 900 samples per sec over a single umbilical cable to ground recording equipment.

. . . **A $4.3-MILLION CONTRACT** to extend range and high-altitude capabilities of the Sparrow III missile has been awarded to Raytheon Co. by the Bureau of Naval Weapons.

. . . **THE COAST GUARD** has awarded Texas Instruments, Inc., a contract for 138 strip chart recorders and related components for use in Loran-C systems.

. . . **AN/ANP-130 DOPPLER RADAR** navigation sets, spares, support equipment, and engineering support items will be produced by Ryan Aeronautical Co., under a $5.9-million contract from the Navy.

. . . **THE SOLID-STATE 7080** large-scale business computer recently announced by IBM has a 109-μsec rate of data transfer between tape units and main storage, a reading or writing rate of 312,500 bits per sec, and a main storage capacity of 160,000 bits. A basic 7080 system will sell for about $2.3 million.

. . . **A COST-REDUCTION** conference held at Eclipse-Pioneer of Teterboro, N.J., covered the methods and techniques that trimmed $3,166,400 from the direct cost of instrumenting the supersonic fighter-bomber, the F-105.

. . . **A REVOLUTIONARY** automobile ignition system being developed by a major electronics company would use microwave energy as the igniting agent. In this system, the ignition coil and condenser, distributor and timing drive, high-voltage wires and spark plugs would be replaced by a microwave pulser, waveguides and foolproof timing pickup. The microwave energy would ignite the combustible mixture in the cylinders of engines equipped with the system.

CIRCLE 23 ON READER-SERVICE CARD ▸

CHANGES IN PRICES AND AVAILABILITY

. . . **SILICON TRANSISTORS** of the 2N1024-2N1038 series have been reduced in price up to 27 per cent by Sperry Rand Corp. Price reductions include the 2N1025, 2N1028 and 2N1469 (formerly the 2N1026A), which represent the first silicon mil-type pnp transistors offered to the industry.

. . . **LOW-POWER ROTARY SWITCHES** are in factory stock at Oak Manufacturing Co. Consisting of 125 types, the stock switches are offered as completely assembled units or as subassemblies. They are available in quantities from 1 to 249 units.

. . . **LECTROFILM B TUBULAR CAPACITORS** have been increased in price from 21 to 25 per cent by General Electric Co. The increase was made necessary by manufacturing controls and testing standards required for the "high reliability" of the line, according to GE.

. . . **GLASS RODS** for fabrication of electron guns have been reduced in price by Mansol Ceramics Co. They are now available in round, square, D-shape and triangular cross-sections. The Mansol rods are ready for jigging and assembly to components of the gun structure upon delivery.

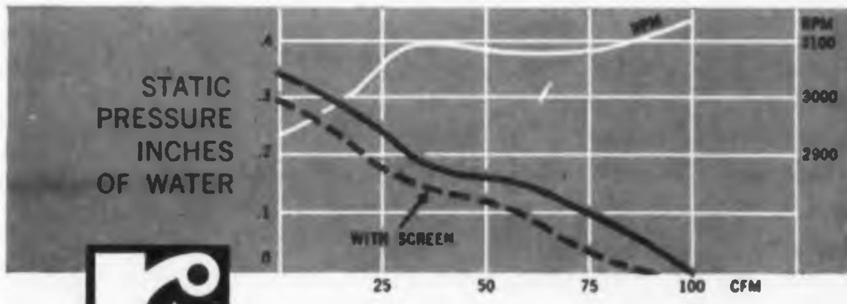
. . . **DIFFUSED SILICON TRANSISTORS** have been reduced in price across the board by Fairchild Semiconductor Corp. Typical of the revised prices are the 2N696 and 2N697 all-purpose npn units, reduced from $28.50 to $22.70 in 1-99 quantities.

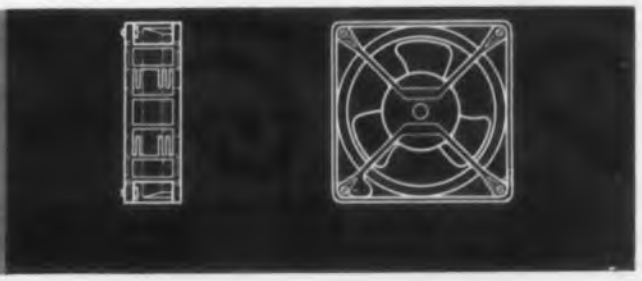
. . . **LOW BORON MAGNESIUM** oxide has been reduced in price by International Minerals & Chemical Corp. It is now available at $155 a ton in bulk and $160 a ton in bagged carloads, 30 tons minimum. Former prices were $235 a ton in bulk and $240 in bagged carloads.

. . . **METALLIZED GLASS RESISTORS** (LPI units) have been reduced in price by Corning Glass Works. Lowest unit prices for the resistors have been made available on orders of 10,000 pieces, instead of 25,000. Price changes on per-thousand basis, applicable to 3,000-ohm LPI in quantities of 10,000 are as follows: LPI-3, was $58.50, now is $53; LPI-4 was $61, now $54; LPI-5, was $66, now $55, and LPI-7, was $66, now $59.

Is your company making changes in prices or availability of its products? Send the details to *ELECTRONIC DESIGN*, 830 Third Ave., New York 22, N.Y.

CIRCLE 23 ON READER-SERVICE CARD





An overflow audience turned out to hear Dr. Leo Esaki and other panel members discuss tunnel-diode applications. While specific applications were not outlined, the panel agreed that computers and communication equipment would soon be fitted with the Esaki device.

Wide Application of Esaki Diode Near,

Experts Tell Solid-State Conference

ENGINEERS from over the world heard specialists at the 1960 Solid-State Circuits Conference report that wide application of the Esaki (tunnel) diode is imminent. Only a little more design work and quantity production of the device are needed, the experts said.

Major computer manufacturers confirmed the existence of crash programs to develop Esaki diode circuits. Both large and small companies revealed top-priority projects to apply the diode to communication and microwave equipment. And several large companies discussed practical circuits.

But for circuit engineers, the question was, "Transistors or Esaki diodes?" Designers appear to be in the same position they were in a decade ago, when the transistor made its debut. Then they asked, "Tubes or transistors?" Some stayed with "proved" circuits, others adopted the transistor and changed the character of the industry.

Today designers familiar with standard solid-state technology, are trying to adjust to new concepts forced on them by the Esaki diode: negative resistance, ultra-high speeds and ultra-low power consumption.

Interest in the diode is so great that it dominated the solid-state conference.

More than 3,100 engineers and physicists from the United States, Japan, Great Britain, the Netherlands and Hungary were drawn to Philadelphia for the conference. Ten of the 43 prepared papers and the two most heavily attended informal evening discussions were devoted entirely to the characteristics of the Esaki diode and recent pioneering applications.

Thin magnetic films, digital logic and information-storage techniques, high-frequency amplification and solid-state advances in microelectronics rounded out the program.

Diode Talks Draw Crowds

Over 2,500 engineers—some skeptical, others eager—crowded the opening session. G. C. Dacey of Bell Laboratories reviewed the essential properties of the Esaki diode, with minimum reference to quantum mechanics. The diode's negative: resistance characteristic, equivalent circuit, and its potential uses were outlined.

Dr. J. J. Tieman, researcher of General Electric, followed with a discussion of various relaxation oscillators and frequency dividers that use the Esaki diode.

M. H. Lewin, of RCA Laboratories, described application of Esaki diodes to achieve basic logic functions. Dc-powered bi-stable operation with unconditional reset, monostable operation and clock-pulse operation were cited in computer applications.

M. E. Hines of Bell described possible high-frequency operation with small-spot and narrow-strip diodes for capacitance reduction. He told of a microwave oscillator operating at 3,000 mc, using signals coupled on a coaxial line. By increasing coupling, Mr. Hines said, oscillation can be prevented and amplification achieved. To separate input and output, a circulator may be used, he added.

An rf amplifier, with 30-db gain at 200 mc was discussed by E. Miller of RCA. An interesting characteristic of the amplifier, he said, is its decreasing gain as input signal is increased, caused by decreasing negative resistance as rf input is applied to the diode. The noise figure was said to be better than 4 db.

Semiconductor Growth Outlined

At the conference's formal opening, Dr. C. Guy Suits, GE's director of research, referred to the staggering growth of the semiconductor industry. In the last decade, he reported, the U.S. semiconductor market—diodes and transistors; not radios or equipment using these components—has doubled every year. An annual figure of $500 million is forecast for 1960.

More than 10,000 scientists are engaged in world efforts to achieve greater solid-state developments, Dr. Suits said. He reported that 66 per cent of world research was done by four countries—Soviet Union, 24 per cent; U.S., 21 per cent; Great Britain, 11 per cent, and Japan, 10 per cent. In the last seven years, solid-state research has increased by a factor of 2.5, the speaker noted.

Dr. Suits indicated that the recent Soviet announcement of polymeric transistors might be an error, since the published technical reports describing the material did not point to a suitable device. However, he envisioned such possibilities in the near future through increased efforts by organic chemists in leading companies.

Finally Dr. Suits mentioned GE's gallium arsenide tunnel diode, recently announced, with oscillation obtainable at 10,000 mc.

European Efforts Described

Prof. M. J. O. Strutt of the Swiss Federal Institute of Technology outlined solid-state research in Europe. Since most European countries do not sponsor extensive programs, as is common in the U.S., Professor Strutt said, they cannot hope to achieve the rapid and wide progress reached here. Secrecy among countries, he said, precludes a combined European research program.

As the conference concluded, it was apparent that visitors had been impressed with the quality of the papers, the distribution of fully detailed abstracts in advance of talks, and the well-attended, active discussion sessions.

Copies of the "Digest of Technical Papers," are available at $5 a copy from H. G. Sparks, the Moore School of Electrical Engineering, University of Pennsylvania, 200 S. 33d St., Philadelphia 4, Pa.

The Panel Sessions— A Report to Designers

A group of *ELECTRONIC DESIGN* editors attended the key panel sessions at the Solid-State Circuits Conference. Here are their seven reports.

TUNNEL DIODE APPLICATIONS:

Low-Noise Amplifiers, Computers May Use New Esaki Device

Panel members discussing tunnel-diode applications at the solid-state conference became slightly peeved after numerous questions aimed at pinning down exact frequency limits, switching speeds and circuit configurations for the Esaki diode. The experts conceded they had no precise answers at present.

However, in view of the high-speed switching capabilities of the device—speeds of 10^{-12} sec theoretically—most specialists agreed that the device would find initial widespread use in computer equipment. Three-phase pulse-clock systems, hybrid-T arrangements and other configurations are under investigation to achieve unilateralization, the conference heard.

A Bell Laboratories scientist presented details

of a 4.5-kmc amplifier using a germanium Esaki diode with a peak current of 1.1 ma and a peak-to-valley ratio of 2.5. Stable power gain of 25 db was achieved, he said, with a noise figure of 8.4 db, and additional work is expected to reduce the noise figure to a value closer to the theoretical level of 5.5 db. The bandwidth was measured as 20 mc, and the diode capacitance was estimated to be about 2 μμf. The power output, with linear gain, was reported as only 1 μw, representing a swing of about 3 per cent of the negative resistance region.

MAGNETIC LOGIC

All-Magnetic Logic Challenges Semiconductor Systems

Better core materials were the principal topic at the magnetic logic panel session. The obvious advantages of an all-magnetic logic—no diodes, transistors or other active elements—have made it an industry-wide design goal. In practice, however, magnetic elements of considerable output are needed to drive succeeding logic stages.

Those attending the session were unanimous in expressing their requirements for higher-energy materials.

But, as one delegate noted, "magnetic properties under various conditions are not well-known; we are still in the pot-mixing stage." Since properties often cannot be predicted in advance, delegates reported that much of their time was devoted to trial-and-error work.

Even so, the prevailing attitude was one of general optimism. On a cost and reliability basis, all-magnetic logic was seen competitive with transistorized and diode-core logic systems in lower speed applications. Speed is presently limited to 1 mc, but films and thin-rolled sheets were mentioned as possible entries in the high-speed derby.

Do-It-Yourself Logic Kit Possible

Designers predicted wide application of all-magnetic logic in special-purpose computers. Modular logic packages would be readily combined for a wide variety of logic functions. Do-it-yourself kits of integrated logic packages would permit assembly of special computers directly from system logic diagrams. The time lag between logic design and a working circuit would be sharply reduced.

"Logic designers never did worry much about transistor circuitry," was one comment, "and now they won't have to."

The general optimism of the session was only somewhat dampened when the subject of microminiaturization was raised. With available and foreseeable magnetic materials, the energy to drive complex, self-powered logic systems requires cores of appreciable size. Not only does power output fall off with size, but the fine connecting wires in microminiaturized arrays would reduce available power still further. Nevertheless intelligent design and the inherently simpler circuitry of all-magnetic logic can make size competitive with other systems, it was brought out.

Bell Labs Shows Miniature Register

To illustrate, Bell Laboratories displayed a working model of a 10-bit, all-core shift register of approximately 1 cu in. Available power permits considerable fan-out, and other integrated logic units are being designed on a similar scale.

For the cost-conscious, news of rolled-sheet panels being developed by RCA at Princeton was particularly welcome. Thin Permalloy sheet is being applied to a base material, and cores are etched out. Printed wiring is then applied to the cores. Since this method is particularly suited to automatic production, cost could be a small fraction of that possible with wired ferrite cores.

The panel moderator, D. C. Engelbart, described work in progress at the Stanford Research Institute. Much of the pioneering work in all-magnetic logic was performed there and an experimental computer employing MAD (Multiple Aperture Device) magnetic elements is being built under joint Government and commercial sponsorship.

Bits from the Conference

"Help stamp out klystrons" was proposed by J. B. Angell of Philco as a battle cry for transistor designers trying to boost power and frequency. He thought it in much better taste than the "Help stamp out transistors" line of the early Fifties. Transistors are being stamped out even faster than automobile bodies these days.

* * *

Overheard between panel sessions: "Tunnel diodes? Most people can't even design a decent transistor circuit—what are they going to do with this monster?"

* * *

Are engineers plumbers? IBM Zurich Laboratories are awash in research on hydraulic computers, conferees heard. Hydraulic memory and logic systems could operate card punches and other low-speed, high-power systems directly. Components are said to be reasonably small, and speeds "considerably in excess of 100 cycles per sec" are hinted at.

* * *

Someone must be trying to lure Dr. Esaki away from IBM. Recruiting folders passed out by a major semiconductor company had covers printed in Japanese. The translation was "Opportunity." But no sake was poured at the various hospitality suites.

The Air Force was reported doing tailspins over gallium arsenide tunnel diodes. While still tricky for transistors, it looks to be just the thing for high-temperature tunnel diodes.

* * *

What's missing . . . missing . . . missing . . . from radar receivers? If it's parametric amplifiers, you'll never know. According to Dana Atchley of Microwave Associates, improvement with paramps was so slight that operators had to be told the device was in the line. High-quality receivers were involved in these tests, but the improvement in input noise from 9 db to 1-1/2 or 3 db, believed possible with parametric amplifiers, is strictly academic.

* * *

Tunnel-diode enthusiasts predict a new generation of "real cheap" communications equipment, going to 1,000 mc. "With tunnel diodes and printed strip conductors," one said, "we can turn out hf equipment at the same price we're getting for the 100-mc units."

* * *

When it comes to atomic radiation, the tunnel diode is said to be a glutton for punishment. Good prospects are seen for nuclear instrumentation amplifier application. Some designers think the Esaki device could be modified to detect radiation.

STORAGE TECHNIQUES

Magnetics and Speed Problems Noted

"Magnetism is one of the very few things Nature gives us without charge," the moderator of a solid-state conference panel, J. A. Rajchman of

RCA Princeton, commented. But a lively, sometimes heated discussion that followed showed that the practical application of this gift to computers involved design headaches.

Nevertheless ideas and developments reviewed at the session portrayed magnetics as the storage workhorse of today and the designer's best bet for tomorrow. Optical and electrostatic storage methods were, for the most part, devalued by those attending.

Interest in the well-known but little-applied technique of cross-field magnetization was renewed by the announcement of Burrough's Fluxlox. This device, now in advanced development, uses standard ferrite cores in which cross-field magnetization is said to result in a non-destructive, high-speed memory. Fluxlox developers noted that only at higher speed is the cross-field effect readily apparent and its application feasible.

Delegates agreed that much exploratory work and research into new techniques and effects were needed. Certainly cross-field data in many a laboratory are due for a second, closer look.

Ferrite Plate Memories Considered

Ferrite plate memories also came in for a good deal of attention. In such memories, the usual array of cores is replaced by a thin, perforated ferrite sheet. Microsecond switching times and low cost were reported. This technique would seem ideal for miniaturization and automated production. Bell Laboratories and RCA are among those actively developing ferrite sheet units.

High-speed developments attracted much interest and criticism, the latter primarily because of high cost. Many designers, however, said final unit cost should be an incidental consideration in R&D.

"If you're going to consider money," said one, "you'll never begin anything." This view was generally held by those whose projects were in the early stages of development. It was opposed, quite naturally, by designers whose work was within sight of the production line.

Accent on Speed Questioned

Though switching speeds on the order of millimicroseconds were reported for thin films and even cores, some designers challenged the practical applications of such devices.

"Sure it's fast, but you can feed what's left of the core through a sieve," was one doubtful observation.

A more telling point was scored by those who noted that the delay in peripheral equipment and connecting wires exceeded that of many core arrays already in use. Others questioned the capacity possible in a millimicrosecond memory whose switching time approached the time r quired for light to travel only 1 ft. One possi solution to this problem would be the disper of small, high-speed memories within a lar computer.

Discussion also centered on papers read b panel members at the general sessions. Subjec covered included tunnel-diode memories, s millimicrosecond core memories using multip coincidence read-write and multiple apert cores, and a fast, non-destructive memory wi two cores per bit developed by the United Kin dom Royal Radar Establishment.

PARAMETRIC APPLICATIONS

Harmonic Generators Held Key to Extension of Solid-State HF Limits

In a conference room shaped like a long wa guide section, the application of solid-state d vices to parametric amplifiers was discussed in spirited, informal way.

The use of varactors in parametric amplifie is saddled with a variety of problems, it beca obvious during the session. Speakers noted th the desire for an all-solid-state microwave pa metric amplifier, independent of electron-tu pump sources, had led to experiments with h monic generators.

H. Hsu of General Electric discussed selecti of the best nonlinear device for a frequency m tiplication job. While a first-order nonlinearity preferred for other applications, a higher-ord nonlinearity is more suited for harmonic gene tors, he said. Since oscillators drop off as frequen becomes higher, he went on, the use of a h monic generator is expected to extend the upp frequency limit of solid-state sources.

Solid State T-R Devices Proved Successful

Varactor solid-state T-R tubes were mention as a very promising area of application. Su devices, it was said, have been used successfu at 900 mc in protecting detectors from as mu as 20 kw. Insertion loss of less than 2 db reported achieved, and even lower figures anticipated. Such devices require a very high for the higher frequencies and are presently li ited to rather short pulses, the panel brought o

Protection against tremendously large tra mitter power can be achieved, it was said, by tiny device, since the device does not absorb the power but passes it, acting as a short-circuit. Robert Rider of Bell Laboratories mentioned that varactors had withstood 100-amp surge current.

Ferrites Found Disappointing

Ferrites were described by A. Berk of Hughes as a general disappointment so far. One type of ferrite parametric amplifier uses reasonably low power, he said, but does not work very well. Another type works very nicely, but requires 1-kw pump power. This was essentially the status a year ago. Progress since then has been nil, Mr. Berk said. Several laboratories have abandoned work on these devices, he noted, while several others have cut back their effort drastically.

Paramps Improve Pulse Radar Systems

How effective are parametric amplifiers when inserted in the input of a pulse radar system? Two views were put forward. Two "parametricians" cited cases in which input noise in S-band radars was cut from about 9 db to 3.5 db in one case and to 1.5 db in the other, with a corresponding increase in range of 20 per cent. Dana Atchley of Microwave Associates tagged such an improvement in radar as almost academic. His experience was that operators had to be told that the improvement was achieved before they could detect the difference. In radar, it can only be proved by photographs or careful measurement, he said, adding that this was not the case in radio-astronomy, where every db counts.

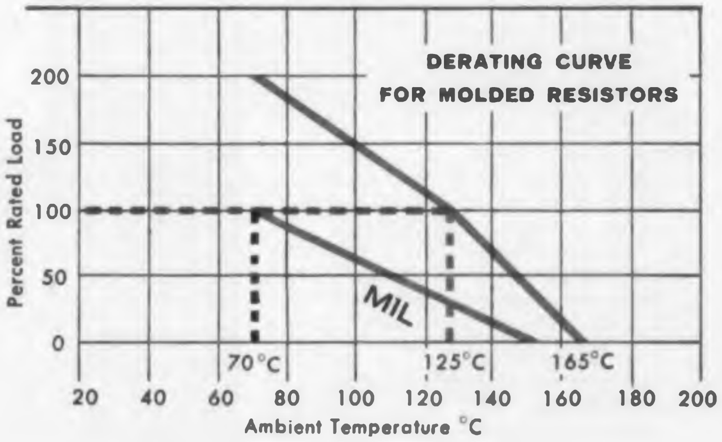
HIGH-FREQUENCY AMPLIFICATION AND GENERATING

Rises Predicted In Transistor Power And Frequency

High-frequency, solid-state components now showing promise for the circuit designer were discussed by a panel at the solid-state conference.

Researchers present expected that the power-handling capability of the "injection triode," or transistor, would be considerably increased by new fabricating techniques and materials. In fact, J. B. Angell of Philco Corp. and the panel moderator predicted that transistors would soon be replacing klystrons in the 10-kmc, 10-20-mw range.

With the fabrication methods to come, transistor frequencies approaching 50 kmc (at a liquid nitrogen ambient temperature) were anticipated. New advances were also expected in the fabrication and use of the field-effect transistor (which depends on the motion of only one type of car-



this standing wave amplifier defies comparison

FEATURES:

- A new low in noise levels — down to 0.007 µv providing 0.02 µv full scale sensitivity at minimum bandwidth.
- 5 db steps
- Attenuation range of 85 db
- FOUR regular VSWR scales plus one expanded
- All meter scales automatically normalized when switching ranges
- Large 5¾" meter with 1% linearity
- Continuous gain control over 15 db range
- Continuously variable bandwidth control
- Front panel meter monitors bolometer bias current

SPECIFICATIONS:

Frequency: 1,000 cps; adjustable over a 2% range.

Sensitivity: 0.02 µv at minimum (4 cps) bandwidth. 0.1 µv at maximum (40 cps) bandwidth.

Noise Level: 5db below full scale (0.007 µv at minimum bandwidth).

Amplifier Q: 250 at 4 cps; 25 at 40 cps.

Bandwidth: Continuously variable from 4 to 40 cps.

Calibration: Square Law. Meter reads SWR, db.

Range: 85 db. Input attenuator provides 70 db in 5 db steps. Gain control provides 15 db adjustable. Accuracy ±0.1 db per 10 db. Maximum cumulative error of ±0.2 db at 40 cps bandwidth.

Scale Selector: Expanded, Regular, and Bolometer Current. Meter scale always normalized when switching from scale to scale or from expanded to regular.

Meter Scales: SWR: 1-4; SWR: 1.8-6; SWR: 3.2-10; SWR: 6-15; Expanded SWR: 1-1.3; db: 0-10; Expanded db: 0-2.3.

Input Selector: 220,000 ohms; Crystal: Bolometer. Bias provided for high 8.4 ma bolometer or 4.3 ma low current bolometer. Bias adjustable ±15%. A bolometer protective circuit permits any switching operation or cable connect-disconnect without damage to bolometer.

Output: Jack for 1500 ohm recorder. 1 ma full scale deflection.

Input Connector: BNC Jack.

Power: 115/230 v ±10%, 50-60 cps, 40 watts.

Dimensions: Cabinet: 7¾" wide, 10½" high, 11" deep.

Weight: 14 lbs. net.

See the PRD 277-B Standing Wave Amplifier at the I.R.E. Show— Booths 3602-3604-3606.

The new portable PRD 277-B Standing Wave Amplifier is designed to meet the present and future needs of microwave test laboratories. Due to its extremely low inherent noise, 0.007 µv, weak signals which once were undetectable by conventional instruments can now be measured. Attenuation in 5 db steps combined with 4 VSWR scales and a large meter permit VSWR measurements to be made with maximum resolution and accuracy.

To find out more about the new PRD 277-B Standing Wave Amplifier, contact your local PRD representative or phone, write, or wire:

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.
Factory and General Office: 202 Tillary St., Brooklyn 1, N.Y., ULster 2-6800
Western Sales Office: 2639 So. La Cienega Blvd., Los Angeles 34, Calif., UPton 0-1940

CIRCLE 29 ON READER-SERVICE CARD

rier); the analog transistor, or spacistor (essentially a field-effect unit); the Read diode (a form of avalanche diode), and the diffusion-delay diode.

Gallium arsenide and indium antimonide were named as two materials appearing to have very interesting and fruitful possibilities. The Esaki diode, panel members felt, would eventually operate at frequencies of up to 100 kmc. However, no one would discuss the feasibility of designing this device into a practical circuit.

Varactor Amplifier Figures Cited

Concerning linear amplification, it was felt that designs would soon be capable of achieving 30 db of gain at 100 mc. Present gain limits were placed at 20 db at 100 mc and 5 db at 200 mc. The variable capacitor amplifier was said to surpass the transistor amplifier by at least a gain factor of 10. For low-noise amplification, the variable reactance amplifier was described as best.

Sample figures for currently designed reactance amplifiers were given as: 2 kmc at 1-3 db noise, 6 kmc at 3-5 db noise and 10 kmc at 5-10 db noise.

Also reported was a harmonic generator circuit furnishing a power level of 5 mw at a frequency of 2.3 kmc. This was a fifth harmonic and had only 4.5 db attenuation. Reports of other harmonic amplifiers noted power levels of 2.4 w at 20 mc with 0.8 db loss, and 1 w at 400 mc with 1.6 db loss.

THIN FILMS FOR MEMORY

Production Problems of Layers Cited

Thin magnetic films, which may one day replace ferrite cores in computer memories, are today posing some rather severe production problems. Chief among these is how to make an array of thin-film spots and be sure that every spot is good.

Conferees at a panel session of the solid-state conference agreed that thin films could provide very fast read-write cycle times—of less than 1 µsec—and that they had less power dissipation and were simpler and more compact than ferrite cores. But beyond this, the panelists appeared to "agree to disagree."

Where one advocated that film arrays be made by vapor deposition followed by photoetching, another suggested electroplating followed by photoetching.

Where one proposed an oxygen-free atmosphere during film production, another argued that oxygen doesn't bother the films at all.

But all agreed that—however they are made—thin films pose problems. The chances of producing a good thin-film spot on a substrate are very high, it was said. With very uniform substrates and films, yields of 90 per cent were reported.

But a 90 per cent yield is not adequate when a plate of 2,500 spots per sq in. is to be produced, the panel reported. One bad spot can make the plane useless.

One approach advocated for this problem is to mount two planes back to back. Then, with a 90 per cent yield per plane, chances are excellent that a perfect array will result—that at each position there will be at least one good spot.

MICROELECTRONICS

Reliability Top Concern of Specialist

"Do we have standards of reliability?" asked an observer at a microelectronics session of the solid-state conference. "No," the panel agreed. "We must have a product before we can establish standards."

Perhaps improved system reliability would be best achieved by redundancy, one panel member suggested. The smaller size of microminiature circuits lend themselves to duplication as a "spare" in the event of failure, he noted.

The objectives of microminiaturization were given as reliability, low cost and simpler components. One panelist pointed out that reliability and cost were closely allied.

"We can reduce cost," he said, "by reducing the number of interconnections. Thus we also achieve greater reliability. Simplicity resulting from the solid-circuit approach should result in increased reliability."

Panel members were divided on the best approach to microminiaturization—the circuit assembled of conventional components or the solid circuit. Practical solid circuits, several panel members contended, are still many years away. However, a spokesman for Texas Instruments reported that TI had developed working practical computer circuits for four customers.

Solid-circuit researchers, namely Westinghouse and Texas Instruments, feel that their best chance of a profitable course is to limit their objectives, the panel was told. In other words, the companies agree that they cannot extend themselves in every area. At present they are attacking computer circuitry, with more complex functional blocks as the next likely step. ■ ■

Enlargement of a high-resolution aerial photo of a Boston neighborhood was processed in part by CBS Laboratories Photoscan system. This photo is a 15-diam blow-up of a 2½-by-2½-in. negative. The negative was made with a special camera and film. The original film, with extremely high resolution was scanned by a line-scan tube to convert its information to an electrical signal. The signal was then played back over a "simulated data link" to provide the light beam that exposed the negative from which this photo was made. Resolution of the enlargement is on the order of 40 lines per mm.

Recon System Designed to Radio Photos Without Loss of Detail

An airborne visual reconnaissance system based on a new scanning tube and other improvements reportedly can telemeter photos without losing detail. When fully developed, the Photoscan system is expected to be capable of transmitting to viewers on the ground a 2-1/2-by-2-1/2-in. aerial photo with a resolution approaching 40 lines per mm. Transmission time would be less than 3 sec.

Heart of the system is a flying-spot line-scan tube of new design that scans at rates up to 20 kc. Also used is image enhancement in both vertical and horizontal directions, an electron gun built to extremely close tolerances, and a new photomultiplier tube.

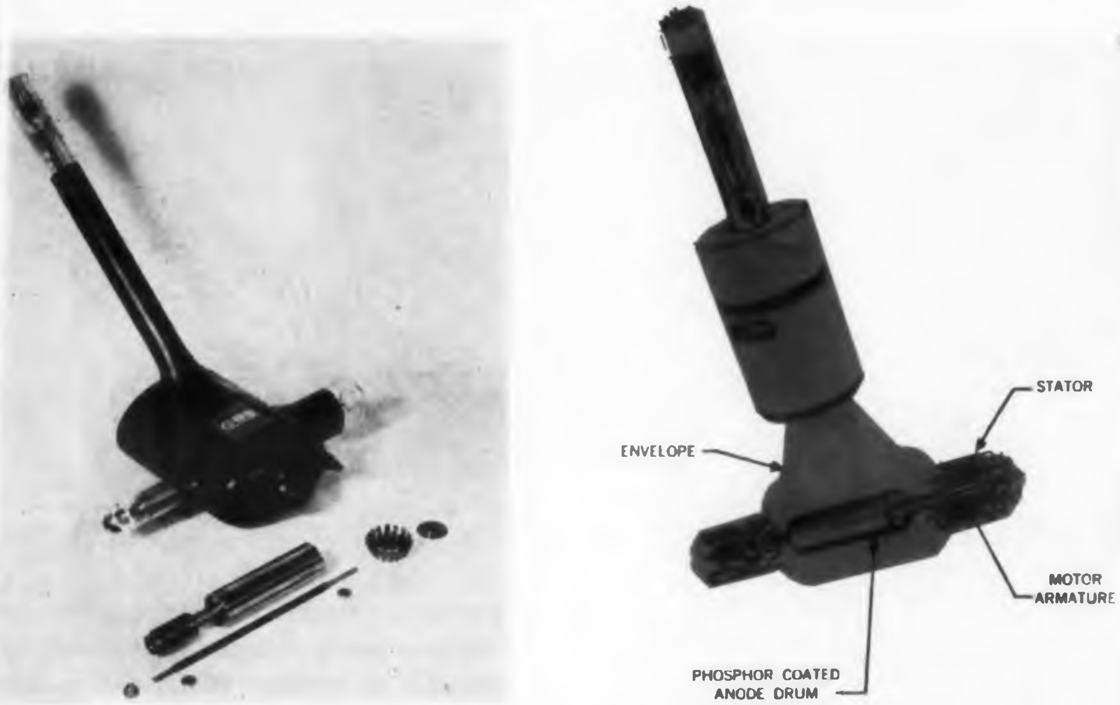
Photoscan is being developed by CBS Laboratories of Stamford, Conn.

The system operates this way:

Movie film exposed by an aerial camera is developed in seconds by a film processor and fed to a temporary storage unit to await scanning and transmission of its image.

The image is scanned by a flying spot focused through a lens that can be oscillated. Scanning can be done in two ways: with the film momentarily stopped and the horizontal and vertical scans provided by the flying spot and moving lens; or with the film moving and the two scans provided by the flying spot and the motion of the film.

Light from the flying spot passes through the film, after being modulated by the film's density, and is picked up by a photomultiplier. The electrical signal from the photomultiplier is fed to a



Line-scan tube on which Photoscan system is based has a phosphor-coated anode that rotates at 1,600 rpm to provide a high-density flying spot for scanning of film. Anode, shown disassembled in foreground, has a motor rotor on its shaft.

Encapsulated line-scan tube is a production version for military environments.

video amplifier and processor and finally goes to a transmitter.

At the receiving station, the process is reversed. The video signal is processed in an amplifier, sync separator and enhancement circuitry. The signal modulates another line-scan tube that generates a spot, which exposes film. The film is rapidly processed and sent to a viewer.

Airborne Components Lightweight

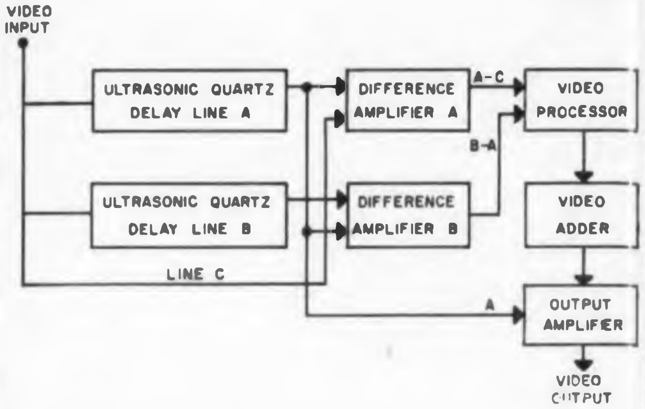
CBS reports that the airborne components weigh less than 100 lb, including making camera, film processor and transmitting equipment rugged to specifications. Total power drain is about 100 w. An aircraft's standard wideband telemetering equipment may be used for the transmissions. CBS is still experimenting with equipment and has not developed a prototype ground unit. Receptions are being handled by a special laboratory unit with duplicated circuits and components.

Scanner Has Rotating Anode

The flying-spot, line-scan tube is capable of generating a high-intensity, small-diameter spot of constant density. The tube has a rotating anode (see illustrations) driven by a motor within the tube envelope. CBS designers adopted a rotating anode to eliminate the phosphor burning that normally accompanies repetitive scanning of a single line.

To reduce irregularities in the phosphor surface, the phosphor is deposited electrically on the surface of the anode, which is a stainless steel drum. The drum is driven by a motor, the rotor of which is on the shaft of the drum and within the tube's glass envelope and vacuum. The rotor is powered by an external field that does not interfere with the normal fields of the tube. The stator is outside the vacuum.

Another advantage of a rotating anode, the designers report, is the fast dissipation of heat generated by the electron beam. Heat is dissipated over the entire drum volume.



Vertical aperture compensation circuit shows how signals for three scanning lines are processed to provide enhancement of final image. Equalizing signal representing the difference in information carried by adjoining scan lines is added to output. Video processor contains amplifying, compensating and other circuitry.

The drum rotates at 1,600 rpm, and its length is scanned by the spot in 0.00005 sec. If necessary, CBS says, the scanning rate can be pushed as high as 100 mc.

The tube's design places the spot of light on the same side of the phosphor as the electron gun. This direct generation of light on the phosphor surface makes it possible, according to the company, to operate the tube with such efficiency that halo effect caused by multiple reflections in the tube face is eliminated.

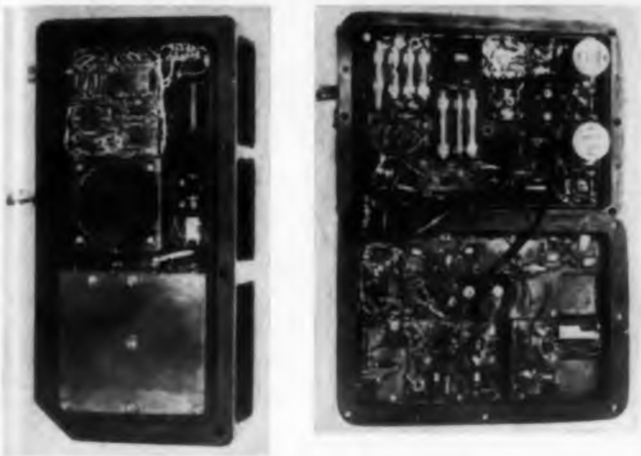
Peak power supply for the tube is 25,000 v at 100 μamp. Intensity of the electron beam is 100 μamp. Size of the spot on the phosphor is 1 circular mil. This spot eventually reaches the film surface as a spot 0.005 mm in diameter.

Standard and Novel Electronics Used

Standard electronics are used for most of the processing of the video signal that is to be transmitted. But while the signal is being amplified, and compensation and synchronization signals are added, an advanced type of gain control compensates for uneven film exposure across single frames and keeps the average signal level constant.

At the ground base the signal is reconstituted by more sophisticated techniques than can be used in the airborne equipment. Ground equipment applies vertical and horizontal aperture compensation, continuous and completely flexible gamma correction, highlight aperture compensation and crispening to the signal, which may vary in bandwidth from 1 to 10 mc.

Circuit designers have developed special ver-



Airborne components for Photoscan are miniaturized and made rugged. Total airborne package weighs less than 100 lb. Unit at left contains a high-gain video amplifier that provides phosphor-decay compensation and power supplies. It also houses a signal-level, controlled high-voltage source for the photomultiplier tube. At right is a completely solid-state synchronizing and scan generator. Silicon-jelly potting is used for insulation and for suppression of arcing.

tical aperture compensation techniques in Photoscan that provide enhancement for information that lies parallel to the scanning line. They believe the technique is adaptable to interlaced television.

The basic vertical aperture compensating circuit (see block diagram) processes three-line groups of adjacent scan lines. It uses the difference in information carried by two lines to generate an equalizing signal. Special ultrasonic quartz delay lines store individual lines of video information, so they can be compared.

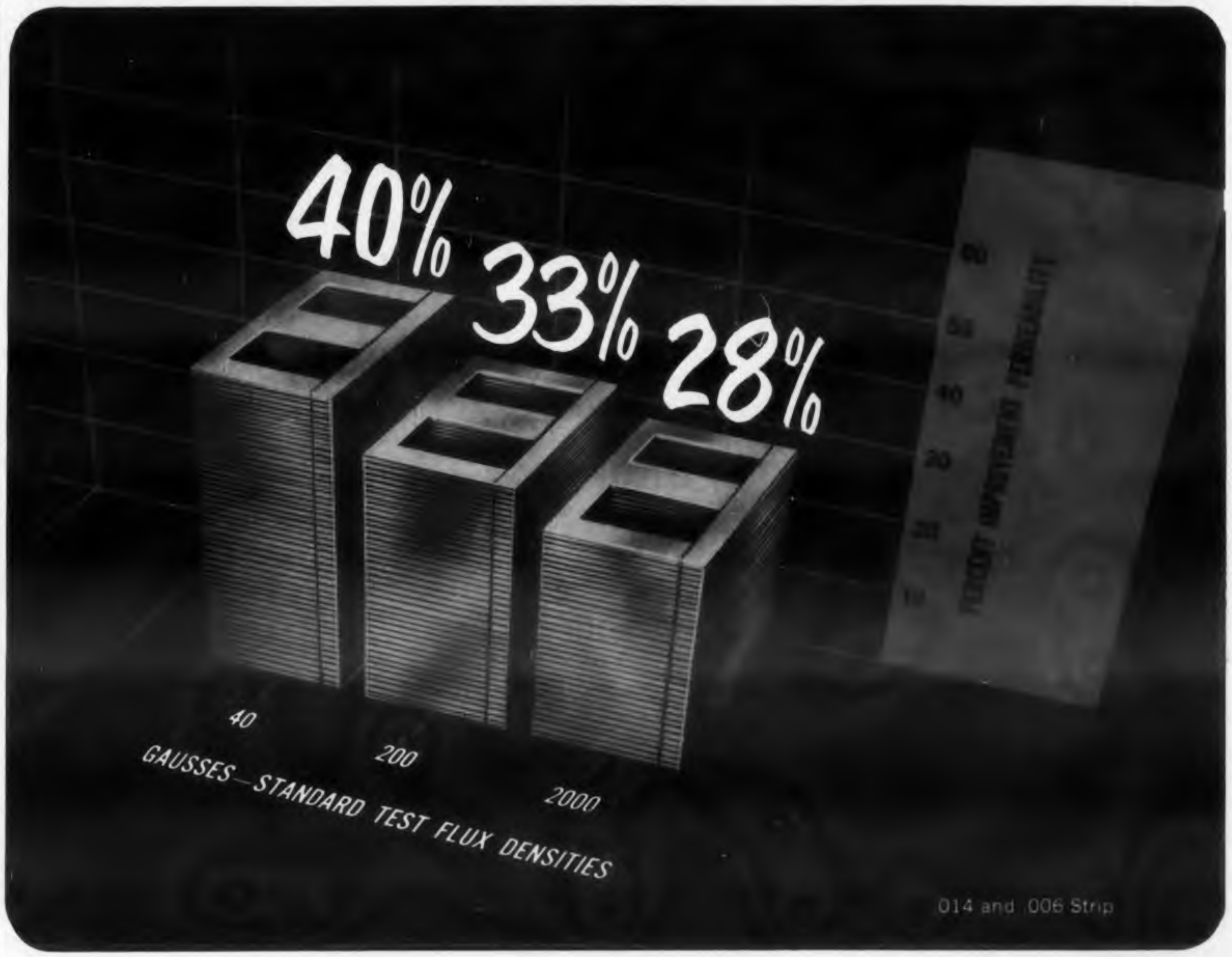
If an individual spot in a line overlaps a dark and a light area, its signal is adjusted to give the spot either the dark or light tone of its adjacent spots, thus providing enhanced edge contrast.

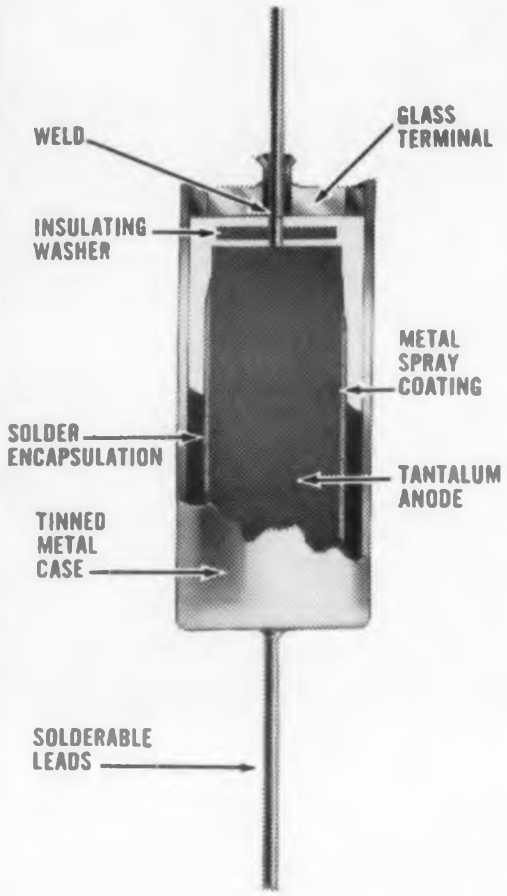
Electron Gun and Photomultiplier

The electron gun that generates the scanning beam has specially designed scanning and deflection coils mounted on the gun's glass tube, where they are aligned. The coils must be mounted externally to permit adjustment through the tube's encapsulation.

The photomultiplier tube developed for Photoscan has a dynode structure designed to reduce the transit time spread of the signal pulse. Because of the new structure, transit time spread in the tube is 2 to 3 μsec. This helps provide a bandwidth on the order of 3 to 5 x 10^8 cps.

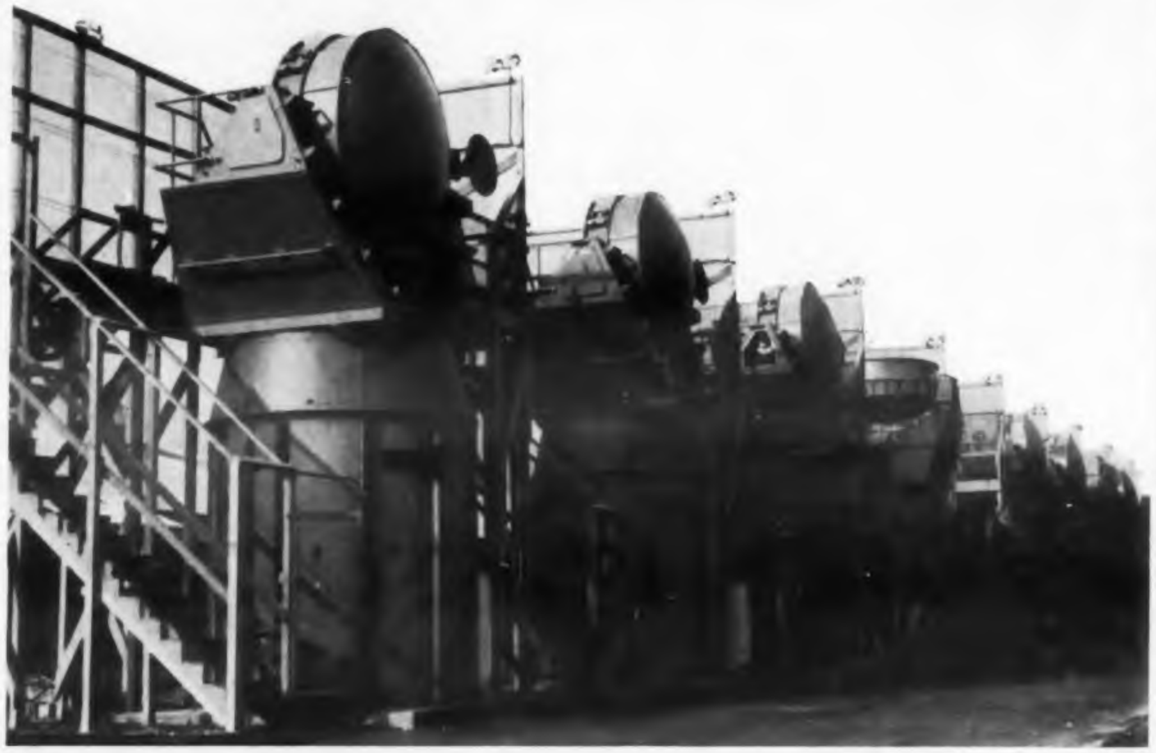
The company, which is developing the system under a military contract, has not disclosed which service is sponsoring the project. CBS Laboratories are known to be working on the Samos reconnaissance satellite program, however. ■ ■





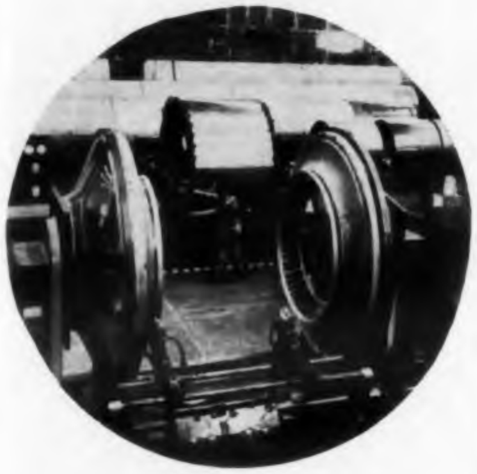
NEWS IN PICTURES

These spun aluminum bulkheads will be used in the 70-in. booster tanks to be used in the Saturn missile cluster. The 1,500,000-lb pound thrust booster in the Saturn booster is shown in production. Aluminum Co. of America is supplying aluminum for the tanks.



Guidance of the Navy's Terrier missile is the function of these nine SPG-55 radar installations now in operation at Sperry Gyroscope's plant at MacArthur Field, L.I., N.Y.

Results of static-firing tests for the Saturn booster will be recorded in this instrumentation room at the Army Ballistic Missile Agency, Huntsville, Ala. The room is in the agency's test laboratory blockhouse. The tape and strip-chart recorders that circle the room will be controlled by the master control panel in the center. The Saturn is being developed for the National Aeronautics and Space Administration.



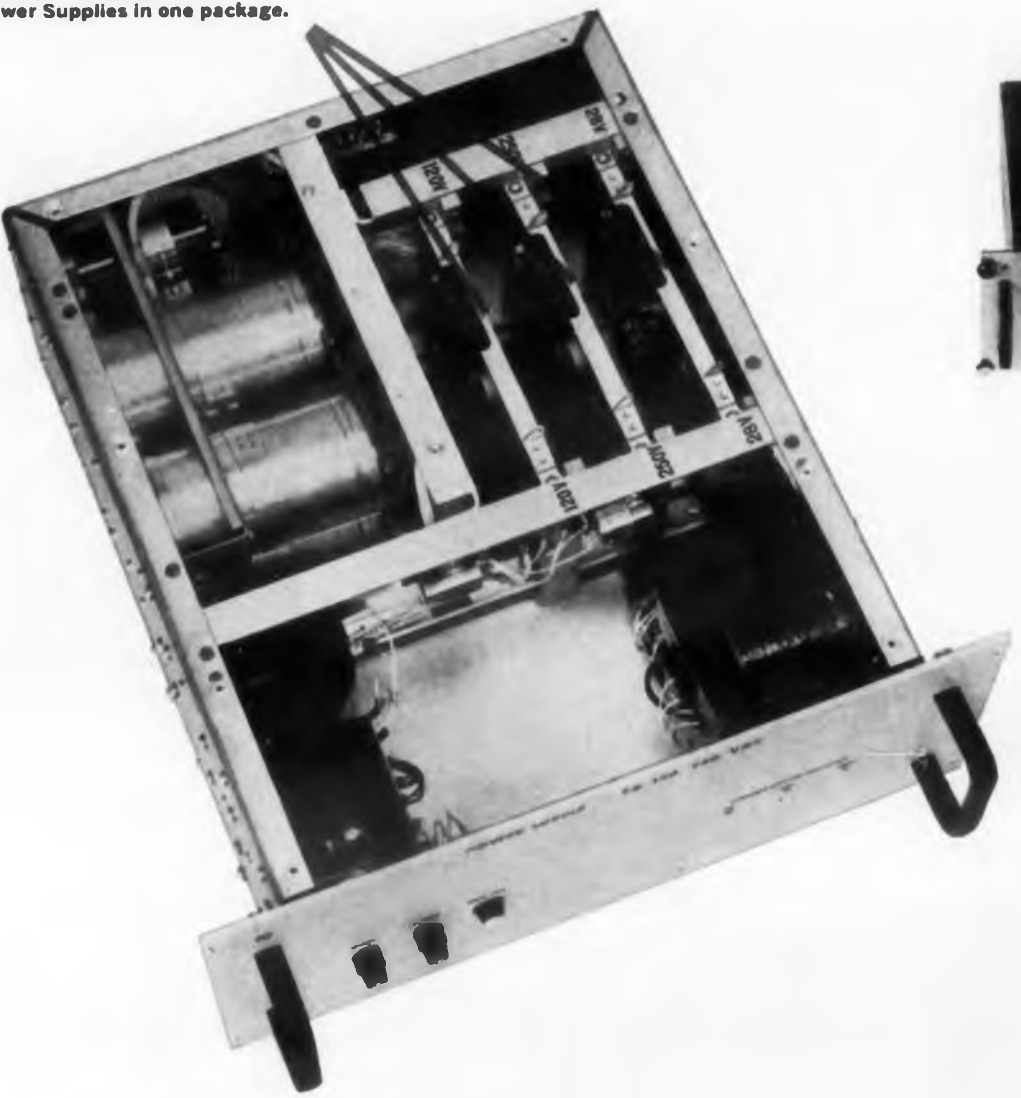
LOX tanks and other fuel tanks are shown under construction at Redstone Arsenal's fabrication and assembly engineering laboratory.

The skin for one of the 70-in. tanks in the Saturn booster is shown in production. Aluminum Co. of America is supplying aluminum for the tanks.

The 175-ft-high Saturn static test stand at Redstone Arsenal, Ala. The tower was used previously for Redstone and Jupiter tests.

CIRCLE 37 ON READER-SERVICE CARD ➤

Model pictured is a unique design, developed by Hydro-Aire Electronics for ground support equipment, which combines three AC/DC Power Supplies in one package.



Another *New* Hydro-Aire Product for the *Aircraft*, *Missile Support*, *Missile* and *Electronics* Industries

The AC/DC Power Supply shown is typical of many new electronic products being developed, engineered and produced by Hydro-Aire—a name well known for quality, reliability and fast delivery. The unit illustrated is one of a unique family of fixed voltage, transistorized, power supplies. Through unusual design, Hydro-Aire engineers have combined three power supplies into a single package. The same basic circuit allows regulated outputs over a wide range. Range is determined by selection of transistorized, printed circuit, plug-in modules.

Characteristics Model #50-121

Input: 120 ± 5 % VAC
Outputs: 28 VDC @ 2.5 amp; 120 VDC @ 250 ma;
250 VDC @ 500 ma
Regulation: ±0.1% for combined temperature, time and load variations
Temperature: −10°F to +125°F operating; −54°F to +165°F non-operating
Ripple: 5 millivolts RMS (maximum)
Size: 8¾ x 17 x 20 (for 19″ rack mounting)
Weight: approximately 70 lbs.

Write for Catalog Order your copy of our new Electronics catalog. It contains detailed facts, specifications. Send for your copy today—on your letterhead, please.

HYDRO-AIRE
BURBANK, CALIFORNIA
Division of CRANE CO

Solid state devices include time delay relays, voltage regulators, power supplies, inverters. Rotating components motors, tachometers, generators

PERFORATED
TAPE READER

new DYKOR® all-solid state photo-electric reader offers optimum reliability, faster stops and higher reading speeds...

For applications such as digital computers, machine tool control and tape conversion, the *fastest, most accurate* Tape Reader available is the unique DYKOR 3500. Built by pioneers in data processing technology, the 3500 provides *high reliability* at high tape speeds.

FEATURES...

- **STOPS FASTER**—Before the next character at 1,000 char./sec.
- **READS FASTER**—1,500 char./sec. (or faster if required).
- **RELIABILITY ASSURED**—By use of silicon photo-diodes, completely transistorized circuitry on etched circuit boards, simple integrated optical system with regulated lamp current.
- **VERSATILITY**—5, 6, 7 or 8-channel tapes handled interchangeably. Reads any standard tape material including oiled yellow Teletype paper.
- **SIMPLE HANDLING**—In-line load and unload.
- **CHOICE OF SINGLE OR DUAL SPEEDS.** Spooler unit available.

MODEL 4500—This DYKOR reel/strip Reader handles 8" or 10½" reels or strips interchangeably.

DIGITRONICS CORP.
103 Albertson Avenue ● Albertson, L. I., N. Y. ● Pioneer 7-5090

DIGITRONICS INVITES INQUIRIES FROM QUALIFIED ENGINEERS FAMILIAR WITH DIGITAL TECHNIQUES SOME TERRITORIES OPEN FOR REPRESENTATION

CIRCLE 38 ON READER-SERVICE CARD

An automatic transistor assembly system has been developed by International Business Machines Corp. Units of machine (clockwise from upper right): three turntables for loading collector dots, germanium disks and emitter dots into carbon cylinders, or "boats"; oven for alloying of parts; two turntables for positioning of base tabs and emitter wires; oven for bonding parts; turntable for positioning collector wire; and welding unit.

Miniature Assembly Line Producing 1,800 Computer Transistors Per Hr

A MINIATURE automatic assembly line is now turning out 1,800 computer transistors per hr.

International Business Machines Corp. has developed the assembly system. Its machine for doing the work has just completed successfully its first test-month of production.

The 500-sq-ft machine has nine units, joined by

Turntables of IBM's assembly system inject transistor parts into carbon boats for transport on system's conveyor. Photocell and mechanical devices at each turntable signal the machine to reject boats with missing or poorly positioned parts.

Plug and boat, shown being fitted together, serve to position and transport tiny parts through automatic transistor assembly system. Made of hard carbon, boats and plugs have tolerances as close as 0.0005 in. for precise positioning of transistor parts during alloying, bonding and welding.

conveyers. It automatically assembles six transistor parts. The machine is roughly five times faster than the semi-automatic assembly of transistors now in general use. It has by far the highest production rate of the few existing automatic methods, IBM reports.

Holding tolerances as close as 0.0005 in., the IBM machine is reported able to produce transistors of greater uniformity than those made by previous methods.

IBM's system is the first automatic means of making the npn alloy junction transistor, a basic component of the company's powerful computers. With modification, the system can produce any type of alloyed transistor. ■ ■

1,800 transistors per hr are produced by IBM's system. It is the first automated means of making the npn alloy junction transistor.

ST

IN
CUSTOM
POWER
EQUIPMENT

The Industrial Products Division of ITT offers a complete facility for custom airborne, ground, and ground-support power equipment and systems. Backed by the research, development, manufacturing, and technical experience of the worldwide International Telephone and Telegraph Corporation, we can package power equipment with built-in reliability to your exact requirements. Our complete engineering staff and environmental testing facilities enable us to supply reliable, high-quality units and systems, both quickly and at reasonable cost –

- DC Transformers
- T/R units
- Partial Systems
- Complete Systems
- High-voltage Supplies
- Inverters
- Magnetic Amplifiers
- Transistor-regulated Supplies

20-Amp Silicon T/R used on Chance-Vought F-8-U and Douglas A4D-2N

Launcher power supply for Lockheed's F-104 Starfighter

Static power unit for this nation's most advanced jet bomber.

Typical ITT Power Units. More than 50 different models of ITT power equipment are proving themselves in use every day.

THE LATEST IN STATIC POWER DESIGN

We have a complete line of fully qualified static power equipment, from 20 to 200 amps, in silicon or selenium. No moving parts. Long life – models up to 10,000 hours.

ITT provides power source for Convair's B-58 Hustler — a completely integrated electrical power system

Let us know your requirements . . . write, wire, or phone.

ITT **Industrial Products Division**
INTERNATIONAL TELEPHONE & TELEGRAPH CORPORATION
15191 Bledsoe St. • San Fernando, Calif.

REGIONAL OFFICES: NEW YORK (Lodi, N.J.), PRescott 3-1550, DALLAS, FLeetwood 1-4468
CHICAGO, LOng Beach 1-3936; LOS ANGELES (San Fernando), EMpire 7-6161

CIRCLE 39 ON READER-SERVICE CARD

PROVEN RELIABILITY—
SOLID-STATE POWER INVERTERS,
over 260,000 logged operational hours—
voltage-regulated, frequency-controlled,
for missile, telemeter, ground support,
135°C all-silicon units available now—

INTERELECTRONICS VOLTAGE REGULATED INTERVERTER POWER SUPPLY

Interelectronics all-silicon thyratron-like gating elements and cubic-grain toroidal magnetic components convert DC to any desired number of AC or DC outputs from 1 to 10,000 watts.

Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. High conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry.)

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards.)

Complies with MIL specs. for shock (100G 11 msc.), acceleration (100G 15 min.), vibration (100G 5 to 5,000 cps.), temperature (to 150 degrees C), RF noise (I-26600).

AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

Now in use in major missiles, powering telemeter transmitters, radar beacons, electronic equipment. Single and polyphase units now power airborne and marine missile gyros, synchros, servos, magnetic amplifiers.

Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how—has designed and delivered more working KVA than any other firm!

For complete engineering data, write Interelectronics today, or call LUdlow 4-6200 in New York.

INTERELECTRONICS CORP.
2432 Gr. Concourse, N. Y. 58, N. Y.
CIRCLE 40 ON READER-SERVICE CARD

Computer Tasks Vary at NBS

Laboratory Facilities Helping to Solve Problems Of Other Government Agencies

IBM 704 is used by NBS to tackle problems for other Government agencies. One project at this facility is the use of linear programing techniques in the selection of radio navigation frequencies for the Federal Aviation Agency.

COMPUTER solutions to problems of national interest, ranging from traffic jams to military strategy, are being sought by the National Bureau of Standards' Computation Laboratory.

Requests for assistance from Government agencies have led to the use of the NBS computation facilities for an odd assortment of tasks.

Battlefield strategy is the object of a war game, called Autotag, played on the Bureau's IBM 704. The "game" is designed to evaluate the performance of anti-armor weapons systems under varying conditions. Two "sides" are formed, each with up to 31 mine fields and artillery pieces. The results of ensuing battles are stored on computer tape for statistical analysis.

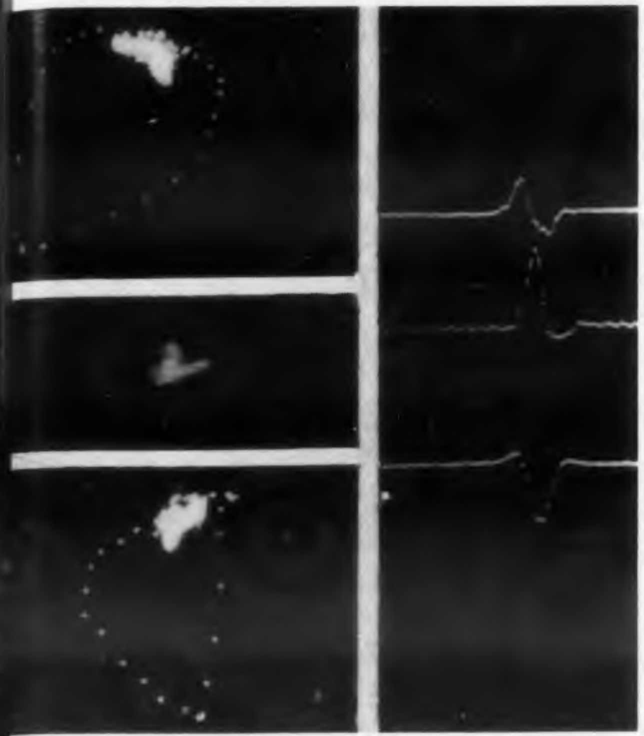
Equations to predict traffic patterns are being formulated in another study. These equations will be used by the Bureau of Public Roads for more effective highway design.

Some of the other computer tasks assigned to NBS are illustrated on these pages. ■ ■

Translation of Russian technical information into English is one of the continuing projects at NBS. Here Ida Rhodes of the bureau translates a sentence, showing how structure and syntax are included in translation methods. Clauses and phrases along with punctuation, rather than individual words, are analyzed and interpreted.

tems
are
d ar-
s are
lysis.
being
tions
s for

d to



igital techniques to study heartbeat data are being eveloped by NBS. It is hoped that these techniques ill improve procedures used in diagnosing various eart ailments. At left are oscilloscope traces of the , Y and Z components of a heart vector. Under present ethods, these are analyzed by two-dimensional proections of the space curve generated by the coordiate values, as shown at right. NBS is working on mahine methods for accomplishing this analysis.

nalog-to-digital converter to change heartbeat ata into digital form for analysis has been developed y the NBS Data Processing Systems Laboratory. Here r. H. L. Mason of the bureau watches Mrs. H. A. Pipberger, a medical technician from Georgetown Hospital, select a particular cardiac complex by monitorng oscilloscope signals.

Visit us at the IRE Show
March 21-24, 1960
Booths 2527-2531

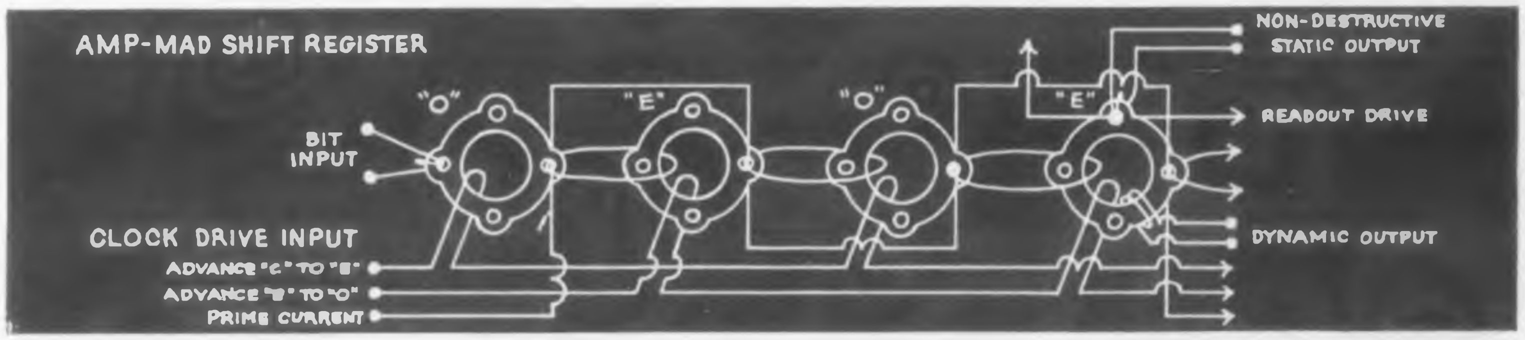
10 BIT REGISTER
ACTUAL SIZE

AMP INTRODUCES

A COMPLETELY NEW KIND OF SHIFT REGISTER USING MAGNETIC ELEMENTS ONLY...

Here is the first commercially available line of all-magnetic shift registers. Now you can have both non-destructive dynamic and static output in the same register. Now you can have the minimum number of components, the minimum number bit to bit interconnections and any serial/parallel input and output combination. Made with AMP multiaperture ferrite cores and copper wire only (see schematic below), the AMP Shift Register line has a number of other useful features:

● —40°C to +75°C temperature operating range
● minor aperture output level up to 100 mw at several volts
● immune to nuclear radiation
● small size—ideal for miniaturization requirements
● ultimate in reliability and simplification



For complete information, including operating data, send for our AMP-MAD Shift Register brochure.*

*Trade Mark

AMP INCORPORATED
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • West Germany

CIRCLE 41 ON READER-SERVICE CARD

INDUSTRO

KEEPS MOVING AHEAD!

DO YOU?

DIFFUSED SILICON MESA TRANSISTORS
GERMANIUM ALLOY JUNCTION TRANSISTORS
SILICON CONTROLLED RECTIFIERS
SILICON RECTIFIERS
TUNNEL DIODES

Associate yourself with Industro for new opportunities in professionally fulfilling, creative engineering.

PROCESS ENGINEERS: ***Minimum Requirements:***

Two years semiconductor manufacturing experience.

B.S. in Electrical Engineering or Physics.

The Assignment: Developing high yield techniques for premium quality semiconductors.

APPLICATIONS ENGINEERS: ***Minimum Requirements:***

Two years of circuit design related to semiconductor product testing and applications.

B.S. in Electrical Engineering.

The Assignment: Liaison with sales organization involving customer application problems.

QUALITY CONTROL ENGINEERS: ***Minimum Requirements:***

Two years experience in establishing and maintaining the highest standards of quality and inspection methods for all phases of semiconductor manufacturing. Must have thorough knowledge of Military Quality Assurance Specifications.

B.S. in Electrical or Industrial Engineering.

The Assignment: To insure that Industro semiconductors continue to remain at the highest levels of quality in the industry.

OUR ASSOCIATES ENJOY full fringe benefits, including stock options, hospitalization, group insurance . . . plus salaries fully commensurate with experience and ability.

Forward resumes or telephone:

MR. ARCHIE McDOUGALL, Executive Vice President

All inquiries will be completely confidential.

INDUSTRO TRANSISTOR CORPORATION

35-10 36th Avenue, Long Island City 6, N. Y.
EXeter 2-8000

CIRCLE 930 ON CAREER INQUIRY FORM, page 317

BMEWS Installation Provides Missile Surveillance

Radar System Being Completed Transmits Multimillion Watts, Receives Millimicromicrowatts

High-speed scanning switch for surveillance radar in the Air Force's Ballistic Missile Early Warning System is he being installed at an arctic site. The rotary switch, used to distribute transmitter power in the multimillion-watt rang to radar feedhorns, is inside a housing 21-ft in diameter and 16-ft high.

Duplexers to protect receivers in the BMEWS radar subsystem are tested in a resonant ring set up at General Electric Co.'s high power radar laboratory in Syracuse, N. Y.

BMEWS transmitter performance is checked General engineers. From these consoles, energy flow the 9-ft-high klystron tubes in the power amplifiers be precisely adjusted.

Antenna reflector towers over workman and bulldozer at Arctic BMEWS site. The reflectors are 165 ft high. The surface consists of 2,240 5-by-7-ft steel screen panels, each bolted to the truss structure. The reflectors are 400 ft wide. Transmitted pulses are directed at these antenna reflectors from 704 feed-horns. Each feedhorn must be set within 1/16-in. tolerance, so that the energy will bounce off the reflectors at the proper angle. To direct the rf energy from the transmitter to these reflectors, 21 mi of waveguides are required. Special construction problems had to be solved because of the high winds and low temperatures at the site.

Antenna reflector supports, each of 42-in. diam, are used with 1,500-ton reflectors that go with the BMEWS surveillance radar. Each of the reflectors has twenty of these supports. D. S. Kennedy Co. of Cohasset, Mass., produced the reflectors to the design requirements of General Electric Co. GE's Heavy Military Electronics Dept. received the subcontract for the radar subsystem from Radio Corp. of America, prime BMEWS contractor.

HERE'S WHY CENTRICORES ARE PROBABLY THE MOST CONSISTENTLY UNIFORM CORES YOU CAN BUY:

The exceptional uniformity you get in tape-wound Centricores is not easy to come by. It's the result of painstaking precision at every stage of the manufacturing process —and, in fact, *before* manufacturing. Three principal factors help produce Centricore uniformity:

Careful classification of materials—Raw alloys are first "pedigreed"—meticulously selected, then tested for some 14 parameters, and classified by magnetic properties. We're the largest buyer of nickel alloy magnetic materials in the world . . . which permits us to choose material for Centricores from an unusually wide distribution of magnetic properties.

Special winding machines—We build our own machines, to die-making tolerances, for winding magnetic alloy tape into cores. We also build our own machines for applying insulating coating to the tape. These machines give us far greater uniformity in dimensions, insulation and ultimate performance of Centricores.

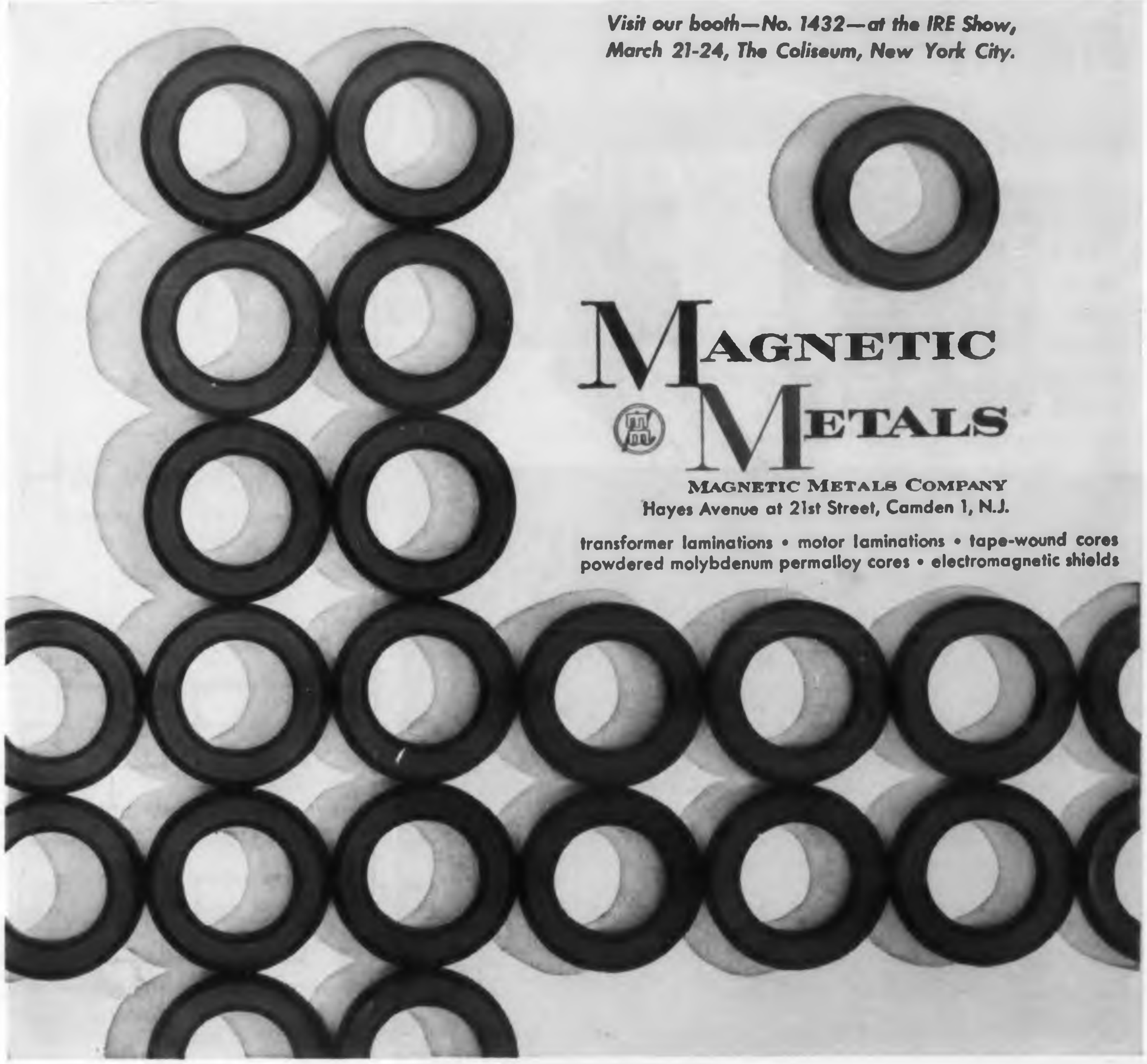
Closely-controlled annealing—Annealing—perhaps the most critical phase of the core-making process—is done under precisely regulated atmospheric and temperature stabilized conditions to hold Centricore magnetic performance to uniformly high levels.

Exceptional uniformity from core to core and lot to lot is further assured with Super Squaremu "79", a new high-performance alloy we've developed. It has outstanding magnetic qualities and is remarkably uniform in squareness, thermal stability and gain. Super Squaremu "79" offers an effective solution to problems of variation in magnetic performance.

WRITE FOR BULLETIN C-3

SIZE	MATERIAL	THICKNESS
1	HIGH NICKEL Hymu 80 Squaremu 79 Super Squaremu 79	.001"*
THRU	LOW NICKEL Squaremu 49 Carpenter 49	THRU
225	GRAIN-ORIENTED SILICON Crystaligned Microsil	.004*

**Special sizes, shapes and thicknesses quoted on request.*



Visit our booth—No. 1432—at the IRE Show, March 21-24, The Coliseum, New York City.

MAGNETIC METALS

MAGNETIC METALS COMPANY
Hayes Avenue at 21st Street, Camden 1, N.J.

transformer laminations • motor laminations • tape-wound cores
powdered molybdenum permalloy cores • electromagnetic shields

CIRCLE 43 ON READER-SERVICE CARD

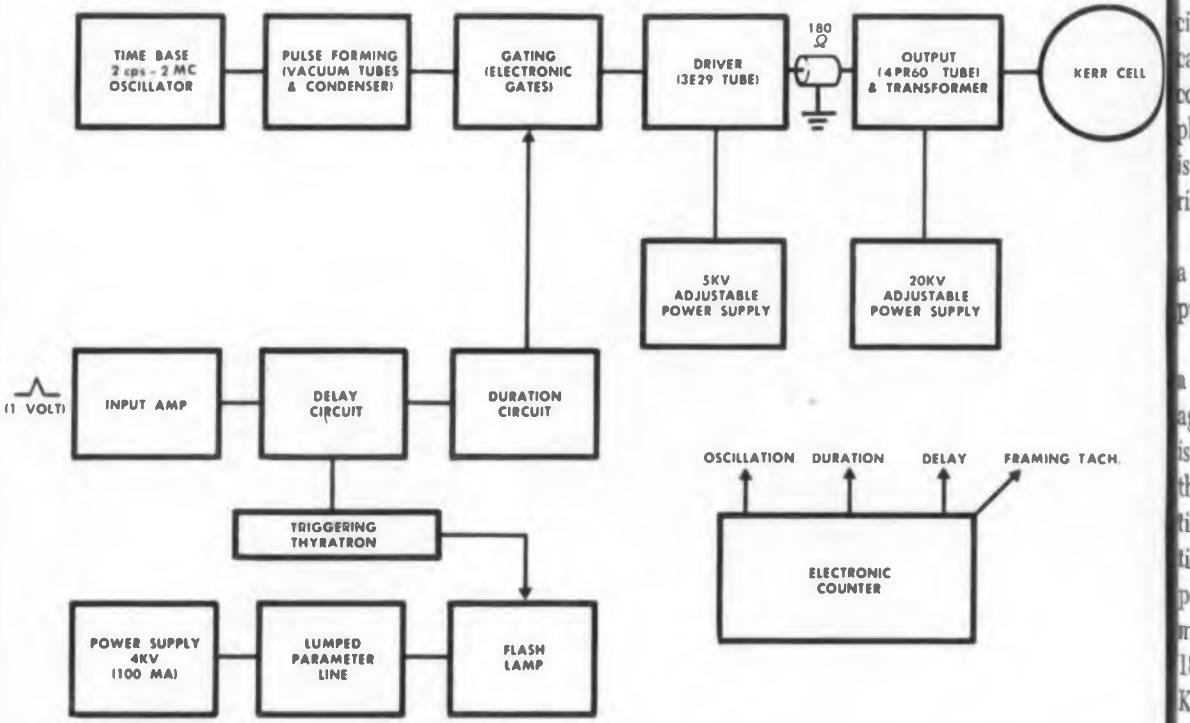
1.6 Million Pictures a Sec With New 35-Mm Camera

An ultra-high-speed camera has been developed to take from 480 pictures a sec to 1.6 million at exposures down to 0.05 μsec. With the system, photos can be taken of wire explosions, arc discharges, ultrasonic flow patterns and other high-speed phenomena.

The camera was originally designed by A. T. Ellis of the California Institute of Technology and is now being made in a commercial version by Benson-Lehner Corp., Santa Monica, Calif.

To achieve its high speeds, the camera has a mirror mounted on the shaft of an air-driven turbine rotating at 100,000 rpm. The mirror reflects images onto stationary 35-mm film, which can be either standard black-and-white or color.

Images are fed into the system by a Kerr-cell shutter activated and timed by a pulsing system. The shutter consists essentially of two polaroid filters, placed



Electronics of camera system provide timing, excitation and power supply. Kerr-cell shutter requires up to 18 kv and 20 amp for maximum generation of its field. Counter unit is optional.

ltra-high-speed camera set up to take avitation photos has four units: (from left) ghting control, camera control, flash lamp nd camera with circular film box. Film lies nside the periphery of the box, with emulsion acing a rotating mirror at the center axis. The nirror rotates at 100,000 rpm to flash images nto film, which does not move.

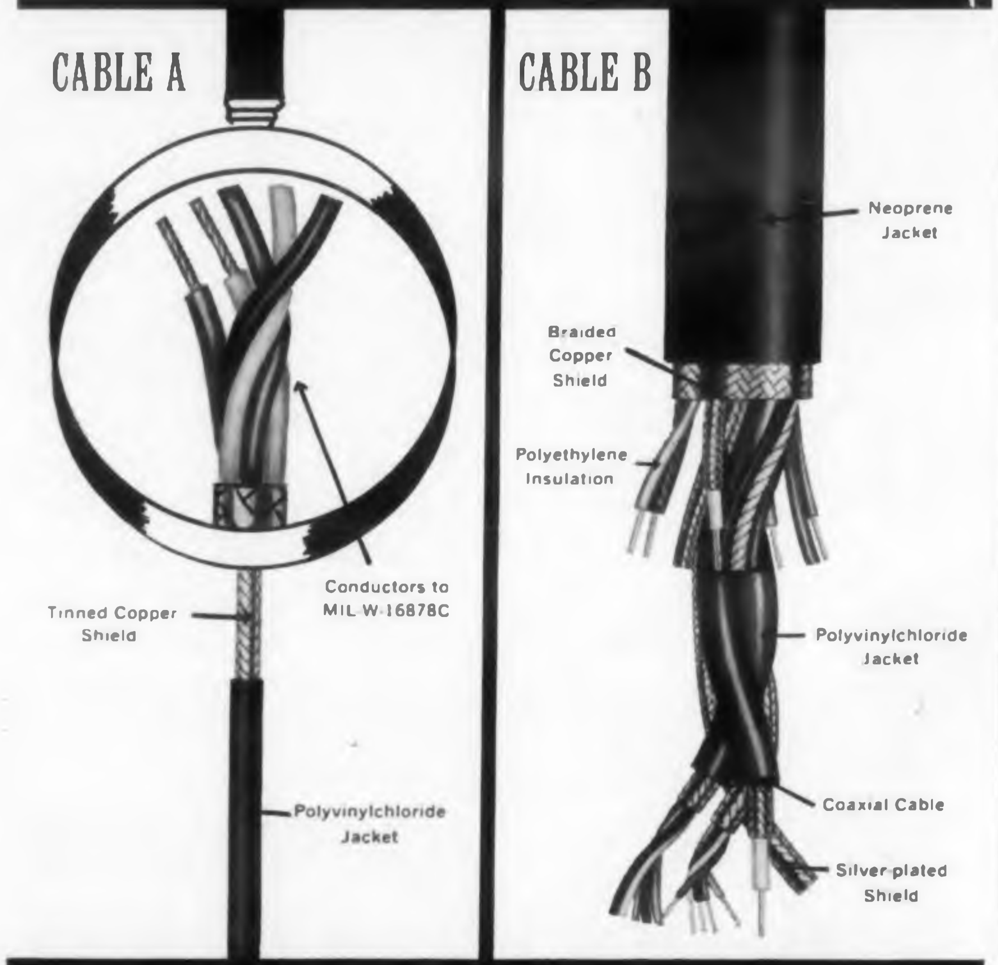
o block light, and a cell filled with itrobenzene. When an electrical field is pplied to the cell, its polarization vector s rotated 90 deg and light passes through he system.

The pulser includes a time-base oscillator that generates a spike-shaped wave with an amplitude of 25 v; frequency is djustable between 2 cps and 2 mc. The oscillator signal is fed to a pulse-forming circuit containing modulator tubes and capacitors. In this circuit the negative component of the wave is removed, amplitude is raised to 150 v, and the wave s integrated into a square pulse with a rise time of 2 μsec.

A gating circuit releases the signal into a driver, whence it goes to the final output stage and the Kerr-cell shutter.

Light transmission through the cell is a non-linear function of the applied voltage, and minimum effective exposure time is slightly less than half the rise time of the activating pulse. Benson-Lehner estimates that a minimum effective exposure time of about 0.02 μsec is theoretically possible with its Kerr-cell shutter. At maximum repetition rates, approximately 18 kv at 20 amp are used to generate the Kerr-cell field.

The system uses lighting equipment that provides 400,000,000 lumens for 3 msec. ■ ■



Optical Celestial Tracker Separates Moving Targets on 2-Color Screen

AN OPTICAL system for tracking objects in outer space is reported able to display moving-target information in one color against a background of stationary information in another color.

Called a celestial moving-target indicator by its developer, ACF Electronics of Paramus, N.J., the system is designed to satisfy "a requirement associated with satellite and missile tracking programs that cannot now be satisfied by any presently existing equipment."

How the Indicator Works

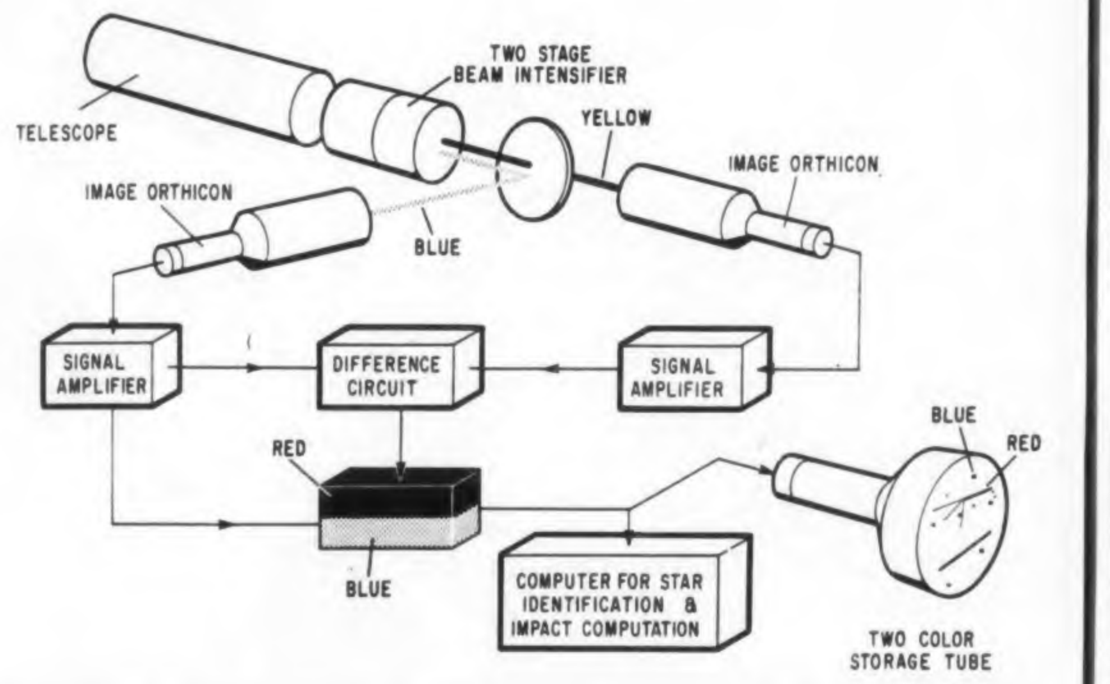
A telescope in the indicator views a sky field and directs the image onto a beam intensifier. The output stage of the intensifier is a P-7 phosphor screen of the type used by most radars and long-persistence scopes. Fixed objects in outer space fluoresce blue and phosphoresce yellow simultaneously on the screen, while moving objects phosphoresce yellow.

The blue-yellow light of fixed objects is separated and used to develop independent electrical signals. The signal from the yellow light contains position information on fixed and moving objects, while the signal from the blue light contains essentially only information on fixed objects.

A difference circuit compares the blue and yellow signals and yields a signal that describes the position of only the moving objects. This signal is combined with star reference material and displayed on a two-color crt. In practical use, ACF reports, the moving source can be represented in red, with the star background in blue.

The company reports that range is "thousands of miles" and that the unit can operate from the surface of the earth despite dust and other atmospheric interference. Best results, however, would be obtained from an orbiting platform, ACF says.

The technique is said to be applicable to the tracking of orbiting satellites, missiles carrying flash bombs, and to rockets during their boost phase. ■ ■



Indicator for tracking objects in space separates moving from fixed targets by color. System would give best results when operated outside earth's atmosphere.

Amateur Radio Pioneer Retires 'To Play with Amateur Radio'

John L. Reinartz, a pioneer in amateur radio, has retired from the Amateur Service Dept. of an electronics company—so he can have "more time to play with amateur radio."

Mr. Reinartz was lauded upon his retirement by prominent persons in the electronics industry and the military, including Herbert Hoover Jr. and Lt. Gen. Francis H. Griswold, vice commander of the Strategic Air Command.

Mr. Reinartz, who first theorized that short waves are reflected by the Heaviside layer of the atmosphere, holds 28 patents in radio communications with Radio Corp. of America and Eitel-McCullough, the corporation from which he is retiring.

In 1908, when he was 14 years old, Mr. Reinartz got interested in radio and built a station from scrap parts.

As radio grew, so did his enthusiasm and abilities. In 1923 he participated in the first two-way contact between points in the United States and Europe. When Richard Byrd attempted his first flight over the North Pole, he chose Mr. Reinartz to handle the expedition's communications.

During World War II Mr. Reinartz was a captain in the Navy and participated in communications and radar developments.

John Reinartz examines a modern transmitter

◄ CIRCLE 47 ON READER-SERVICE CARD

For more precise measurement of transients

Hughes MEMO-SCOPE® Oscilloscope

The new Hughes MEMO-SCOPE Oscilloscope offers you higher performance, greater dependability and easier operation in all of your transient measurements. Maximum accuracy is assured by new advanced circuitry, new panel layout, new mechanical design and many other added features.

The MEMO-SCOPE Oscilloscope eliminates expensive "hit-or-miss" methods of measuring non-recurring transients. It stores nonrepetitive events for an indefinite period—hours, or days—keeping them available for thorough study until intentionally erased.

For full information on how the MEMO-SCOPE Oscilloscope can help solve your measurement problems, write today to: Hughes, Industrial Systems Division, International Airport Station, Los Angeles 45, California.

For export information, please write: Hughes International, Culver City, California.

Hughes MEMO-SCOPE Oscilloscope: The Hughes MEMO-SCOPE Oscilloscope is one of the most versatile measuring and recording devices available to science and industry today. It is a dual service instrument—for storage or conventional oscilloscopy. Features: *simplified panel layout and carefully designed trigger circuit* for ease of operation; *built-in single sweep ("one-shot") trigger circuit* to avoid cluttered display; *advanced mechanical design* for better cooling and easier maintenance.

New Storage Tube Burn-Out Protection! A circuit designed to protect the delicate storage mesh surface is now incorporated in the Hughes MEMO-SCOPE Oscilloscope. This circuit renders it virtually impossible to burn the storage tube unintentionally as a result of improper operation of the intensity control on the instrument. The intensity control is automatically adjusted by the new protective circuit in the event the operator suddenly switches from the fastest sweep rate to the slowest without decreasing the intensity (an action which formerly might burn the tube), or in the event of similar operational errors.

Hughes Scope Cart: Especially designed for the MEMO-SCOPE Oscilloscope, an all-aluminum scope cart facilitates movement of the instrument to different locations for varied applications. Features: *mounting provisions* for two spare amplifiers, 6' *retractable power cord* for convenience in connecting equipment, ample *drawer space, accessibility* from both sides, pull-out *writing board, full-swivel casters* for ease of movement from one area to another.

Hughes Multitracer Unit: Designed to operate in conjunction with the MEMO-SCOPE Oscilloscope, the portable Hughes Multitracer enables you to store and compare up to 20 stepped-down traces in one display. The stored sweeps appear at equal, preselected intervals forming a raster type of display. The all-electronic Multitracer is a combined attenuator, gate amplifier and storage counter designed to be placed between the signal source and the regular MEMO-SCOPE Oscilloscope input.

Creating a new world with ELECTRONICS

HUGHES

©1960 HUGHES AIRCRAFT COMPANY

INDUSTRIAL SYSTEMS DIVISION

See the MEMO-SCOPE Oscilloscope in operation at the Hughes exhibit, I.R.E. Show—Booths 1609-1615.

CIRCLE 48 ON READER-SERVICE CARD

NEWS

Named Fellow for Medical Electronics Work

Roland C. Bostrom, left, has been named a Fellow by the New York Academy of Science for his work in medical electronics. Here Mr. Bostrom, a supervisor in the Department of Medical and Biological Physics of Airborne Instruments Laboratory, discusses operation of AIL's Cytoanalyzer with Dr. Douglas Sprunt, head of the Tennessee Institute of Pathology. The instrument is used in the detection of cancer.

Hungarian Electronics Industry Concentrates On Home Market

The Hungarian electronic industry is a modern but do-it-yourself affair, according to reports reaching the Solid-State Circuits Conference. Transistors and other components are almost entirely of domestic origin; only high-precision items are imported, it was said.

Hungary's electronic industry was described by Dr. I. P. Valko of the Budapest Technical Institute and Dr. I. Szep of the Hungarian Federal Research Institute, here to survey developments in electronic plants and laboratories.

Hungarian electronic production consists primarily of entertainment devices for the home market. These were described as up-to-date in design and employing transistors and printed circuitry where feasible. A transistorized TV receiver is said to be in development.

Transistor Production

Transistors are mainly germanium alloy junction types, though Mesa and Drift transistors are being turned out in pilot quantities. Germanium is locally produced in Hungary and silicon will be available within the country "soon," it was said. Other semiconductor items listed as produced in Hungary included microwave diodes and crystal rectifiers—again for home consumption. Production figures were not given.

The balance of production consists of measuring instruments, signal generators and equipment for national telephone, broadcasting and other communications systems, according to the reports. A 4,000-mc microwave link was described as completed for TV transmission between Hungary and Czechoslovakia. Tubes of all kinds, including magnetrons, klystrons, traveling-wave and backward-wave units, were said to be needed locally.

Although manufacturing is essentially a state monopoly in Hungary, the visitors asserted that competition from imports kept quality high. As in many Eastern countries, they said, equipment tends to be overdesigned and rugged.

Exports of electronic equipment are small both to East and West, the visitors said, but tubes and instruments have been shipped to Western Europe. Increased trade with western countries would be welcomed, they added.

Research Limited

Hungarian research, like that in much of Europe, was reported limited by available funds. Hence independent basic research is on a small scale.

Dr. Valko and Dr. Szep were quite proud, however, of such limited basic research as did take place in Hungary. A cybernetics laboratory is under construction, they said, and a digital computer for research data processing is being completed. Mathematics has always been a Hungarian forte, the visitors declared, and much of the pioneer work in electroluminescence is of Hungarian origin. Work in these fields is being continued on a relatively large scale.

The visitors hoped that their tour of the U.S. would encourage American scientists to "come and see for themselves the work that we are doing."

Try This One, Computer Designers . . .

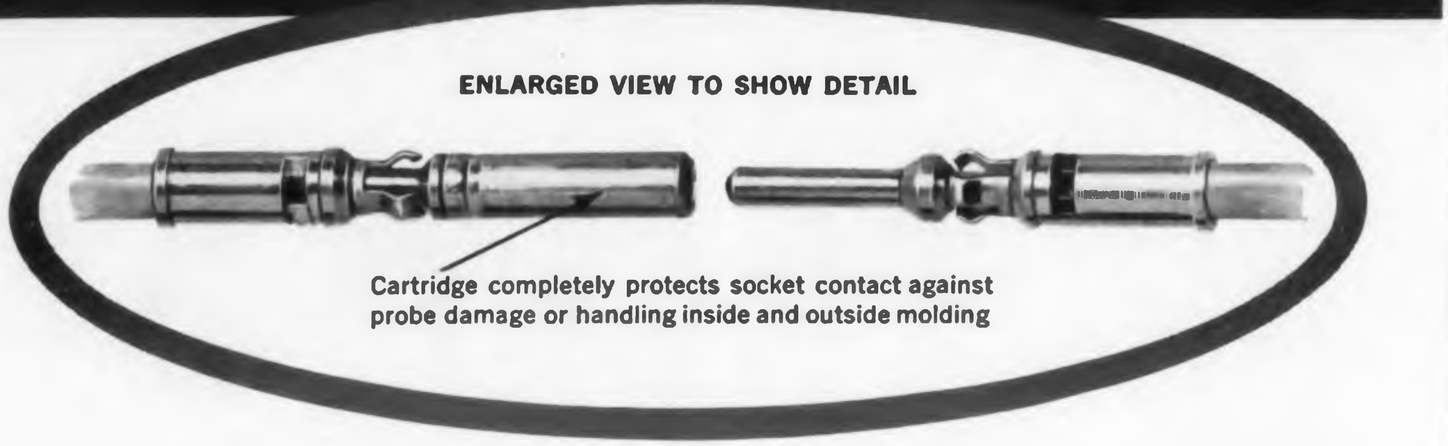
Air Force pilots, alarmed at growing missile stockpiles, can take solace in this thought of Mundy I. Peale, Republic Aviation Corp. president:

Until someone builds, for $100 or less with unskilled labor, a computer no larger than a grapefruit, requiring only a tenth of a volt of electricity, yet capable of digesting and transmitting incoming data in a fraction of a second and storing 10,000 times as much data as today's largest computers, the pilots have nothing to worry about.

This is the competition offered to flight control designers by the human brain, according to Mr. Peale, whose company recently completed work on the all-weather F-105D near-automatic fighter-bomber.

He was addressing an American Legion Committee studying the future of manned aircraft.

New! REMOVABLE CONTACT
BY CONTINENTAL CONNECTORS



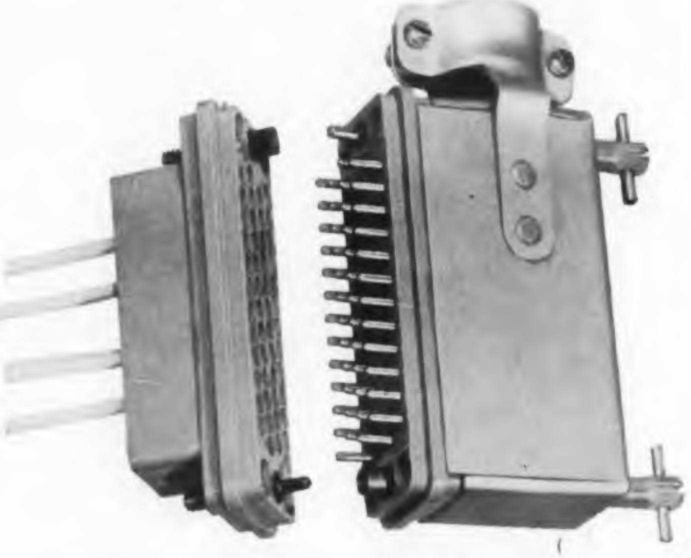
Eliminate all connector soldering operations with Continental Connector's new, improved removable contact with crimp terminations. Extra wide, three-tine spring clutch on pin and socket provides maximum holding area between contact and molded block. Contacts are supplied separately and are wired independently. This permits mounting of plug and socket connector units at any convenient time without waiting for completion of wiring operation.

Wire crimping is fast and easy with hand or power crimping tools readily available for small or quantity production. Contacts are quickly removed and replaced with a simple, low cost hand tool.

These removable contacts are designed for use with Continental Series 25 Miniature Rectangular Connectors in sizes of 14, 26, 34, 50, 75 and 104 contacts. Both socket and pin contacts are made of phosphor bronze with gold plate over silver plate. Terminations accommodate any #16 to #22 AWG wire. Removable contact connectors are interchangeable with existing fixed contact types.

For complete technical data bulletin on Continental Removable Contact Connectors, write to Electronics Division, DeJUR-AMSCO CORPORATION, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agent.)

Closed Entry Cartridge For Miniature Rectangular Connectors



Series 25 plug and socket connector with removable contacts and patented polarizing screwlocks. Plug is illustrated with side opening aluminum hood.

CONTINENTAL CONNECTORS

MANUFACTURED BY
CONTINENTAL CONNECTOR CORPORATION,
AMERICA'S FASTEST GROWING LINE OF
PRECISION CONNECTORS

SEE US AT THE IRE SHOW . . . BOOTHS 2307-2309

CIRCLE 51 ON READER-SERVICE CARD

Grid Design Improves Solar Cell Efficiency

By redesigning its solar cell to operate as three smaller cells in parallel, Hoffman Electronics Corp. of Los Angeles says it has increased cell efficiency "by a factor of 1.15." Former efficiencies were on the order of 10 per cent for good production units, according to Martin Wolf, manager of the company's solar section.

In this type of energy converter, where maximum theoretical efficiency is only about 22.6 per cent, any small increase is proportionately great.

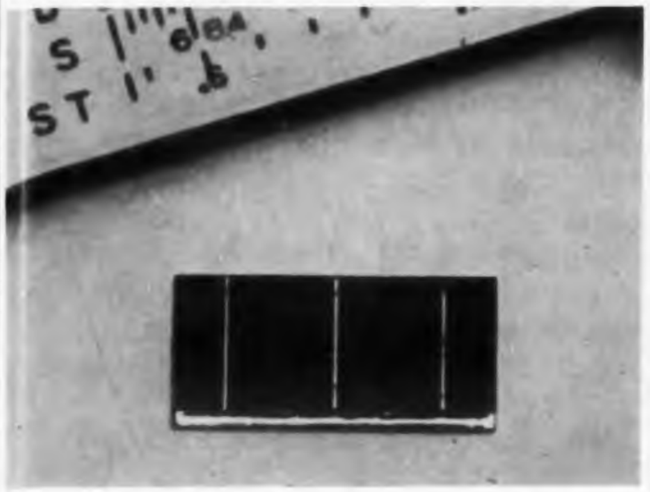
To achieve up to a 15-per-cent increase in efficiency, Mr. Wolf made cells that measure 1 x 2 cm. Each has a three-wire grid of soft-solder-covered nickel plate. Since the current flows as a sheet on the surface of the cell, the grid lowers the high resistance of the p-layer. The three grids effectively provide several small cells in parallel.

"The calculated optimum," says Mr. Wolf, "would be five thinner lines. For practical reasons, the design uses only three."

He said the grid design had been attempted before, but there were so many other problems the cells never showed enough improvement. "Now we have better solar cells," he added, "and the improvement is worthwhile."

In the manufacture of solar cells a compromise must be struck between the thickness of the p-layer, the amount of doping of the p-layer and the

Martin Wolf of Hoffman Electronics diagrams the operation of a solar-cell equivalent circuit. New design effectively decreases R_s, the series resistance of the cell.



Gridded solar cell is reported up to 15 per cent more efficient than former cells. Grid makes several small cells in parallel.

collector efficiency. In Hoffman's solar cells the thickness of the p-layer is about 2 microns. This is within the diffusion length from the surface necessary to collect all carriers.

Heavy doping is needed to decrease the resistance of so thin a layer. With the grid technique, the p-layer thickness can be reduced even more, and the total resistance is still kept low (two to three times lower, in the laboratory). Collector efficiency is improved.

Still looked for: breakthroughs to rid silicon of unwanted impurities, like gold.

Radar Views Atlas Launch

This composite photograph shows what the tracking radar used with the General Electric radio-command guidance system for the Atlas missile views during the initial stages of a launch.

A 2-WAY SAVING

ON THE RESISTORS THAT ARE SETTING TODAY'S QUALITY STANDARDS

1. Now you can get Stackpole Coldite 70+ Resistors IMMEDIATELY through 28 strategically located distributors — *at favorable prices for quantities up to 1,000 of a value!* This makes an ideal set-up for obtaining resistors for small runs, production emergencies, military prototypes and "hurry-up" engineering projects. And it saves you money in their procurement!

2. No other resistors can match Coldite 70+ for production line efficiency — because they're far and away the easiest resistors to solder by any method. This saves your company money on their use!

Coldite 70+ Resistors are the latest development of a firm which, since the early days of radio, has been one of the largest, most dependable resistor suppliers. Laid end to end, the resistors Stackpole has produced would extend around the world so many times you'd get dizzy counting them!

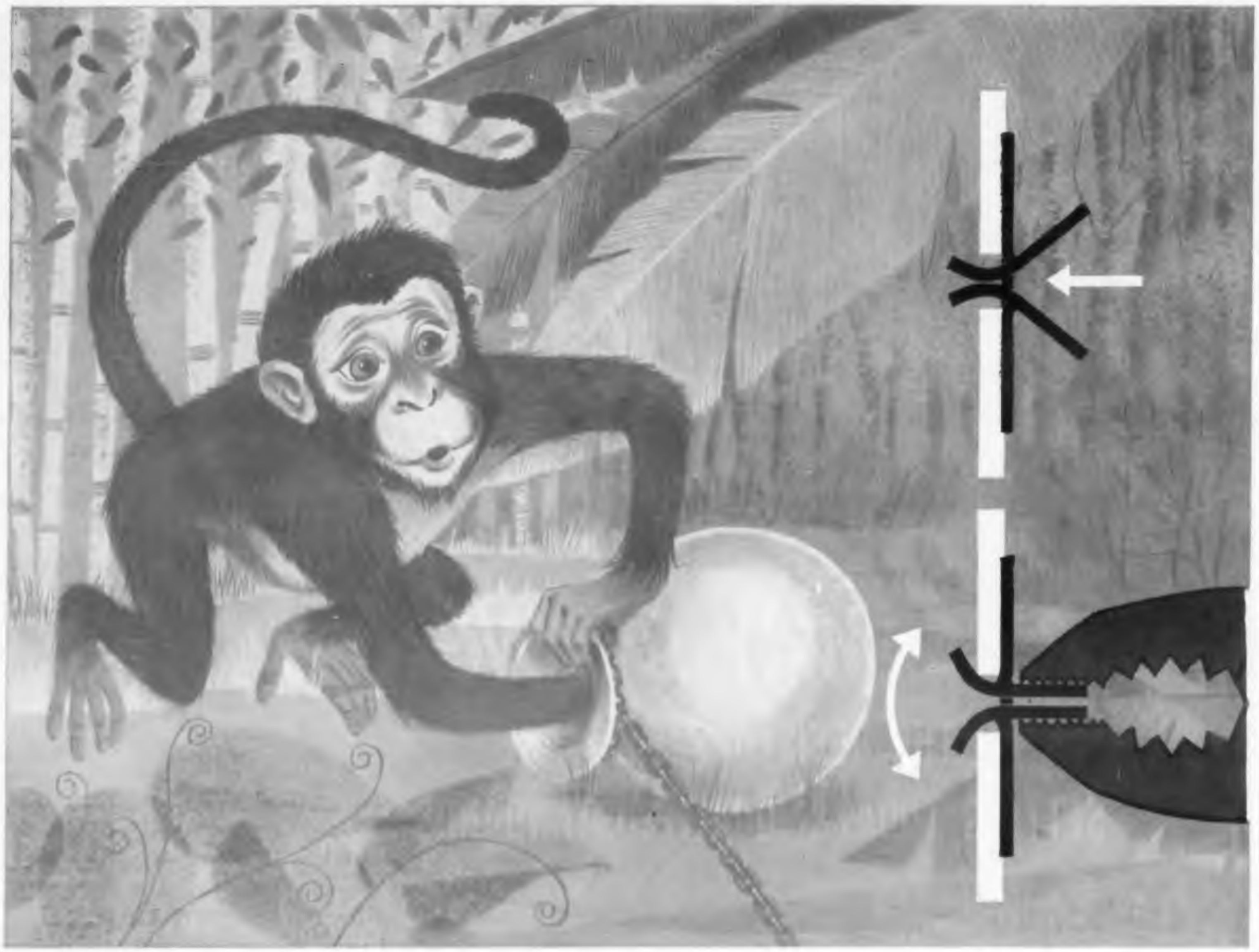
Coldite 70+ Resistors look good — and they're every bit as good as they look. They're unmatched for load life and moisture resistance. What's more, performance far exceeds MIL-R-11 requirements. And now, for the first time in resistor procurement history, you can get such resistors in a complete line of RC-42 (2-watt); RC-32 (1-watt) and RC-20 (1/2-watt) styles FROM STOCK from leading distributors!

FOR ECONOMY AND CONVENIENCE on your smaller lot purchases, write, wire or call for name of nearest Coldite 70+ distributor with complete stocks of all 3 sizes, all 269 standard values, and all 3 standard tolerances.

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pa.

STACKPOLE
Coldite 70+®
fixed composition RESISTORS

CIRCLE 52 ON READER-SERVICE CARD



NEWS

Electrically Exploded Wires Studied as New Energy Source

Rockets theoretically could be propelled by exploding wires electrically, a group of California engineers has found.

The exploding wire conceivably could be used also as sources of high-intensity light (as for searchlights) and as generators of hypervelocity particles for use in impact research.

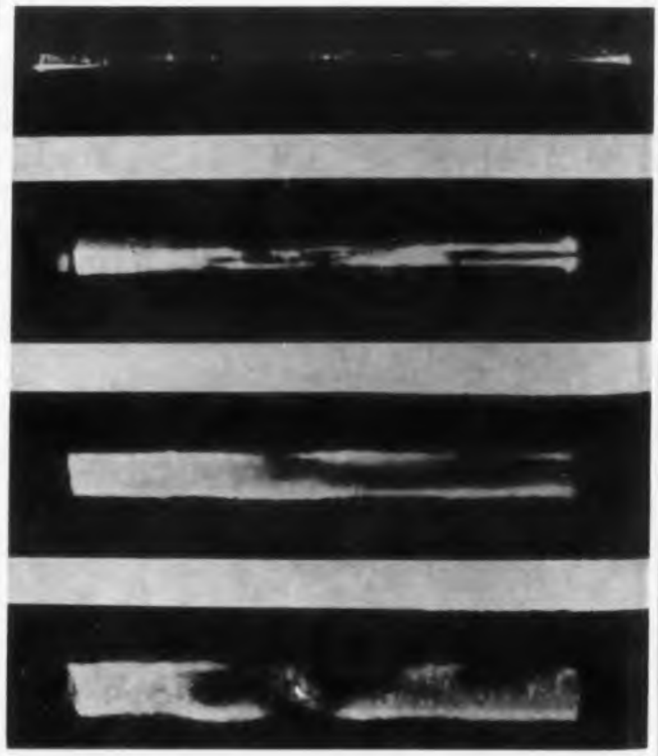
The engineers, of Electro-Optical Systems, 170 North Daisy Ave., Pasadena, exploded the wires by injecting several thousand amperes into them. The wires vaporized in 50 to 100 mμsec, their temperatures exceeding 100,000 C. The pressures that developed measured in megabars.

The impulses obtained could provide a space vehicle with two to ten times the specific impulses presently produced by chemical means.

The hypothetical propulsion system also offers a better thrust-to-power-consumption ratio than many proposed electrical systems, such as one using ions.

However, Electro-Optical scientists say, the problems in producing a practical exploding wire or exploding film system appear formidable.

Less formidable and more practical, they say, is using the technique to produce hypervelocities in the laboratory for high-speed impact studies. Dense vapors, which have impact characteristics like those of solids, could be accelerated by exploding wires to 20 to 30 kilometers per sec. These



A charged aluminum wire, 1 mil diam by 1/4-in. long, as it explodes in Electro-Optical Systems laboratory. Camera has stopped action at 3, 8, 32 and 45 mμsec after the switching on of current.

velocities are higher than those presently attainable in the laboratory.

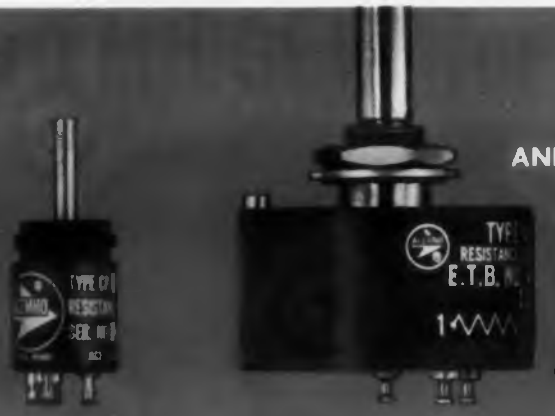
The high currents required to vaporize the wires were obtained by suddenly discharging a capacitor. The capacitor, of 0.002 to 0.02 μf, had been charged to 10 to 20 kv. The wires were 1 mil diam by 1/4-in. long. Hence the circuit inductance was small (from 0.03 to 0.1 μh), and the rapid discharge of the capacitor was facilitated.

The switching required to produce the rapid discharge was obtained by using a hydrogen thyratron to drive a trigatron, a triggered air spark gap.

Experiments were performed with wires made of aluminum, iron, gold, copper, silver, nickel, tungsten, molybdenum, tin, titanium, zinc and cadmium. Specific impulses of 1000 sec were obtained with aluminum, and it is likely that the range will be extended to 5000 sec.

Missile Test Chamber Shielded From All Electrical Interference

This 100-ft-high, completely shielded missile test station in Denver is protected against interference from 60 cps to 10,000 mc. Shielding, Inc., of Riverton, N. J., which built the facility for Martin, reports that all electrical devices entering the 40-ft-square chamber are completely filtered.



ANNOUNCING *a full range of sizes now available!*

ACE ELECTRONICS ASSOCIATES, INC.

ACEMHO*

conductive plastic precision potentiometer

INFINITE RESOLUTION
LONGEST LIFE
LOWEST NOISE
EXTREMELY HIGH RELIABILITY

Now in a full range of sizes! the ACEMHO — Ace Electronics Associates, Inc. superior conductive plastic precision potentiometer! Available to you — for your low noise and infinite resolution needs — in 1/2", 7/8", 1-1/16" and 1-5/16"!

For critical applications where infinite resolution and extremely low operational noise is vital — the ACEMHO will prove to be the answer — whatever your size requirements! The ACEMHO — developed by Ace Electronics Associates, Inc., specialists in precision potentiometers only, after more than four years of research — is unsurpassed in lowest noise and longest life characteristics.

Life guarantee: 10 million cycles.

Life expectancy: Tests indicate a 50 million cycle life with noise and resistance change remaining within useful limits. No sudden failure due to homogeneous conductive plastic element.

1-5/16" size condensed specifications: Noise: less than 25 ohms at 1K, less than 50 ohms at 100K. Power rating: 2W at 85°C, 2K and up. 3W at 85°C, below 2K. Operating temperature range: — 55°C to 125°C. Resolution: essentially infinite — .0005°. Torque: 0.1 in.-oz. running and starting. Independent linearity: down to 0.1%. Contact resistance: lowest available in conductive plastic. Meets all applicable MIL specs: completely shock, vibration, humidity, moisture and acceleration resistant. In a series of resistance ranges from 100 ohms to 1 megohm.

Full engineering specifications upon request. Call, telegraph or write with your engineering sample requirements. Prompt delivery of prototypes.

See the full range of ACEMHO sizes at IRE — Booth 1811-1813

*Reg. TM. Patents Pending

ACE ELECTRONICS ASSOCIATES, INC.

99 Dover Street, Somerville 44, Mass. Tel: SOmerset 6-5130 Western Union: WUX Somerville, Mass.
Representatives in all principal cities TWX SMVL MASS 181

CIRCLE 54 ON READER-SERVICE CARD

NEWS

15.6 Million Radios Made in '59, Greatest U.S. Output Since '48

Production of radio receivers in the U.S. last year was the highest since 1948, the Electronics Industries Assoc. reports. But retail sales of sets were only slightly above those of 1958.

More than 15.6 million radios were manufactured in 1959, against 12.5 million in 1958. Retailers, however, sold less than 8.9 million sets, compared with about 8.6 million the previous year.

Of more than 6.3 million TV sets produced last year, 4.9 million TV receivers were produced and 5.1 million sold to consumers.

Phonograph sales at retail last year reached nearly 4.4 million units, of which more than 2.7 million were stereo. Factories sold more than 4.3 million phonographs, including 3 million stereo units.

EIA figures show that factory sales of receiving tubes last year totaled nearly $27 million more than in 1958. Revenue from sales of TV picture tubes increased by more than $20 million.

The EIA totals:

Production

	1959	1958
TV	6,349,380	4,920,428
Total Radios	15,622,357	12,577,243
Auto Radios	5,555,155	3,715 362

Units Sold at Retail

	1959	1958
TV	5,748,676	5,140,082
Radios	8,897,451	8,631,344
Monaural Phonographs	1,653,137	Not Available
Stereo Phonographs	2,744,720	Not Available

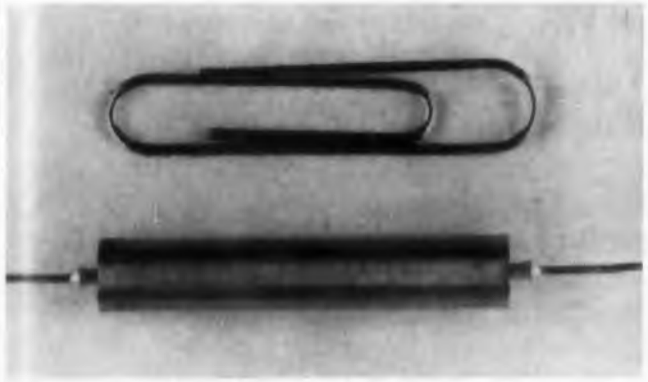
Units Sold by Factories

	1959	1958
Monaural Phonographs	1,267,781	2,867,606
Stereo Phonographs	3,035,836	1,104,924
TV Picture Tubes	9,522,546	8,252,480
Receiving Tubes	432,936,000	397,366,000

High-Temperature Capacitor Made With Thin-Film Dielectric

A miniature, high-temperature capacitor using a thin-film dielectric of electrically deposited plastic has been developed for low-voltage applications.

Called the "glow discharge film" capacitor, the



"Glow discharge film" capacitor uses micron-thin dielectric film for 1 µf at 25 v. Operation at 200 C is claimed.

device is 75 per cent smaller than foil-paper units and is said to operate at temperatures up to 200 C. As such, it should find ready use in transistor circuits.

The capacitor was developed by the Signal Corps Laboratory, Ft. Monmouth, N.J., and Radiation Research Corp. of New York City.

Micron-thin films of Teflon, Mylar or polystyrene are deposited and polymerized on an aluminized surface by a glow-discharge current. The aluminized surface is supported by a thin plastic substrate. Teflon films and substrates are employed for 200 C application; other materials permit somewhat lower operating temperatures.

Capacitances of up to 15 µf at 100 v are attainable. At still higher voltages, the dielectric thickness necessary is available with conventional plastic tapes and does not warrant the new process.

Limited production of these capacitors should begin later this year. The price is expected to be competitive with conventional units.

English Prof and Computer Turn Out Index to Poetry

A Cornell University English professor has used a computer to analyze the vocabulary of Matthew Arnold, the poet.

The professor, Stephen Maxfield Parrish, used an IBM 704 Data Processing System to compile a 965-page volume, "A Concordance to the Poems of Matthew Arnold."

The concordance lists alphabetically the 10,097 principal words in Arnold's vocabulary and indicates where in his works they may be found. An appendix lists the words in the order of their frequency and shows the frequency of each word.

Professor Parrish, his three colleagues and two technicians supplied by IBM saw printed copies of the book 197 hours after beginning their work. Cards for the computer were punched in 149 hours. The computer operated for 38 hours, and 10 hours were required for the printing.

NEWS

Topside Study of Ionosphere Planned by U.S. and Canada

Radio soundings of the ionosphere from above, using a transmitting satellite sweeping its sounding frequencies through a range from 2 to 15 mc, are planned as a joint Canadian-United States experiment in 1961.

Information on ionization, densities and transmitting characteristics as a function of frequency up to 700-mi altitudes is expected from the experiment. The topside sounding satellite, to be launched in an elliptical polar orbit, will also gather data from geographical areas not covered by present ground-sounding stations. Of particular interest will be data from the auroral zones, which cause special communications problems at high latitudes.

Previous vertical and oblique incident reflective-type soundings of the ionosphere from the ground have been limited to altitudes of about 200 mi.

Signals transmitted from the satellite will be monitored by tracking stations in Canada, the U. S. and South America. Transmissions at some of these frequencies will be reflected by the ionosphere and received by the satellite. Particular frequencies will depend on the time of the day and the position of the satellite in its orbit.

The reflected signals will be used to modulate a telemetry carrier transmitted by the satellite, according to a National Aeronautics and Space Administration spokesman, so that both penetrating and reflected signals can be monitored by the ground tracking stations.

Recent evidence that the ionosphere has a continuously changing rather than a layered structure will also be checked by the satellite soundings, according to the NASA spokesman. Canada's Defence Research Telecommunications Establishment is cooperating with NASA in the project by providing the satellite, its instrumentation and Canadian tracking facilities. NASA will provide the tracking stations outside of Canada, as well as launching facilities and equipment for testing Canadian prototypes.

Instrumentation for the experiment is presently in breadboard and design stages, the NASA spokesman added, and complete technical details have not yet been settled. Telemetry receiving equipment is currently available, he said, but other equipment will be required to monitor the sounding frequencies.

The satellite will be tracked with the 136-137-mc telemetry tracking equipment now used by the U. S., he explained.

The joint effort with Canada is one in a continuing NASA program of international cooperation in space sciences.

Germanium Transistor Used As 3-Kmc Oscillator, 1-Kmc Amplifier

A germanium pnp transistor that can be used as an oscillator at 3 kmc and as an amplifier at 1 kmc or lower has been developed.

High frequency was achieved by using very small active-area dimensions and coaxial mounting to cut capacitance and inductance losses.

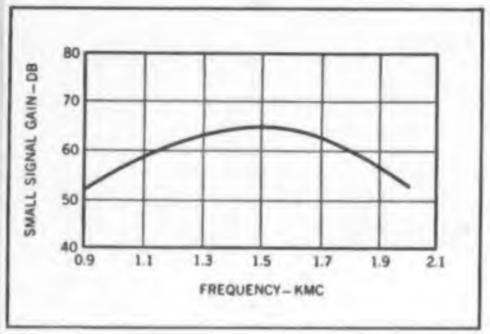
The mesa in the diffused-base, alloyed-emitter transistor is 1.8-mils long and 1.5-mils wide. Three metal stripes, each 0.3-mil wide and 1.5-mils long, are evaporated onto the mesa plateau and alloyed into the semiconductor. Gold wires 0.2-mil in diam are used as connections. The diffused base is 0.02-mil thick.

The device, developed by Bell Telephone Laboratories, is mounted in a coaxial shell that electrically matches a 50-ohm transmission line. The transistor's base stripes are connected to the center conductor of the coaxial input line; the emitter stripe is connected to an internal shield built into the encapsulating shell, and the germanium wafer is gold-bonded to the inner conductor of the output line.

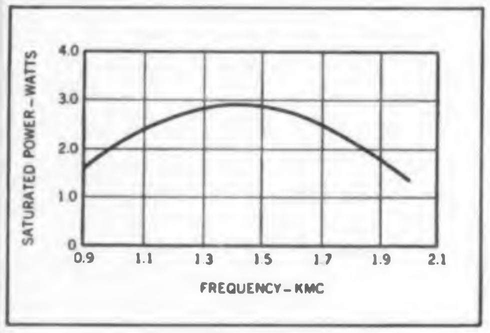
Wide-band and narrow-band feedback amplifiers using the transistor have been built using transmission-line principles. The three-stage amplifiers are said to have gain of 18 db, flat within 1 db over the frequency band from below 1 mc to above 750 mc.

Work on the device at Bell by R. E. Davis, C. A. Bittmann and R. J. Gnaedinger has been supported in part by the Army Signal Research and Development Laboratories. The amplifier circuits were designed by Mr. Bittmann and Mr. Davis along with V. R. Saari and R. J. Kirkpatrick, also of Bell.

Germanium Esaki diodes on the center of a stripline waveguide provide amplification in this traveling-wave type 1-kmc amplifier described at the Solid-State Circuits Conference. M. E. Hines of Bell Labs inspects the device, which uses ferrite attenuation to prevent self-oscillation. Three-kmc units should be possible with the technique.



Small-Signal Gain vs. Frequency



Saturated Power vs. Frequency

Harvard Gets $265,000 Grant For Weapons Procurement Study

The Ford Foundation has granted the Harvard Business School $265,000 to find out what it takes to develop weapons besides technology.

The research supported by the money will determine the administrative and economic characteristics of the development and procurement of advanced weapons. The study will explore the relationship between the buyer of weapons—the government—and the seller—the contractor.

Officials at the Harvard school hope the work will be completed by the end of this year. The school intends to publish as much of the findings as security regulations will permit.

Ultimately, it is expected, the research group will offer methods of improving the policies and practices associated with weapons procurement.

Exploratory work on the project began in 1958. The development of several non-defense products was studied to provide a basis for comparison with the development of advanced weapons.

In 1959 12 advanced weapons systems came under the research group's scrutiny. This phase of the study examined the following questions:

- How are prime and principal subcontractors chosen?
- How are responsibility and authority divided between the government and the contractors?
- What incentives are there for the contractor to do an outstanding job?

The members of the Harvard Business School Faculty engaged in the project are Prof. George P. Baker, senior faculty adviser; Prof. Paul W. Cherington, project director; Prof. Merton J. Peck; Charles Stein, Jr.; Gerald W. Siegel; Frederic M. Scherer, and George Harmon.

David Novick, head of the Cost Analysis Department of Rand Corp., is a consultant to the project.

Computer Slated to Figure Target of Enemy Missiles

The course, target and impact time of an enemy missile projected at the United States across the polar region would be computed in seconds with a data-processing system under development.

The system, which performs 200,000 mathematical operations per sec, is manufactured by Sylvania Electric Products Inc., New York. It is scheduled to monitor radars of the Air Force's Ballistic Missile Early Warning System.

Specialized computers in the system analyze radar echoes and decide whether or not the

Sylvania officials inspect data-processing apparatus to be used on conjunction with the radars of the Air Force's Ballistic Missile Early Warning System. At left is Richard W. Couch, Sylvania's BMEWS program manager. Eugene J. Vigneron, general manager of the data systems operation, looks on.

source of the echoes is a projectile. The computers then determine which among the projectiles are hostile missiles.

The points and times of impact, as well as the number of hostile missiles, are determined and transmitted in less than a second to operating personnel and to United States command centers.

The system checks its own internal performance, Sylvania said, and maintains contact with a standby computer to verify results. If the main computer does not function properly, the standby computer takes over.

Computers Will Assign Frequencies After Scientists Pick Best Method

Scientists at the National Bureau of Standards, will teach computers the best way to assign frequencies to radio transmitters that mark air routes—as soon as they learn how themselves.

The problem of assigning the frequencies belongs to the Federal Aviation Agency. Each year a substantial number of new transmitters, which help pilots fly a straight-line course, are added to the nation's network of commercial and military airlanes.

Signals from new transmitters should not interfere with those from existing transmitters. However, the FAA has available only 100 discrete frequencies for allocation.

When adding new transmitters, it is often necessary to change the frequency of existing transmitters. This could, however, create new areas of interference.

The problem was turned over to L. Joel, G. M. Galler and A. J. Goldman of the NBS Applied Mathematics Div.

very accurate local time comparisons

generation of very accurate local time
with atomic or quartz oscillators

this new hp 113AR Clock

is the ultimate

This new hp 113AR Frequency Divider and Clock makes possible precision time comparisons between stable oscillators and standard WWV or other transmitted time signals. This permits adjustment of frequency or time standards for greater absolute accuracy, and simplifies obtaining detailed records of drift rates, or time or frequency differences between oscillators in widely separated systems.

Propagation path errors can be averaged out and Doppler errors are virtually eliminated.

hp 113AR's unique optical gate (no contacts, no wear, cannot add jitter) and a directly calibrated precision phase shifter make possible the unique accuracy of the Clock providing a time comparison capability of ± 10 μsec. Regenerative dividers, a phase-stable motor and precision gear train provide fail-safe operation not attained by pulse counting systems.

Model 113AR is conservatively designed from premium components, fully transistorized for longer standby battery operation, and meets performance requirements of MIL-E-16400. The unit is rugged, dependable and measures only 7" high.

SPECIFICATIONS

Input Frequency:	100 KC ± 300 cps.
Input Voltage:	0.5 to 5 v rms.
Input Impedance:	Approx. 300 ohms
Output Signals:	(1) 1 pps, 10 v, 10 μsec rise time, approx. 20 ± 10 μsec duration, into 5,000 ohms (2) 1 pps, 4 v, 10 μsec rise time, 100 ± 3 msec duration, from 50 ohms (3) 1 KC pulses, pos and neg, 4 v peak, 8 μsec nominal duration from approx. 5,000 ohms.
Frequency Divider:	Regenerative; fail-safe.
Time Reference:	Continuously adjustable, calibrated in 10 μsec increments.
Clock:	Manual start, 24 hr dial.
Auxiliary Output:	1, 10 and 100 KC sine waves, 0.25 v rms from 1,200 ohms.
Power Requirements:	26 v ± 2 v (hp 724A Power Supply).
Size:	7" high, 19" wide, 19½" deep. Wt. 35 lbs.
Price:	$2,500.00 f.o.b. factory.

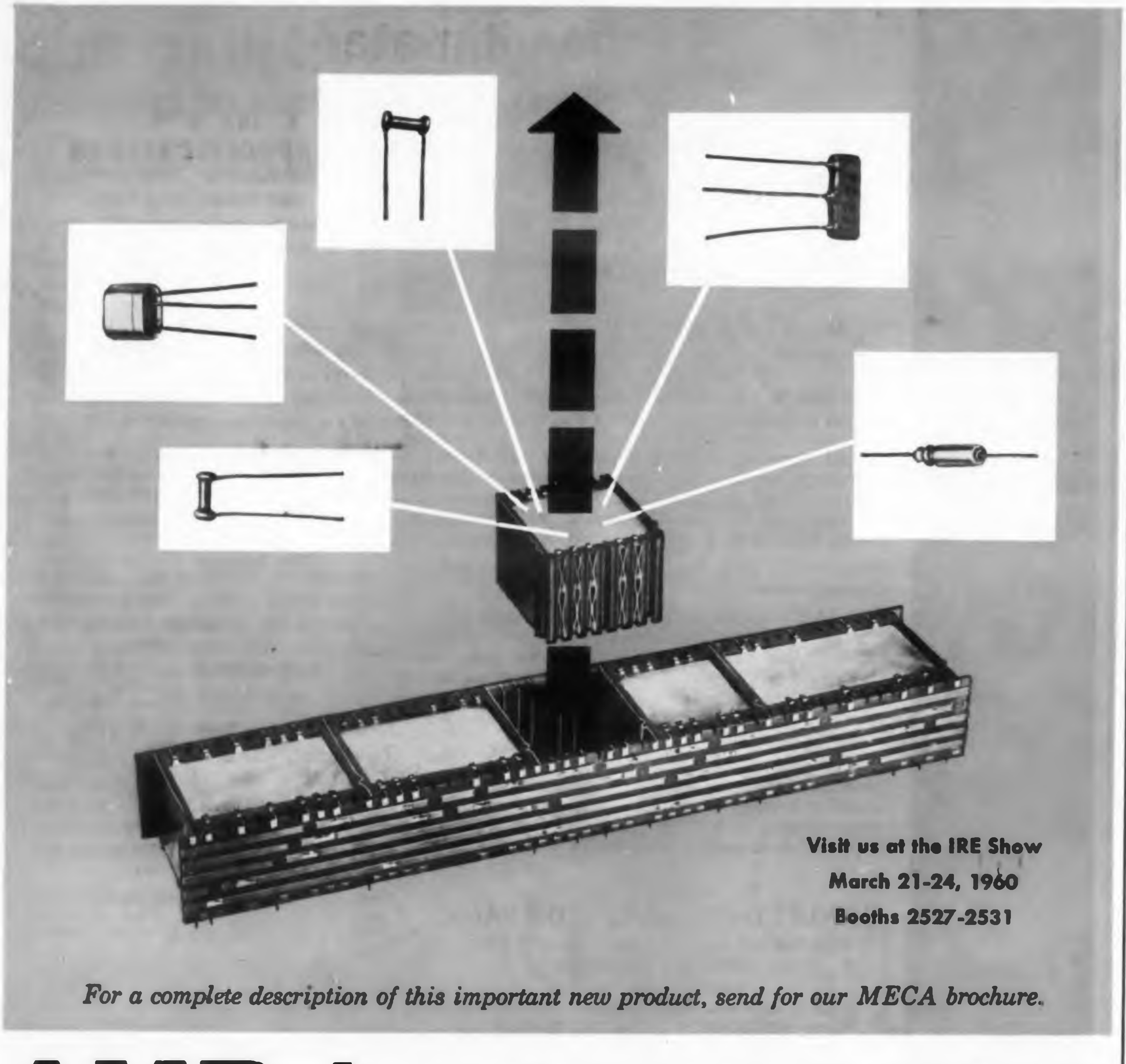
Data subject to change without notice.

HEWLETT-PACKARD COMPANY

1022K Page Mill Road • Palo Alto, California, U.S.A.
Cable "HEWPACK" • DAvenport 5-4451
Hewlett-Packard S.A.
Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" • Tel. No. (022) 26. 43. 36

hp world's largest line of electronic measuring instruments

CIRCLE 60 ON READER-SERVICE CARD



Brighter Radar Display Tube Developed

Daylight radar indicator shown here is said to be 1,000 times brighter than its predecessor, so that no hood is needed for viewing in sunlight. Sperry Gyroscope Co. developed the indicator tube for its APN-59 radar used in Air Force tankers, cargo and troop transports.

L.I. Electronics Industry Sets 5-Year Goal of 100% Growth

The future of a regional electronics industry occupied 1,000 engineers at a two-day exposition sponsored by the Long Island Electronic Manufacturers Council (LIEMC).

At the Futuronics Exposition, LIEMC announced a five-year goal: 100 per cent growth in sales of Long Island-manufactured electronic equipment. Growth in dollar value of sales during this period would be from $750 million to $1.5 billion. From 1954 to 1959, Long Island's electronic sales increased about 50 per cent, while sales of the total industry grew by 85 per cent. According to LIEMC executives, industry-wide electronic sales are expected to grow by only 65 per cent during the next five years.

The optimism of the regional group is based on achievement of these goals:

- Organized and cooperative effort to gain recognition of Long Island's capability as an integrated electronic research, development and production complex.
- Diversification of the area's electronics industry to include more of the growing fields of defense and civilian electronics.
- Educational and cooperative research facilities to insure long-term growth in the area's largest manufacturing industry.

At the exposition, progress of the area's technology was displayed in 47 booths exhibit and many exhibitors discussed ambitious plans for the future. Important work in progress and in planning was described in papers delivered at two morning technical sessions.

Faster Computers Under Study

A roadblock in the drive toward larger and faster computers—namely components of a size approaching wavelength of the frequencies used —is being attacked from two angles at Sperry Gyroscope. According to Dr. Peter Isaacs, the company is making the components smaller by using microminiature circuitry, and it is taking into account the dimensions of the components by applying microwave techniques to the computer.

In line with these approaches, thin magnetic films constituting single magnetic domains are being used to reverse magnetic state in a few millimicroseconds for logic and memory devices. Cryogenic switching, where thin films can be switched in or out of the cryogenic state in 10^{-10} sec, has also been demonstrated at Sperry. Microwave techniques have made possible switching times of 1,000 mc, as demonstrated in several computing devices.

Molecular Electronics Analyzed

Ralph Redemske, vice-president for research at Servomechanisms, Inc., gave his audience a fascinating look at what molecular electronics might do to component and circuit engineering. The virtual replacement of lumped components by chemical and atomic building blocks will require a new type of engineering team he said, adding that the familiar parts catalog would be replaced by a periodic table of chemicals.

Research and computer development at Servomechanisms is performed by a team of chemists, physical chemists, logical designers and circuit engineers who have learned to speak each other's technical language. The largest laboratory at Servomechanisms Research is the chemical.

Mr. Redemske observed that the day of woman assemblers was drawing to a close. Because of the size and environmental extremes involved in molecular electronics, he said, automatic forming and assembly machinery will be a must for molecular electronics.

Walter Tengelsen, Systems Research Engineer, described several approaches to space guidance by means of hybrid systems under way at Arma Div. of American Bosch Arma Corp. He said that in space vehicles, gyro drift and the absence of gravity for correction dictated the use of some aiding system to override the inertial guidance system. To save weight, he reported, components must be used in multiple roles. He cited the example of antennas used for communication, radar ranging and power transmission. ■ ■

WASHINGTON REPORT

Ephraim Kahn

. . . STATE TAXATION of property owned by the federal government and used by defense contractors — such as machinery and plant — should be imposed according to uniform rules established by Congress. Decisions of the Supreme Court permit states to engage in such taxation, but only four states have laws imposing this sort of tax. State officials, who would like the extra revenue, are fearful that they would give an edge to industries in other areas if they slap on such a tax. To prevent use of this tax as an element in cost competition for defense contracts, they are seeking a federal law on the point. Defense Department estimates that such a tax could hike the cost of military hardware alone by $500 million a year or more.

. . . PREFERENTIAL CONTRACTING by the Defense Department so as to allocate more prime business to labor-surplus areas is again being pushed in Congress. In an election year, chances of enactment of a new contracting law are improved, but it will still be an uphill fight. Sen. Jacob K. Javits (R., N.Y.) would give preference to small business and to labor-surplus areas under the present "set aside" program. A measure to do this has been introduced with the co-sponsorship of the entire New York Congressional delegation. The proposed law would also give a statutory basis to the policy of encouraging competitive bidding techniques in defense procurement. Where national security requirements preclude their use, it would provide for competitive negotiation to the maximum degree possible, involving two or more firms.

. . . MANAGEMENT STUDY of Air Force weapons systems is being evaluated by Air Force Secretary Dudley C. Sharp. A major area covered by the study is the question of systems management by the Air Force itself as against management by contractors. Though the management study itself has not been made public, it is conceded that it will play a role in the formulation of recommendations for "future organization and Air Force—industry relationships" in space and ballistic missile programs.

. . . TITAN ICBM program is here to stay, says Lt. Gen. Bernard A. Schriever, chief of the Air Research and Development Command. Crucial decisions on Titan were made three years ago. If Titan were cancelled it would slash planned ICBM strength by one-third. Those who suggest dropping the Titan, he says, "simply are not familiar with all the facts and problems of bringing missiles into the operational inventory."

. . . BID-BOND RULES, which were tightened by the Comptroller General last year, show no sign of easing. In fact, there is a disposition to enforce them literally, with no room for any sort of latitude. Last year, it was ruled that bonds must accompany bids, and be received prior to the bid opening. It has now been held that a bidder fell short of meeting requirements in the following circumstances: the bidder, replying to an invitation which permitted telegraphic bids, wired his proposal along with the bond number and the name of the surety. This was held insufficient to meet the bid-bond requirement.

. . . EXPORT OUTLOOK for the U.S. electronics industry is good, says the Commerce Department. Electron tubes and semiconductors made in U.S.A. have a good reputation abroad and the "brisk market that has been established for products of specialized types and technically advanced design holds further promise." In a survey of European markets, the Department notes that Austria's electronics trade is largely oriented toward the Netherlands; Belgium offers a good market for transmitting and special-purpose tubes; Denmark is a limited market for U.S. products; American producers have a "strong position" in the French market; prospects are good for expansion of U.S. sales to Italy; Norway buys power, special purpose, and transmitting tubes from the U.S.; competition in the Swedish market is strong and U.S. tubes are generally priced about 20 per cent higher than those from other sources; U.S. products "should continue to compete successfully" in the Swiss market; and the United Kingdom tends to import "relatively specialized types" of tubes.

. . . PRICE REVISION CLAUSES in fixed-price contracts have been interpreted by the U.S. Court of Claims. In a case involving an electronics firm, the court held that existence of such clauses does not change the contract into a type banned by law, the "cost-plus-a-percentage-of-cost" contract. The court rejected the contractor's contention that price revision clauses are an incentive to pushing prices up, since lower costs would result in lower profits. In effect, the contractor asserted, a contract providing for price revision after completion is equivalent to the type that has been banned. The court, however, said that it did not agree. It noted that the law provides for cost-plus-a-fixed-fee contracts, and said that the specific authorization of this type is sufficient ground to justify the legality of a fixed-price contract that includes price revision clauses.

. . . CONTRACT POLICIES of the Defense Department will be probed by the Senate Small Business Committee. To be given special scrutiny is the handling of negotiated contracts, particularly where only one source is involved. Hearings, which will include an explanation by the three Armed Services of their contract negotiation procedures, are tentatively slated to begin about April 1.

. . . SLOWER SPENDING for military procurement during the balance of fiscal 1960 — but the military will very likely step up the rate at which it awards new R&D contracts and makes commitments for future buying. On an annual rate basis, the military overspent by $1 billion during the first half of the fiscal year. Procurement was at an annual rate of $16 billion in contrast to the budget's target of $13 billion. Obligations, at an annual rate of $40.2 billion, were under the budget estimate of $41.6 billion. Significant shortfall was in RDT&E which is budgeted at $4.2 billion while obligations hit an annual rate of $2.7 billion. This leaves plenty of room for new contracts during the next few months.

PN Junctions Produced Directly From Vapor Phase

Silicon pn junctions reportedly have been produced directly from the vapor phase.

The new technique for producing pn junctions, conventionally made by alloying or diffusion methods, is said to be applicable to molecular electronics. Current applicability of the deposited junctions in conventional components depends on the evaluation of device producers, according to Merck. Laboratory samples are being prepared for evaluation.

The process, reported developed by Merck & Co., Inc., Rahway, N. J., is said to permit close control of resistivity, thickness, and other junction factors. Complex junction configurations may be obtained with the technique.

Resistivity of a p or n layer can be varied from a degenerate level to several thousands ohm-cm. The nature of the material may be varied to produce a step-type junction similar to that resulting by alloying, or a graded junction like that obtained by diffusion.

Resistivity varies within 25 per cent and layer thickness within 10 per cent of desired values, according to Merck.

Junctions with reverse breakdown voltages above 1,500 v, and with reverse leakage currents of less than 5μ amp were obtained with experimental devices produced at Merck using the vapor phase grown materials. Forward currents in test rectifiers made from the junctions were between 50 and 200 amp per sq in.

Europe Reported Deficient In Long-Range Basic Research

The popular notion of Europe as a mecca of basic research is somewhat overstated, according to reports by overseas delegates at the Solid-State Circuits Conference. In public addresses and private conversations, European scientists cited money—or the lack of it—as their main problem.

European electrical industries are relatively small and cannot muster large research staffs and budgets. Government support is likewise small by American standards. The result is greater stress on short-term applied research overseas, compared with the U.S.

These points were made by Dr. M. J. O. Strutt, chairman of the Swiss Federal Institute of Technology, in his remarks at the opening session of the conference.

"As most recent solid-state devices are U.S. inventions, copying takes a considerable place in European research," Dr. Strutt said.

Other visitors from abroad generally agreed with Dr. Strutt and pinpointed other weaknesses in European research. Tight company secrecy and national frontiers hinder the cross-fertilization of research ideas, it was said. Applied research was described as often parochial, aimed at solving an existing problem within a company rather than the development of devices and applications for wider use. Though the percentage of company incomes spent on research is probably equal to the percentage spent in the U.S., informants said, funds abroad are spent in tackling immediate research problems.

Papers of foreign origin read at the conference tended to confirm European de-emphasis of long-term basic research.

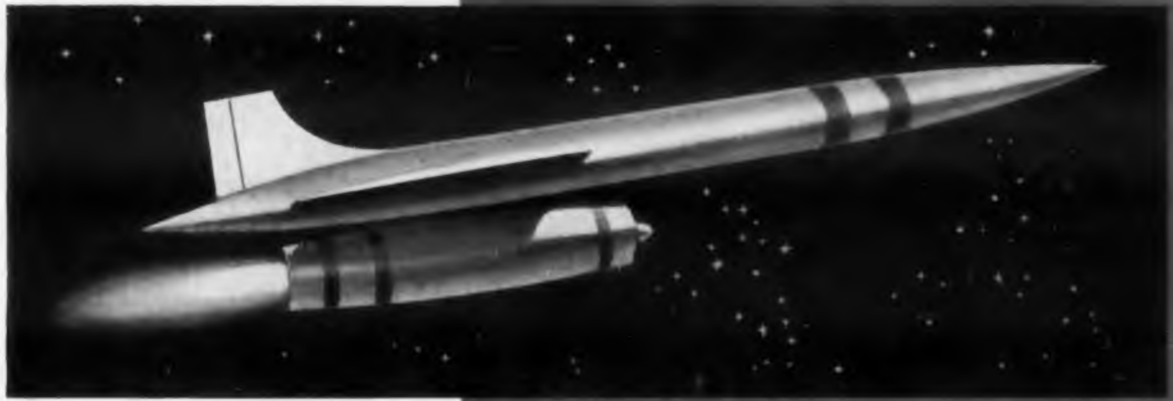
On the other hand, visitors felt that European engineers were perhaps more productive than their American counterparts. This was not attributed to better training but to more rigid work discipline. Motivation of European engineers might well be stronger, it was suggested. Jobs are tighter and salaries are much lower, but an engineer commands high social prestige abroad.

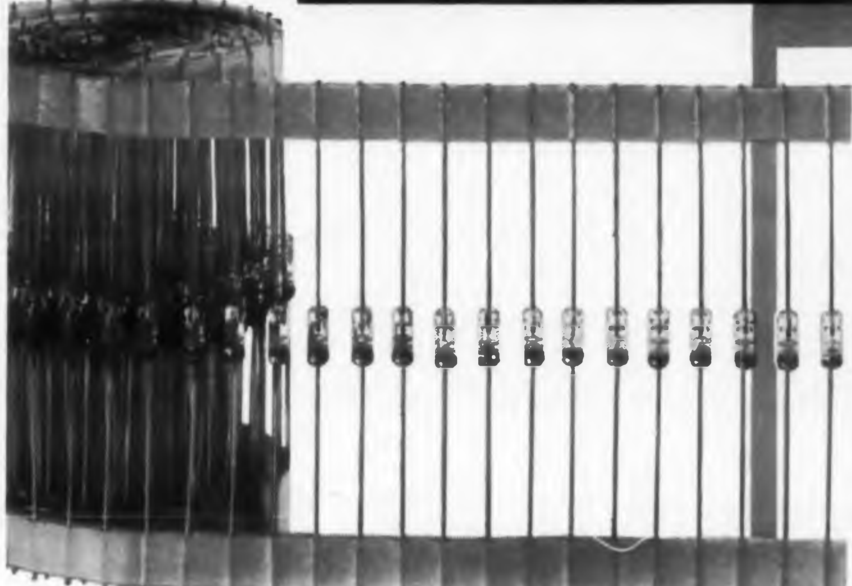
Basic research takes place mostly in universities and government-sponsored research centers. The total effort is quite small but of high caliber, it was said. Principal areas of work include nuclear research, noise in semiconductors and photocells, characteristics of semiconductors, paramagnetics, and photoelectricity.

Fluorochemical Cools Airborne Amplifier

This linear power amplifier, designed by Hughes Aircraft Co.'s communications division for the B-58 Hustler's 1-kw high frequency system, is fluorochemically cooled. The HC-105 amplifier is an 8½-in. cube.

CBS Indium-bonded Diodes Give You Missile Reliability





DIODE SURVIVAL BETTER THAN 99.985%!

Near perfection is demanded of computer diodes used in missiles. CBS Reliable Indium-bonded Diodes meet this challenge with an Acceptable Quality Level of 0.015% . . . a degree of quality never before achieved. in semiconductor mass production. Only one diode out of 6500 can fail!

This dependability is available for *your* computer applications in a wide line of new CBS Reliable Indium-bonded Diodes. Exceptionally rugged design, advanced processing techniques, severe mechanical tests, and automatic electrical tests make the difference. Ask your Manufacturers Warehousing Distributor or your local sales office about these CBS Reliable Indium-bonded Diodes today. Get technical bulletin E-314R.

TYPICAL SEVERE TESTS
New CBS Reliable Indium-bonded Diodes

Environmental
- Temperature cycling, −65° to 85°C
- Hermetic seal, 100 psi
- Moisture resistance exceeding MIL-STD-202A
- Shock, 1000 G for 1 millisecond
- Centrifuge, 20,000 G
- Vibration, 15 G at 50-2000 cps
- Salt spray and lead fatigue

Electrical
- Automatic, both forward and reverse
- Pulse recovery time, JAN 256 circuit
- Electromechanical stability and noise
- Storage, 1000 hours at 85°C
- Over-all quality exceeds MIL-S-19500B

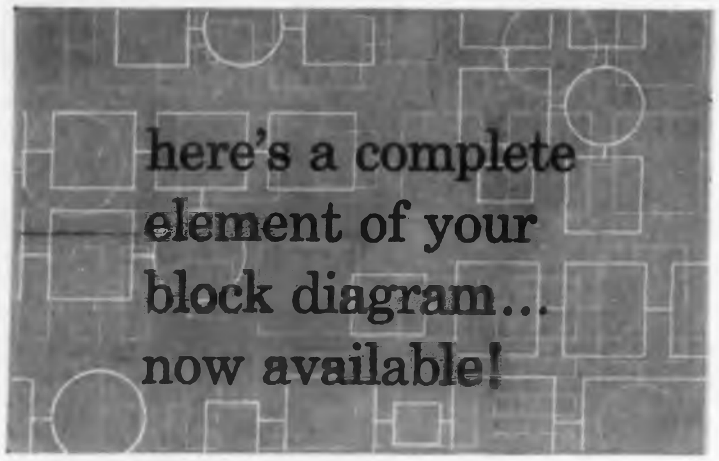
CBS® semiconductors

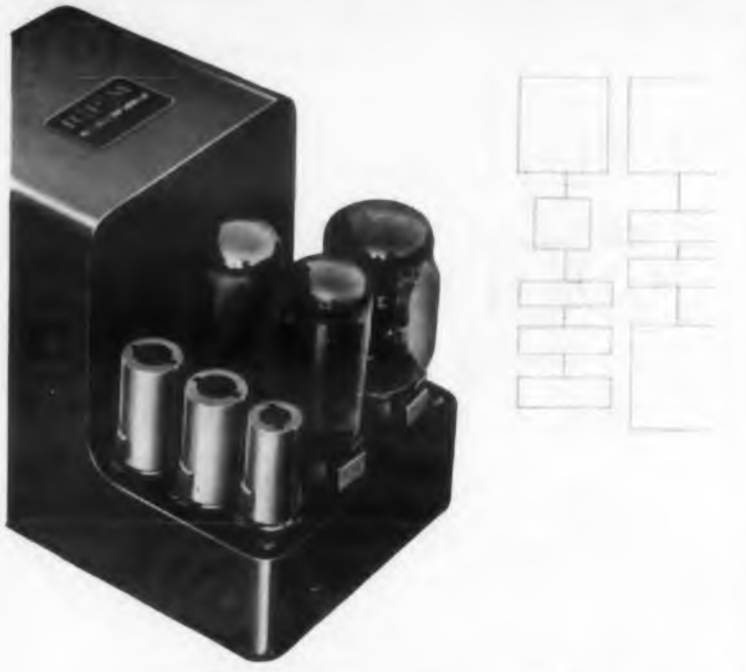
More Reliable Products through Advanced Engineering

CBS ELECTRONICS, Semiconductor Operations • A Division of Columbia Broadcasting System, Inc.

Sales Offices: *Lowell, Mass.*, 900 Chelmsford St., GLenview 4-0446 • *Newark, N. J.*, 231 Johnson Ave., TAlbert 4-2450 • *Melrose Park, Ill.*, 1990 N. Mannheim Rd., EStebrook 9-2100 • *Los Angeles, Calif.*, 2120 S. Garfield Ave., RAymond 3-9081 • *Atlanta, Ga.*, Cary Chapman & Co., 672 Whitehall St., JAckson 4-7388 *Minneapolis, Minn.*, The Heimann Co., 1711 Hawthorne Ave., FEderal 2-5457 • *Toronto, Ont.*, Canadian General Electric Co., Ltd., LEnnox 4-6311

CIRCLE 66 ON READER-SERVICE CARD





NEWS

IRE International Convention

Technical Papers—Subject Index

All am sessions begin at 10:00; pm sessions at 2:30; eve. sessions at 8:00.

Abbreviation Key: At the Waldorf—Astor Gallery (A), Empire Room (E), Grand Ballroom (G), Jade Room (J), Sert Room (Se), Starlight Roof (St).
At the Coliseum—Morse Hall (Mo), Marconi Hall (Ma), Faraday Hall (F).

Audio

Audio (12)	Tues am—Se
Stereophonic Sound Reproduction (36)	Wed pm—Se

Automation and Sound Control Systems

Control Theory (1)	Mon pm—St
Control Applications (9)	Tues am—St
Adaptive Networks (40)	Thur am—St

Broadcasting

Broadcasting—I (11)	Tues am—J
Broadcasting—II (19)	Tues pm—J
Audio and Broadcast and TV Receivers (20)	Tues pm—Se

Circuit Theory

Radar and Coding Theory (17)	Tues pm—St
Electronic Computers and Circuit Theory: How Each Technology Can Help the Other (33)	Wed pm—St
Circuit Theory: Current Contributions (41)	Thur am—A
Symposium on a Decade of Progress in Network Theory (49)	Thur pm—A
Waveform Analysis and Random Vibration (54)	Thur pm—Mo

Communications

Panel: Electronics—Out of This World (24)	Tues eve.—G
Seminar on 1959 ITU Geneva Conference (29)	Wed am—G
Communication Systems Design (30)	Wed am—F
Communication System Techniques (37)	Wed pm—F
Satellite Communications (44)	Thur am—E
Vehicular Communications	Thur pm—F

Computers and Data Systems

Electronic Computers and Circuit Theory: How Each Technology Can Help the Other (33)	Wed pm—St
Equipment and Systems (43)	Thur am—Se
Satellite Communications (44)	Thur am—E
Magnetic Recording (47)	Thur am—Mo
Electronic Computers (48)	Thur pm—St

Electron Devices

Electronic Devices (8)	Mon pm—Mo
Direct Conversion (10)	Tues am—A
Broadening Device Horizons (16)	Tues am—Mo
Electronic Component Parts (27)	Wed am—J
Aspects of Component Reliability (31)	Wed am—Ma
Component Parts (35)	Wed pm—J

Human Factors

Human Factors in Electronics (45)	Thur am—F

Information Theory

Radar and Coding Theory (17)	Tues pm—St
Detection Theory and Applications to Physics (25)	Wed am—St
Symposium on a Decade of Progress in Network Theory (49)	Thur pm—A

Instrumentation

The Brookhaven Alternating Gradient Synchrotron; Transistorized Nuclear Instrumentation (2)	Mon pm—A
Advances in Aerospace Subsystems (6)	Mon pm—F
Control Applications (9)	Tues am—St
Modern Approaches for Improved Air Traffic Management (15)	Tues am—Ma
Industrial Electronic Instrumentation (18)	Tues pm—A
Design of Equipment Reliability (22)	Tues pm—Ma
Communication System Techniques (37)	Wed pm—F
Satellite Communications (44)	Thur am—E
Check-Out Instrumentation and Circuitry (51)	Thur pm—Se

Interference

Radio Frequency Interference (4)	Mon pm—Se

Land and Space

Advances in Aerospace Subsystems (6)	Mon pm—F
Modern Approaches for Improved Air Traffic Management (15)	Tues am—Ma
Panel: Electronics—Out of This World (24)	Tues eve.—G
Space Telemetry (28)	Wed am—Se
Satellite Communications (44)	Thur am—E
Space Electronics (50)	Thur pm—J

Management

Engineering Management—I (5)	Mon pm—E
Engineering Management—II (13)	Tues am—G

Medical Electronics

Varied Views of Medical Electronics (14)	Tues am—F
The Human as Originator of Signals and Schemes (21)	Tues pm—F

Microwaves

Microwave Tubes (23)	Tues pm—Mo
Microwave Filters (32)	Wed am—Mo
Antenna Pattern Synthesis (38)	Wed pm—Ma
Microwave Interaction with Matter (39)	Wed pm—Mo
Scanning Antenna Arrays (46)	Thur am—Ma
Antenna and Propagation Problems (53)	Thur pm—Ma

Military Electronics

Panel: Electronics— Out of This World (24)	Tues eve.—G

Navigation and Traffic Control

Modern Approaches for Improved Air Traffic Management (15)	Tues am—Ma

Production

Production Techniques (7)	Mon pm—Ma

Propagation

Seminar on 1959 ITU Geneva Conferences (29)	Wed am—G
Antenna Pattern Synthesis (38)	Wed pm—Ma
Scanning Antenna Arrays (46)	Thur am—Ma
Antenna and Propagation Problems (53)	Thur pm—Ma

Radio and TV Receivers

Audio and Broadcast and Television Receivers (20)	Tues pm—Se
Broadcast and TV Receivers (26)	Wed am—A

Reliability

Aspects of Component Reliability (31)	Wed am—Ma

Ultrasonics

Ultrasonics Engineering—I (34)	Wed pm—A
Ultrasonics Engineering—II (42)	Thur am—J

Writing and Speech

The Engineer Writes and Speaks (3)	Mon pm—J

The opening meeting will be at 10:30 A.M., Monday, March 21. Lloyd V. Verkner, president of Associated Universities, Inc., will discuss "Can the Social Sciences Be Made Exact?" The high point of the program will be a special symposium on "Electronic—Out of This World." It will be held Tuesday evening, March 22. The symposium will be conducted by Ernst Weber, president of the IRE for 1959, and a panel of space electronics experts.

The convention will be held in New York City at the Waldorf-Astoria Hotel and the New York Coliseum.

INDUSTRIAL SEALED RELAYS—unmatched for reliability

The relay that doesn't know how to fail!

We got tired of waiting for this General Electric Miniature sealed relay to stop. It just kept switching . . . and switching . . . and switching . . . through more than 750 million no-load operations before we finally gave up and took it off test.

Frankly, we just don't have the time or patience to find out what its actual mechanical life really is. We're too busy *building* highly reliable relays for computer, machine tool, instruments, and other industrial electronics jobs.

But, this doesn't mean we're "asleep at the switch" and don't know *why* the G-E Miniature relay performs so remarkably. It all stems from a superior E-frame magnet making possible larger gaps and more overtravel . . . a molded stack for mechanical rigidity . . . Beryllium copper contact springs assuring long spring life . . . and, a knife-edge pivot which eliminates pivot wear.

Now don't get the idea that this reliable performance is confined to a mechanical-life test. To the contrary, this rugged relay is pre-conditioned to a life of "hard knocks." Built-in shock and vibration resistance (ranging to 50G's shock, and 10G's vibration at 5-500 cps) mean that the G-E Miniature can cope with just about any industrial demand. And, under typical conditions, a G-E Miniature relay will switch the coil of a similar relay through at least a hundred million operations. It can switch size "0" or "00" contactor coils more than 40 million times!

What's more, a General Electric industrial Miniature requires less than one watt of power—a significant benefit when a number of relays are in the circuit. And, operating times as short as 10 milliseconds are possible, accompanied by a sustained repetition rate of 2000 operations per minute!

Add to all of this the fact that a G-E Miniature's small size saves valuable panel space . . . that it's not position-sensitive and can mount in any plane . . . that wiring is convenient . . . that the clearance and creepages on the header and socket meet NEMA requirements . . . and you know why the G-E Miniature sealed relay will out-perform any other type of relay in many industrial electronic applications.

Why not see your G-E Apparatus Sales Engineer today? He has all the details on the *seven* forms of General Electric Miniature sealed relays—each in a wide variety of terminations—for virtually every industrial switching need. Or, if you prefer, mail the coupon at right. General Electric Co., Specialty Control Dept., Waynesboro, Virginia.

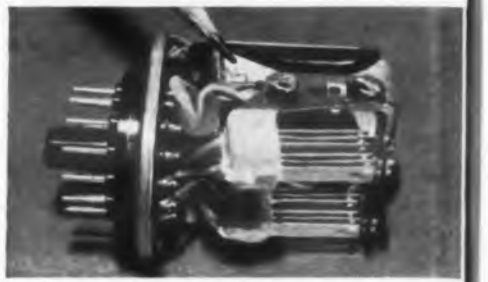
Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 69 ON READER-SERVICE CARD

Unique construction features give G-E Miniature relays unmatched reliability in industrial electronics jobs

LONGER MECHANICAL LIFE of G-E industrial relays is due—in part—to G.E.'s exclusive use of molded contact stacks which won't loosen or shift to the degradation of relay performance.



DEPENDABLE PERFORMANCE is contributed by the powerful G-E E-frame magnet—another exclusive design providing higher contact pressures, larger contact gaps, more contact overtravel.

GREATER STABILITY of G-E relays is a result of G.E.'s unique support design with the relay actually supported by its can. Other relays use a cantilever support from the base only.

General Electric Company
Section A792-15
Schenectady, New York

Please send me a free copy of Bulletin GEA-6665A, Sealed Relays for Industrial Application.

Name ________________
Address ________________
City ________________
State ________________

GENERAL ELECTRIC

EDITORIAL

How to Get Your Money's Worth Out of the IRE International Convention

Industry leaders overwhelmingly endorse the desirability of technical conventions, but they are understandably becoming concerned about the growing number. A recent study of meetings in the field of flight sciences, prepared for the Daniel and Florence Guggenheim Foundation, found that industry leaders agreed, 2 to 1, that there were too many gatherings. The study estimates that the 43 meetings on flight sciences last year had cost the industry 258,000 man-days of technical time and $21,500,000 or more in man-costs. To this was added about $1,000,000 to $3,000,000 for the time and money to prepare papers, arrange the meetings, publish programs, create and install exhibits, etc.

Here are some suggestions for getting the most out of your time at the forthcoming IRE colossus, which features 15 simultaneous technical sessions each day and 850 exhibits on four floors:

1. Plan your attendance at the sessions by checking the advance program. (See tabulation of the sessions on p 68 of this issue.) Decide with other engineers from your company who will cover which sessions.

2. Be an aggressive listener. Before attending technical sessions, check the summaries in the IRE Guide. Make notes at the sessions. Evaluate the discussion. Question the speaker about his paper after the formal discussion period.

3. Plan your booth visits by checking the show product preview in this issue. It begins on p 128.

4. Get in touch in advance with those supplier company engineers with whom you wish to discuss new products or new developments. Breakfast, lunch, or dinner appointments can be handy ways to avoid conflicts with the technical program.

5. Absorb technical information as well as refreshments at hospitality suites.

6. If you are from out of town, plan contacts with companies in the Greater New York area as part of your trip.

When the convention is over, analyze your experiences and make suggestions for improvements directly to the IRE or to this magazine. Constructive ideas are needed and are always welcomed.—*EEG*

ELECTRONIC DESIGN looks forward to meeting you at the show. Drop by and shoot the breeze with our editors at Booths 4404-4406—particularly if you are planning to write an article. But whether you write or not, stop by and shake hands. Our pleasure.

Resistance-Value Curves Simplify Line-Amplifier Design

Jack Shirman
Stromberg-Carlson Div.
General Dynamics Corp.
Rochester, N. Y.

Jack Shirman, tired of repeating calculations every time he needed a slightly different amplifier gain, developed a simple procedure and a handy set of curves. The curves take all the time-consuming slide-rule work out of designing a highly-stable 600-ohm line amplifier.

BY SIMPLY changing resistor values, one can change the gain of the balanced audio amplifier of Fig. 1 over a range from 4 to 20 db. A set of curves in this article gives the required resistance values.

Without an input transformer or other auxiliary input circuitry, the amplifier is fed from a balanced 600-ohm line or from a 600-ohm line with

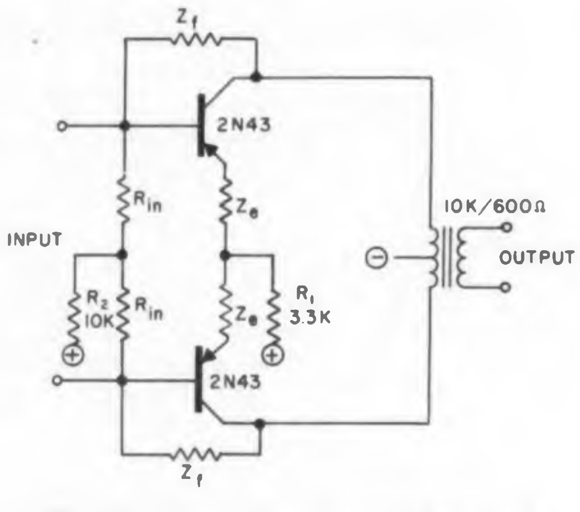


Fig. 1. Basic configuration of a balanced transistor amplifier for 600-ohm lines.

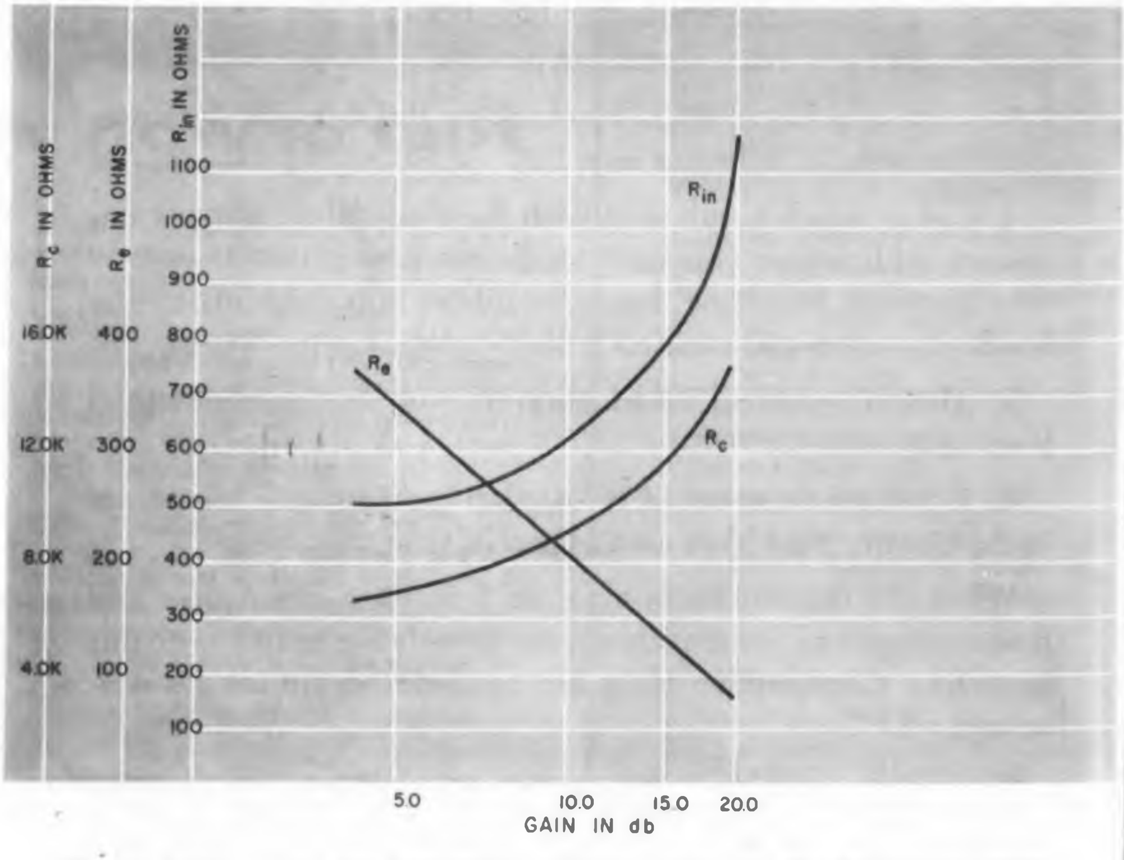


Fig. 2. Design curves for determining resistance values for the balanced amplifier.

one side grounded. Series feedback and shunt feedback around the transistors render the amplifier highly stable.

Its simple circuitry provides these advantages:

- Very low noise level.
- Excellent frequency response, a function only of the output transformer.
- Good temperature stability.
- Operation with balanced or single-ended input.
- Excellent gain stability with variation in transistor parameters and supply voltages.
- Absence of capacitors.

The circuit in Fig. 1 shows the two types of feedback used. Since this is a balanced circuit both values of Z_e are identical as are both values of Z_f and R_{in}. No balance is required in the transistors due to the biasing scheme which provides class AB operation.

The collector-to-base feedback Z_f is an important factor which allows better than a 3 to 1 unbalance in beta. The primary impedance of the output transformer, selected as 10 K, reflects a 2.5-K load to each transistor and helps deliver maximum power out of a 2N43. Both the output and input impedances are 600 ohms ±10 per cent as required for most telephone systems.

The values of R_1 and R_2 give maximum peak-to-peak output at a particular gain. The values of 3.3 K and 10 K for R_1 and R_2 respectively give best results for a 10-db amplifier. Tests show, however, that these values give quite satisfactory results over the entire gain-spectrum of the circuit.

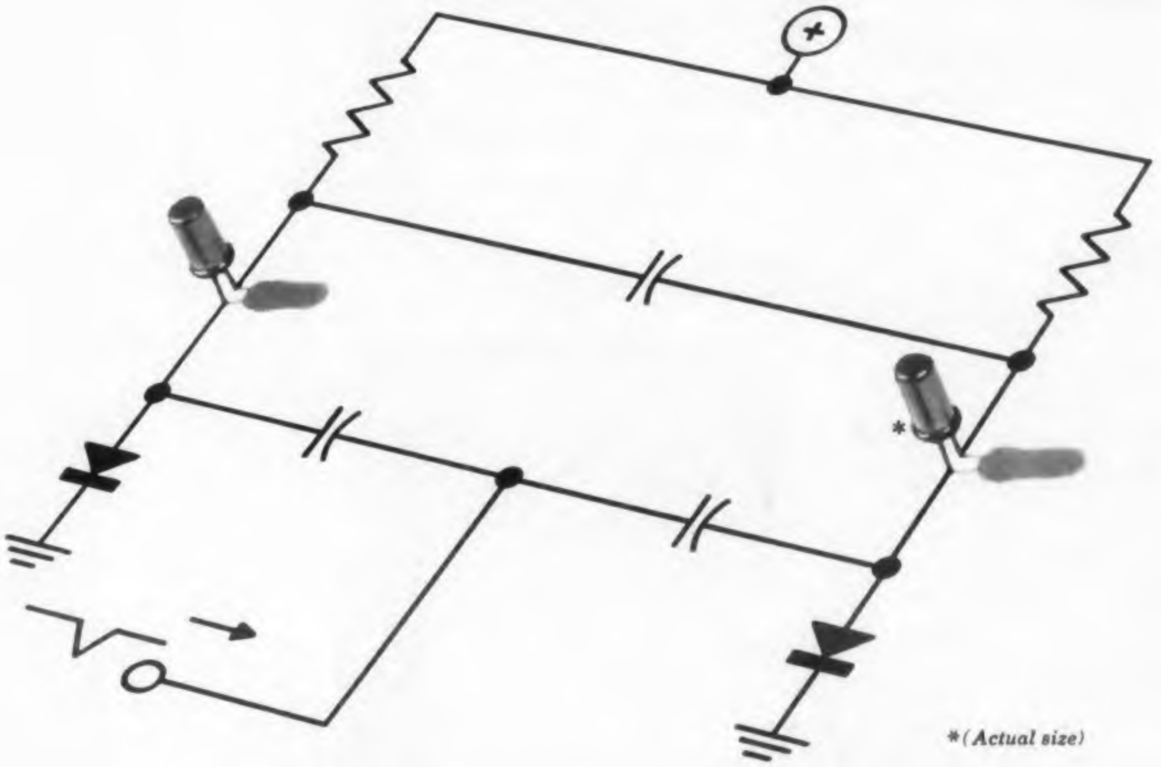
Fig. 2 shows curves for Z_e, Z_f, and R_{in} vs gain. It is a simple matter for the design engineer, requiring a particular amplifier gain to use these curves for the necessary resistance values. It is, of course, obvious that only a few values of gain can be achieved by using standard 5-per-cent resistors.

However, since high stability is usually a requirement when using this circuit, 1-per-cent resistors are generally used. This allows the selection of nearly any desired gain. It should again be pointed out that the input and output impedances remain fixed at 600 ohms ±10 per cent.

The amplifier gain stability for varying supply voltages and transistor betas is shown in Fig. 3. This set of curves shows why it is not worthwhile having a larger gain spread than 4 to 20 db.

As the gain is increased, the effect of transistor beta spread is an exponentially increasing function. That is, as the amount of negative feedback is decreased the effect of beta on gain stability increases exponentially. Above 20 db the reduced stability no longer justifies using this type circuit.

Fig. 3 also indicates that, at the low end of the gain curve, increasing the amount of negative feedback no longer improves the stability. The stability of the amplifier for supply voltage variation is a straight line plotted on semi-log paper as



Simplified A. C. Transfer Standard

Coaxial Design for Broad Frequency Response and Ease of Operation

Model TV 1

THERMAL TRANSFER VOLTMETER

RANGE .5 volts to 1200 volts three decade range multiplier.

NULL SENSITIVITY .04%/C.M. L & N Type 2430A Galvo Provided

THERMO-COUPLE TEMPERATURE MEASUREMENT

The Thermo Couple Potentiometer is calibrated in percent of A.C. Input voltage. Calibration on 2 decades switches and 10 turn pot. This allows operator to read frequency response in percent without D.C. transfer. Zener regulated supplies eliminate battery drift.

FREQUENCY RESPONSE

.5 to 290 volts .02% to 50 KC 300 to 1200 volts .02% to 10 KC Calibration curves provided to 5 megacycles with accuracy of 0.1%.

THERMO-COUPLE

D. C. Reversal Error less than .02%. Couples plug in replacable $40.00. Couple operated in thermally balanced bridge to eliminate temperature drift.

D. C. TRANSFER

Transfer measurement is made to a calibrated D. C. supply of the same voltage as the unknown A. C. being measured. This eliminates ratio errors in the high frequency multiplier resistors.

Write for complete information.

See us in Booth No. 3814 at the IRE SHOW, or at main exhibit in St. Moritz Hotel.

Holt INSTRUMENT LABORATORIES

OCONTO • WISCONSIN

H I LAB

CIRCLE 73 ON READER-SERVICE CARD

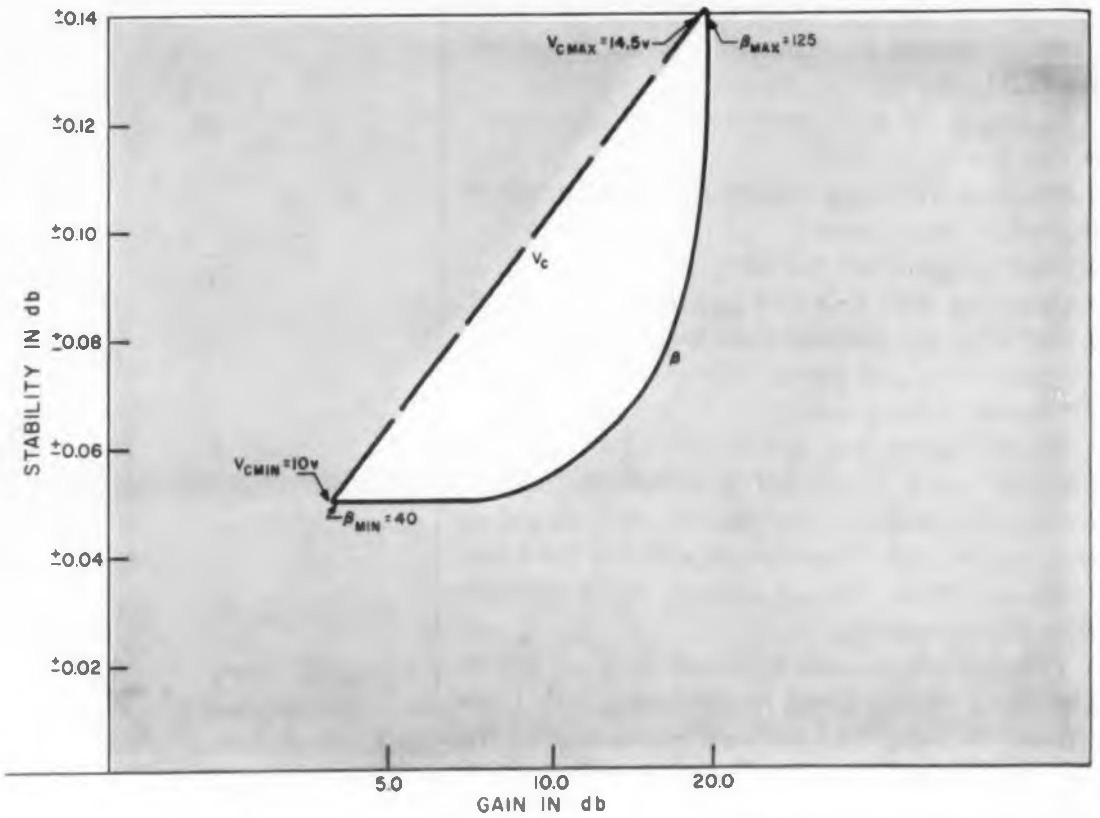


Fig. 3. (above) Gain stability as a function of gain at 1000 cps, 25 deg C. The curves cover a power-supply variation (V_c) of ±10 to 14.5 v and variation in transistor beta from 40 to 125.

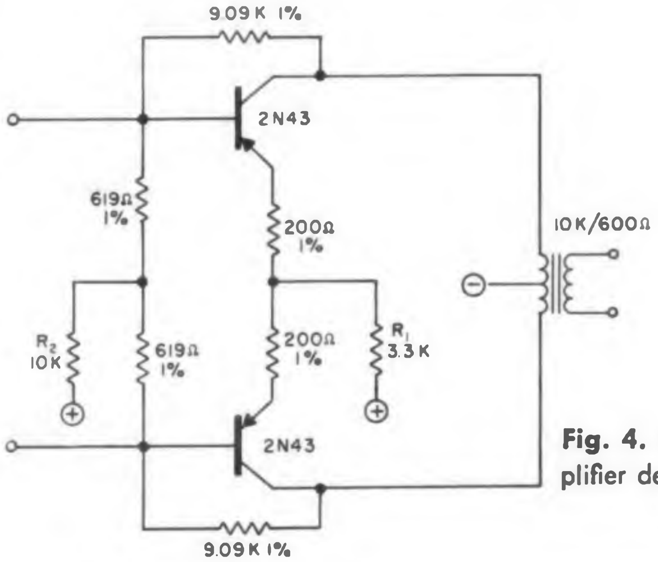


Fig. 4. The balanced transistor amplifier designed for a 10-db gain.

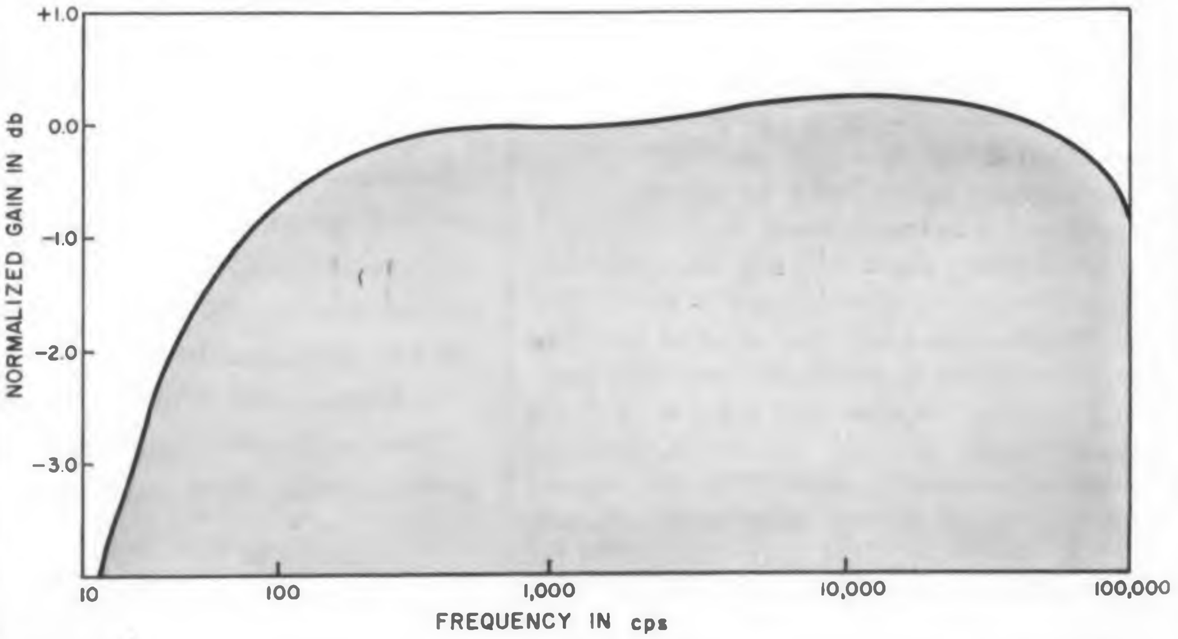


Fig. 5. Frequency response for the 10-db amplifier at 25 deg C. Transistors have a beta of 55 and the supply voltage is 12.3 v.

a function of the gain (i.e. the amount of negative feedback applied). The circuit's gain is highly stable over a temperature range from —20 to +70 C. Several tests at —40 C show no appreciable shift in gain.

With the indicated values of R_1 and R_2, the maximum output of the amplifier is 1.5 v rms to a 600-ohm load for any selected gain. For a particular gain, adjustment of R_1 and R_2 will result in larger output voltages. Care should be taken not to exceed the dissipation rating of the transistors.

Design Procedure

Assume a 10-db amplifier is required which is to deliver 2.2 v peak-to-peak (0 dbm) to a 600-ohm load.

Looking at Fig. 2, we see that for 10-db gain $R_e = 200$ ohms, $R_{in} = 620$ ohms and $R_c = 9.1$ K. These are all standard 5 per cent values but as mentioned before, 1 per cent tolerance resistors are used. Fig. 5 shows that for a β spread of 40 to 125, we get a gain variation of ± 0.055 db and for a battery range of ± 10.0 v to ± 15.0 v, we get a variation of ± 0.10 db. Excluding resistor variations we now have a circuit designed to give a gain of 10 db ± 0.16 db.

The completed circuit shown in Fig. 4 has a noise level of —73 dbm with no input but including battery noise. Maximum output voltage is 2.0 v rms. There is no noticeable change in gain over a temperature range of —20 to +70 C.

The frequency response curve is given in Fig. 5. It should be noted that this response, in the lower frequency range, is entirely a function of the transformer used. Measurements show less than 0.5 per cent total distortion at 0.8 v rms and less than 1 per cent at 1.6 v rms with maximum transistor unbalance.

Circuit Limitations

Several limitations exist in the use of this circuit. The battery voltage range is ± 10.0 v to ± 15.0 v. The design curves are given for only 600-ohm input and output impedance. Though the output transformer secondary can be designed for any desired impedance level the input must necessarily be 600 ohms. If an input transformer is used a large part of the circuit advantage is lost.

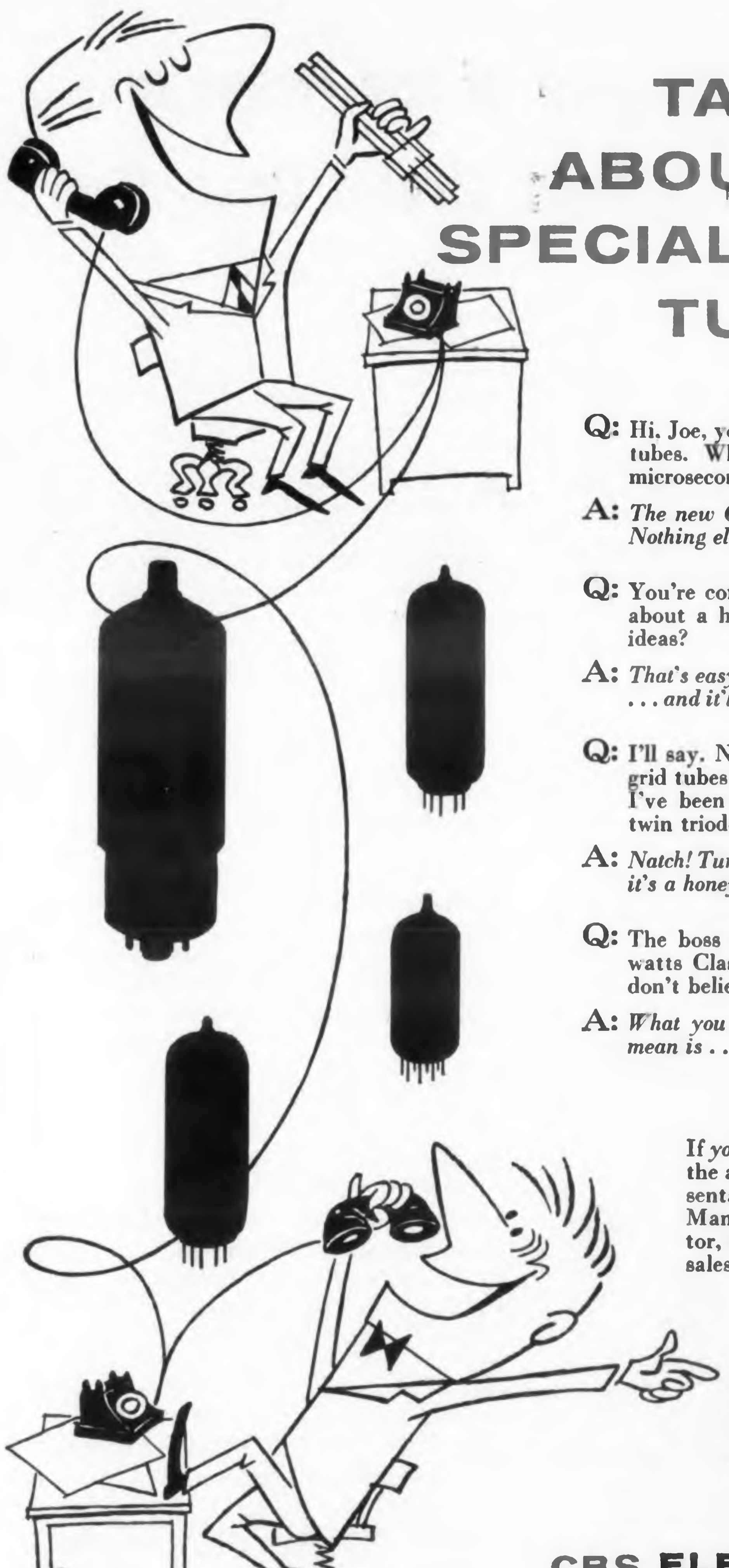
One other important design consideration is manufacturing tolerance on the transformer. Variations in insertion loss and dc resistance have not been considered in any of the curves or calculations. ■ ■

References

L. P. Hunter, Handbook of Semiconductor Electronics, McGraw-Hill Book Co.

R. F. Shea, Transistor Circuits, John Wiley & Sons, Inc.

H. Lefkowitz, Transistor AC Amplifier Uses Multiple Feedback, *Electronics*, May 23, 1958.



Graphical Solution of the Resonance Equation Speeds Circuit Design

Dr. Phil R. Amlinger*
Epsco Worcester
Worcester, Mass.

"Graphical methods," says Phil Amlinger, "can solve many differential equations in a very simple way." He wrote this article, the first in a series on graphical solution of network problems, to show how easily vector diagrams can solve the resonance equation.

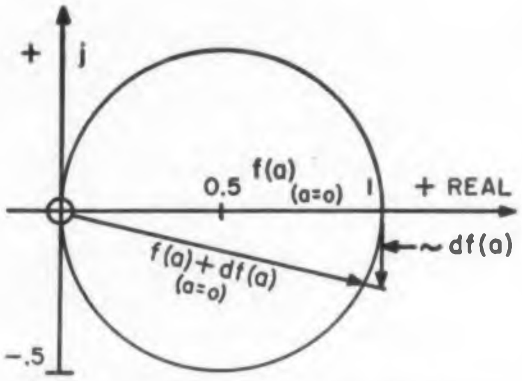


Fig. 1. Development of the vector diagram shows vector differential $df(a)$ applied to point $f(a) = 1$.

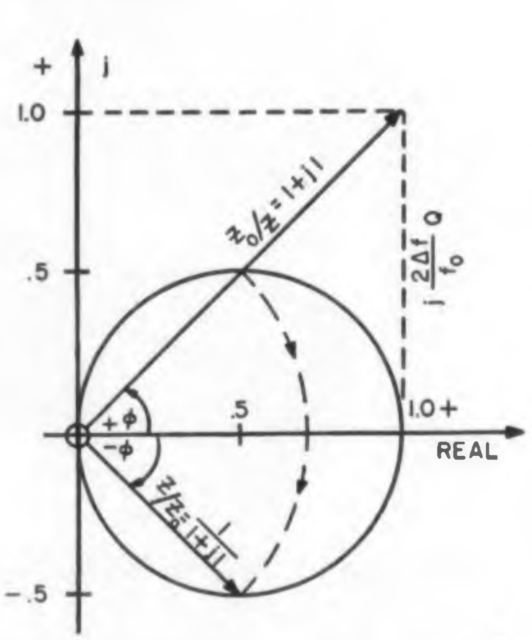


Fig. 2. Construction of vector $f(a)_{(a=1/2)} = 1/(1 + j1)$ from the inverse vector $1 + j1$.

AT A GLANCE, graphical methods can present a complete picture of a complex function and can obviate tedious computations. Applied to the general resonance equation, one graph can show magnitude and phase angle, real and imaginary part, attenuation and bandwidth.

When Q is greater than 10, the general resonance curve is closely approximated by

$$\frac{Z}{Z_0} = \frac{1}{1 + j\frac{2\,\Delta f}{f_0}Q} = \frac{Y}{Y_0}$$

where Z is the impedance of a parallel resonant circuit, Y is the admittance of a series resonant circuit, Z/Z_0 and Y/Y_0 represent the normalized impedance and admittance, and the subscript 0 shows resonance.

One can introduce the term $a = (\Delta f/f_0)\,Q$ where Δf is half the 3-db bandwidth and $Q = \omega_0 L/R$. In terms of a, one can express

$$\frac{Z}{Z_0} = f(a) = \frac{1}{1 + j2a}$$

Vector Diagram Construction Needs Three Points On Circle

This expression represents a circle in the complex plane. Two points of the circle can be found easily for the extremes of the parameter $a = 0$, and $a \to \infty : f(a)_{(a=0)}$ and $f(a)_{(a\to\infty)} = 0$.

To obtain the third criterion for the circle one must see how the function behaves near point $f(a)_{(a=0)} = 1$. Adding the infinitesimal value da to $a = 0$, gives $df(a)$, which represents the increase of the function at the desired point $f(a)_{(a=0)} = 1$. Differentiating:

$$\frac{d}{da}f(a) = \frac{d}{da}\left(\frac{1}{1+j2a}\right) = \frac{-j2}{(1+j2a)^2}$$

yields

$$df(a) = \frac{-j2da}{(1+j2a)^2}$$

and with $a = 0$, one obtains

$$df(a)_{(a=0)} = j2da$$

which is an infinitesimal vector in the direction $-j$. (See Fig. 1.)

The function crosses the real (horizontal) axis at point $f(a) = 1$ at a right angle and vector $-j2da$ is tangent to the circle through points *1* and *0*, with the center at *0.5* on the real axis. Note that $df(a)$ is considerably enlarged for clarity. For $-da$ one finds $df(a)_{(a=0)} = +j2da$. The vector differential can be applied to any point $f(a)$, but the one chosen is most convenient. Choosing

$$a = \frac{1}{2}$$

gives

$$f(a)_{(a=1/2)} = \frac{1}{1+j1}$$

First one draws the denominator, vector $1 + j1$, with magnitude $|1 + j1| = \sqrt{2}$ and phase angle $\varphi = \pi/4$. (See Fig. 2.)
From Euler's Theorem one can write

$$\begin{aligned} 1 + j1 &= \sqrt{2}\,(\cos \pi/4 + j \sin \pi/4) \\ &= \sqrt{2}\,\epsilon^{j\pi/4} = \sqrt{2}\,\underline{/45^\circ} \end{aligned}$$

which leads to

$$f(a)_{(a=1/2)} = \frac{1}{1+j1} = \frac{1}{\sqrt{2}}\,\epsilon^{-j\pi/4} = \frac{1}{\sqrt{2}}\,\underline{/-45^\circ}$$

with magnitude

$$\left|\frac{1}{1+j1}\right| = \frac{1}{\sqrt{2}}$$

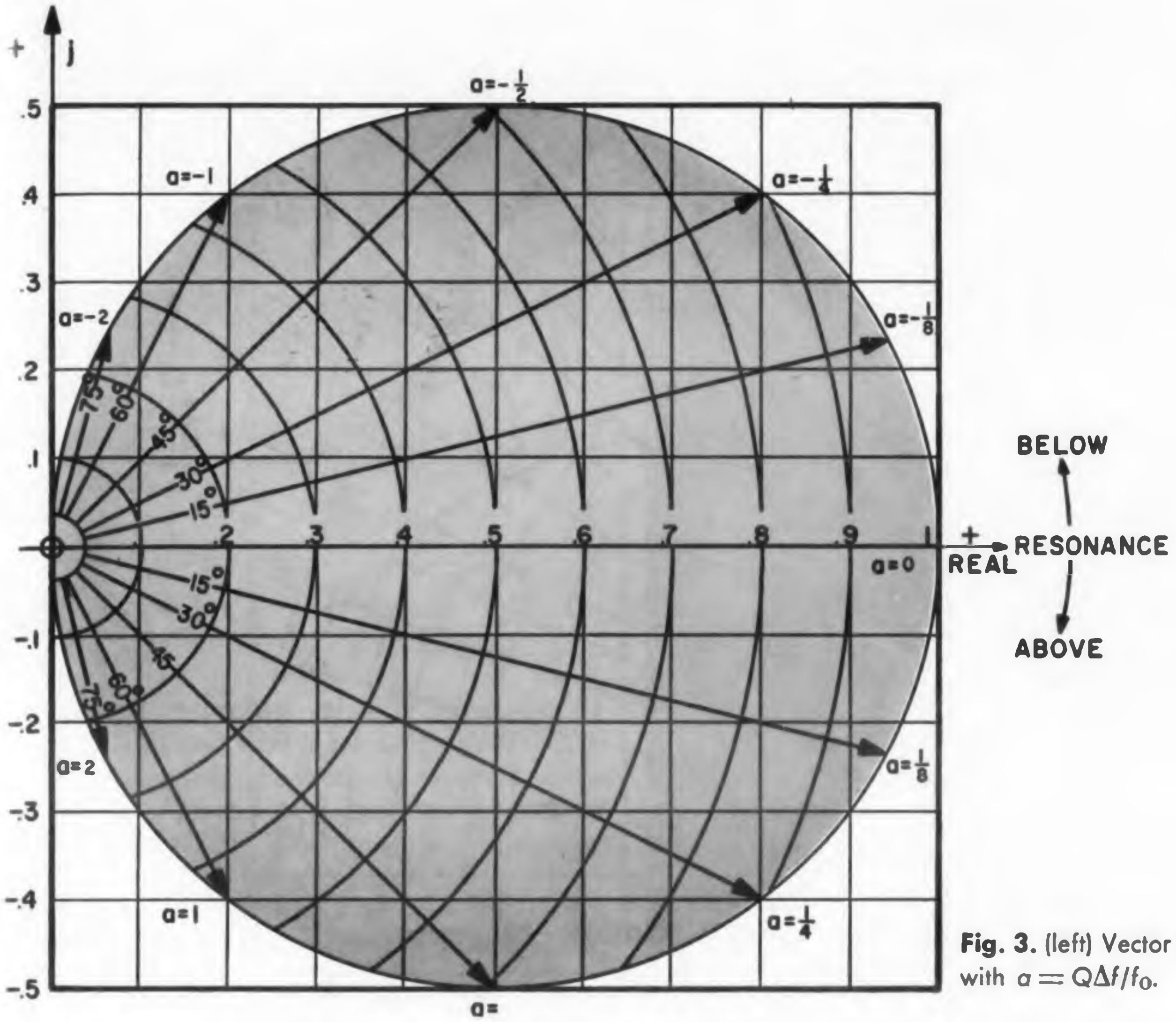
and phase angle $\varphi = -\pi/4$. Hence, as the function $f(a) = 1/(1 + j2a)$ is represented by the circle in Fig. 2, one finds any particular value by drawing vector $(1 + j2a)$ and then swinging it around the real axis by the amount of its phase angle, thus reversing the sign of φ. The intersection with the circle represents vector $1/(1 + j2a)$.

Vector Diagram Shows Off-Resonance Effects

Fig. 3 shows a detailed construction of the resonance equation with different values of a. At resonance, $a = 0$ and $f(a) = Z/Z_0 = Y/Y_0 = 1$. The circuit is resistive. Below resonance, $\omega < \omega_0$, so $a < 0$. For example, $a = -1/2$ gives $Z/Z_0 = f(a) = 1/(1 - j1) = 1/2 + j\,1/2 = 0.708\ \underline{/45^\circ}$. This indicates that the magnitude $Z/Z_0 = 0.708$, the real component $= 0.5$, the imaginary component $= 0.5$. Hence the circuit is inductive with phase angle $\varphi = 45$ deg.

---

*Dr. Amlinger is no longer with Epsco Worcester.



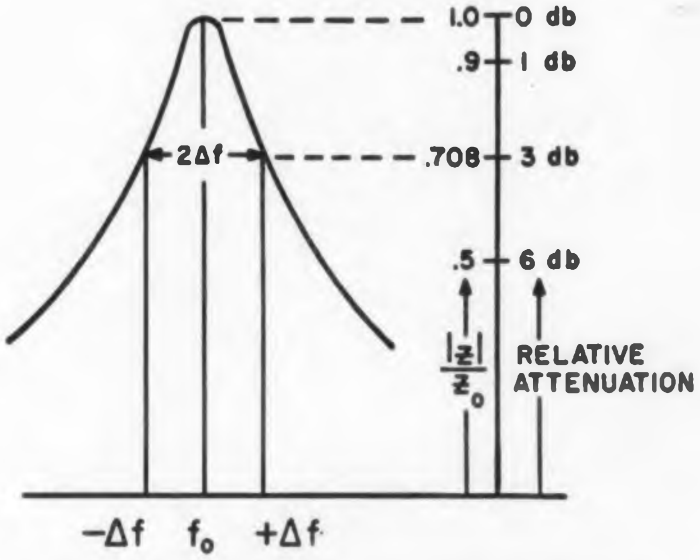


Fig. 4. Parallel resonance curve shows the magnitude of the normalized impedance.

Fig. 3. (left) Vector diagram of the resonance equation with $a = Q\Delta f/f_0$.

For $a = 0$ and da in the negative direction, $df(a)_{(a=0)} = +j2da$ which means that the function runs counterclockwise on the upper semicircle for all negative values of a representing $\omega < \omega_0$. Hence, below resonance $f(a)$ is inductive, and above resonance, with $a > 0$, $f(a)$ is represented by the lower semicircle so the circuit is capacitive.

Fig. 3 shows immediately that the real component is maximum at resonance and that it decreases off resonance. The imaginary component is zero at resonance and reaches its maximum for $a = \pm 1/2$ where real and imaginary parts have equal magnitude and the phase angle is 45 deg. At this point the magnitude of the impedance (or admittance) is 0.708 of the resonance value, that is, it is 3 db down.

Design Application Gives Impedance, Voltage, Phase, Bandwidth, and Q

The magnitude of the normalized impedance

$$\frac{|Z|}{Z_0} = \frac{1}{\left| 1 + j\,\frac{2\Delta f}{f_0}\,Q \right|}$$

as read from Fig. 3, is plotted separately in Fig. 4, together with a db scale for the relative attenuation.

This, of course, is the familiar resonance curve of a single-tuned LC circuit. The impedance, and therefore, the voltage-decrease off resonance is a function of the detuning $\pm\Delta f$ and the circuit Q. The condition for 3-db attenuation is a Q-bandwidth product

$$\frac{Q}{f_0}\,bw_{(3db)} = \frac{2\Delta f}{f_0}\,Q = 1$$

where $2\Delta f$ is the 3-db bandwidth (bw) between the specified impedance vectors, yielding

$$\frac{Z}{Z_0} = \frac{1}{1 \pm j1} = \frac{1 \mp j1}{2} = 0.708 \underline{/\mp 45^\circ}$$

One can now construct a chart for a specified attenuation. Again a circle through points *1* and *0* with the center at *0.5* on the real axis represents the function

$$\frac{Z}{Z_0} = \frac{1}{1 + j\,\frac{2\Delta f}{f_0}\,Q}$$

Along the real axis a db scale indicates the relative attenuation.

The particular value is transferred to the circle by means of a compass. The intersection represents the normalized impedance vector

$$\frac{Z}{Z_0} = \frac{1}{1 + j\,\frac{2\Delta f}{f_0}\,Q}$$

for the particular attenuation.

It is now necessary to find the Q-bandwidth product. The reciprocal vector

$$\frac{Z_0}{Z} = 1 + j2\,\frac{\Delta f}{f_0}\,Q$$

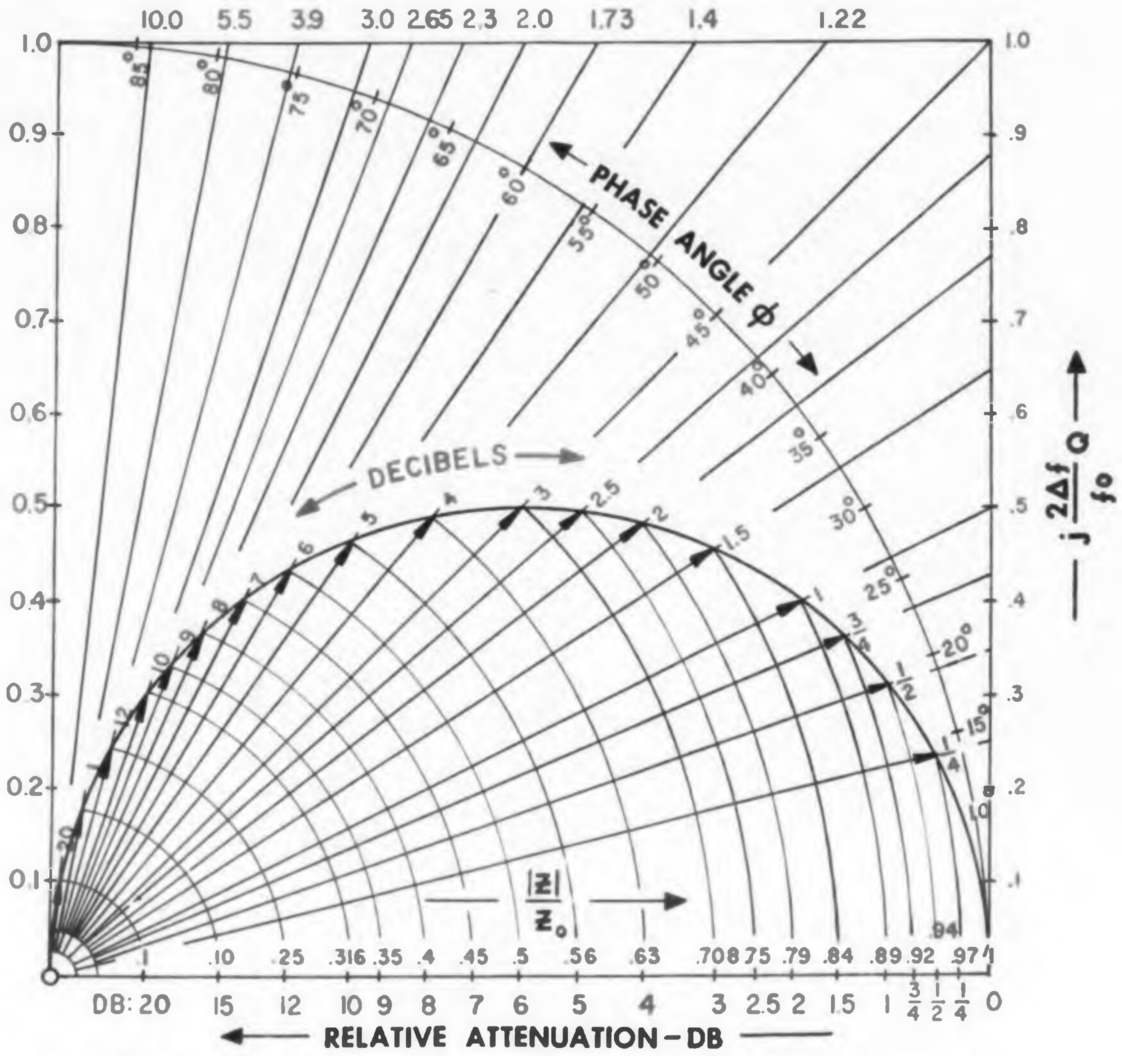
is found at the ordinate through point *1.0* on Fig. 5. Extending the impedance vector, for example, for 3-db attenuation, till it intersects the ordinate, yields vector

$$\frac{Z_0}{Z} = 1 + j1$$

One can simply read the Q-bandwidth product $2Q\Delta f/f_0$ for the particular attenuation at the ordinate through point *1.0*. For 6-db attenuation one reads $|Z|/Z_0 = 0.5$ and $2Q\Delta f/f_0 \approx 1.73$. For 1-db attenuation $|Z|/Z_0 \approx 0.89$ and $2Q\,\Delta f/f_0 = 1/2$. The vectors

$$\frac{1}{1 + j\,\frac{2\Delta f}{f_0}\,Q} \quad \text{and} \quad \frac{1}{1 - j\,\frac{2\Delta f}{f_0}\,Q}$$

are conjugate values or mirror images of each



RELATIVE ATTN.-DB	0	1/4	1/2	3/4	1	1.5	2	2.5	3	4	5	6	7	8	9	10	12	15	20	>20	<1/4
$\frac{2\Delta f}{f_0}Q$	0	.25	.35	.43	.5	.65	.77	.88	1.0	1.22	1.47	1.73	2.0	2.3	2.65	3.0	3.9	5.5	10.0	$\approx \frac{Z_0}{\lvert Z \rvert}$	$\approx$ DB (ATT).
$\lvert Z \rvert / Z_0$	1.0	.97	.944	.92	.89	.84	.794	.75	.708	.63	.56	.5	.45	.4	.35	.316	.25	.178	.1	<0.1	~1.0
PHASE ANGLE φ	0°	14°	19.3°	23.3°	26.5°	33°	37.6°	41.4°	45°	50.7°	55.8°	60°	63.5°	66.5°	69.3°	71.6°	75.7°	79.7°	84.3°	(→) 90°	(→) 0°

Fig. 5. Design chart and table giving resonant circuit parameters—phase angle, Q-bandwidth product, normalized impedance, and attenuation.

other as reflected in the real axis, that is, their magnitudes and real parts are equal but their imaginary parts have opposite sign. Therefore, assuming good symmetry of the resonance curve, one needs only a semicircle to represent Z/Z_0.

The final chart, Fig. 5, enables one to determine quickly the bandwidth vs. Q for a specified relative attenuation or vice versa. The values for $2(\Delta f/f_0)\,Q > 1$ are plotted along the abscissa through point *1.0*, to save space. Some examples will demonstrate the usefulness of the chart!

Design Examples With Single And Cascaded Circuits

■ For a single-tuned tank circuit with resonant frequency $f_0 = 1$ mc and $Q = 150$, what is the 3-db bandwidth?

The chart in Fig. 6 gives the conditions for 3-db attenuation.

$$\frac{2\Delta f}{f_0}\,Q = 1$$

Hence

$$bw_{(3db)} = 2\Delta f = \frac{f_0}{Q} = \frac{1 \times 10^6}{150} = 6.66 \text{ kc}$$

$$= 0\ 66 \text{ per cent } f_0$$

■ For a single-tuned tank, resonant at 1 mc, a 6-db bandwith of 20 kc (2 per cent f_0) is required. What is the required Q?

For 6-db attenuation, the chart in Fig. 6 shows

$$2\,\frac{\Delta f}{f_0}\,Q = 1.73$$

Hence

$$Q = \frac{1.73}{2\Delta f}\,f_0 = 1.73\,\frac{1 \times 10^6}{2 \times 10^4} \approx 87$$

■ A multi-stage, single-tuned amplifier, resonant at 100 mc, is to have a 3-db bandwidth of 1 mc (1 per cent f_0). It has n cascaded stages with $n =$ 3. What is the necessary Q per stage, and what will be the attenuation and phase shift per stage and for the entire amplifier?

Since the overall attenuation is 3 db, the attenuation per stage is 3/n db = 1 db. For 1-db attenuation, the chart gives

$$\frac{2\Delta f}{f_0} Q = \frac{1}{2}$$

$$Q_{stage} = \frac{1}{2} \frac{f_0}{2\Delta f} = \frac{1}{2} \frac{100}{1} = 50$$

yielding

$$\frac{Z}{Z_{0\,(stage)}} = \frac{1}{1 \pm j\frac{1}{2}} = 0.89 \underline{/\mp 26.5^\circ}$$

The overall voltage ratio

$$\frac{E}{E_0} = \left(\frac{Z}{Z_0}\right)^3 = (0.89\, \epsilon^{\mp j\, 26.5^\circ})^3 = 0.708 \underline{/\mp 79.5^\circ}$$

that is, total attenuation within the required bandwidth is 3 db, and total phase shift is ±80 deg.

■ Three-cascaded, single-tuned, identical stages have an f_0 of 70 mc. At $f_0 \pm 20$ mc the attenuation must be 80 db. What must the Q per stage be and the 3-db bandwidth per stage?

The 80-db bandwith is $2\,\Delta f = 40$ mc. Hence, the attenuation per stage is 80/3 = 26.66 db.

$$26.66\ db = 20 \log X$$

$$X = 21.5$$

This gives

$$\frac{|\,Z\,|}{Z_{0\,(stage)}} = \frac{1}{21.5}$$

The table in Fig. 6 shows, for a relative attenuation ≧ 20 db,

$$\frac{Z_0}{|\,Z\,|} \approx 2 \frac{\Delta f}{f_0} Q$$

Hence

$$\frac{2\Delta f}{f_0} Q \approx 21.5$$

yielding

$$Q_{(stage)} = 21.5 \frac{70 \text{ mc}}{40 \text{ mc}} = 37.5$$

and, with the condition for 3-db attenuation of a single stage,

$$\frac{2\Delta f}{f_0} Q = 1$$

$$per\ stage\ bw_{(3db)} = 2\Delta f = \frac{f_0}{Q} = \frac{70 \text{ mc}}{37.5} = 1.86 \text{ mc}$$

For convenience, some values of the chart in Fig. 6 are tabulated below it. ■ ■

NOW EXCLUSIVELY VACUUM MELTED
KARMA High Resistance Alloy
THERLO Glass Sealing Alloy

This dramatic "first" in the manufacture of nickel alloys by Driver-Harris has been achieved by expanded vacuum melting capacity. It is still another example of our continued leadership in producing electrical and electronic nickel alloys of the highest purity.

D-H vacuum melting produces alloys of higher ductility and tensile properties. These are achieved by greatly reducing inclusions, especially oxides and nitrides. Other direct benefits are elimination of gas, not only from the surface but from the entire mass, and general improvement in the electrical, electronic and mechanical properties to meet critical specifications.

For additional information about Karma, Therlo and the other 130 high-nickel alloys manufactured by Driver-Harris, write for a copy of the D-H Alloy Manual.

*T.M. Reg. U.S. Pat. Off.

VACUUM MELTED KARMA* High Resistance Wire

The temperature coefficient of superior KARMA resistance wire has been improved to less than ±10 parts per million from —60°C. to +125°C. Higher stability and linearity are added to these important properties.

- Low thermal EMF against copper (equaled only by Manganin)
- Improved ductility
- High resistance to oxidation
- Wire sizes down to .0005"
- 800 ohms per circular mil foot

VACUUM MELTED THERLO* Glass Sealing Alloy

Improved workability is the major result of vacuum melting THERLO . . . the long established cobalt, nickel, iron alloy for sealing to hard or thermal shock resistant glass.
THERLO also:

- Produces a permanent vacuum-tight seal with simple oxidation procedure
- Resists mercury
- Is readily machined and formed—deep drawn or spun
- Can be welded, soldered, brazed
- Is available as rod, wire, strip, sheet foil—and in special shapes

DRIVER-HARRIS* COMPANY
HARRISON 26, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville
Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario
MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

CIRCLE 76 ON READER-SERVICE CARD

Amplitude-Modulation Techniques Class-C RF Amplifiers

N. Wesler and J. Fokine*
Design Engineers Ford Instrument Co. Long Island City, N.Y.

Amplitude-modulation techniques have not received the glamorous fanfare and publicity given to fm, ptm, pwm, and other more modern methods of impressing intelligence on a carrier. However, the comparatively ancient techniques are still being widely used by the military, industrial and amateur services with satisfactory performance and reliability.

Here is a roundup of the more popular am techniques currently in use.

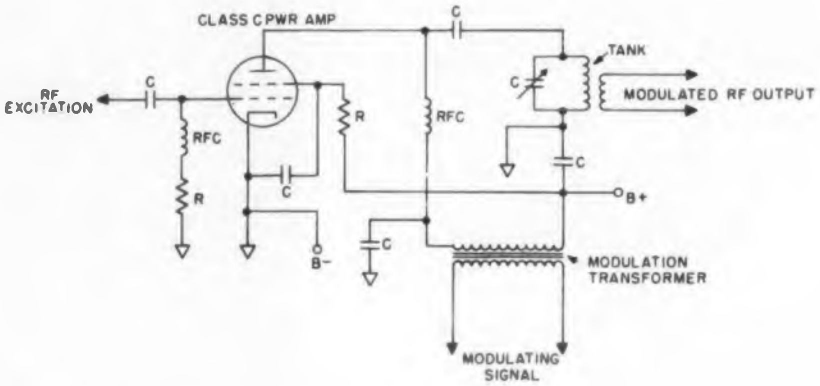


Fig. 1. Plate-modulated output stage.

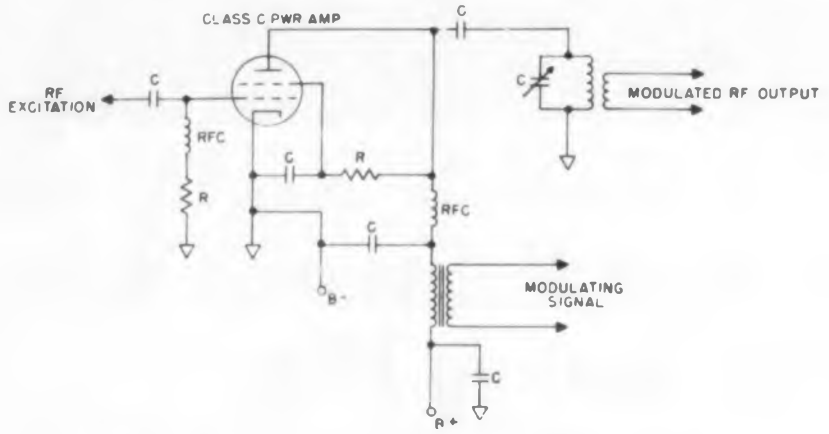


Fig. 2. Combined plate-screen modulated stage.

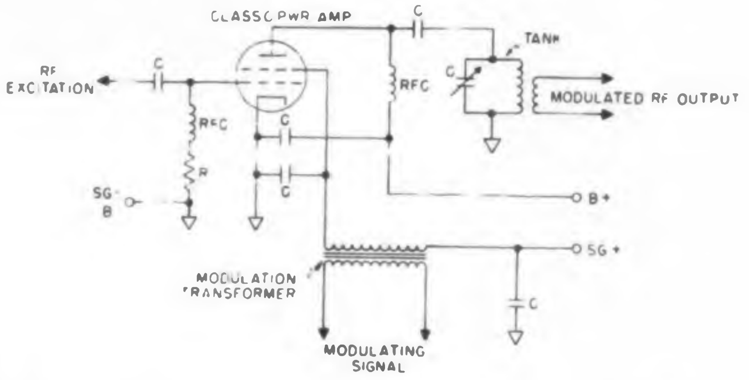


Fig. 3. Screen grid modulation using modulation transformer

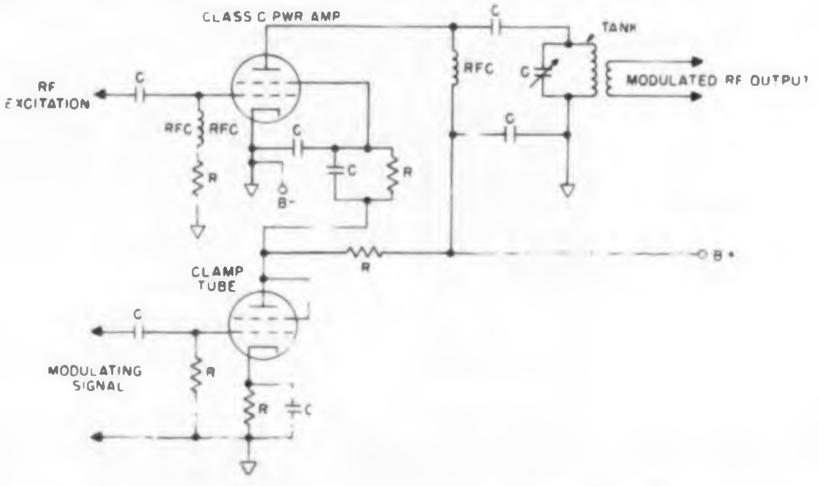


Fig. 4. Screen grid modulation with clamp tube.

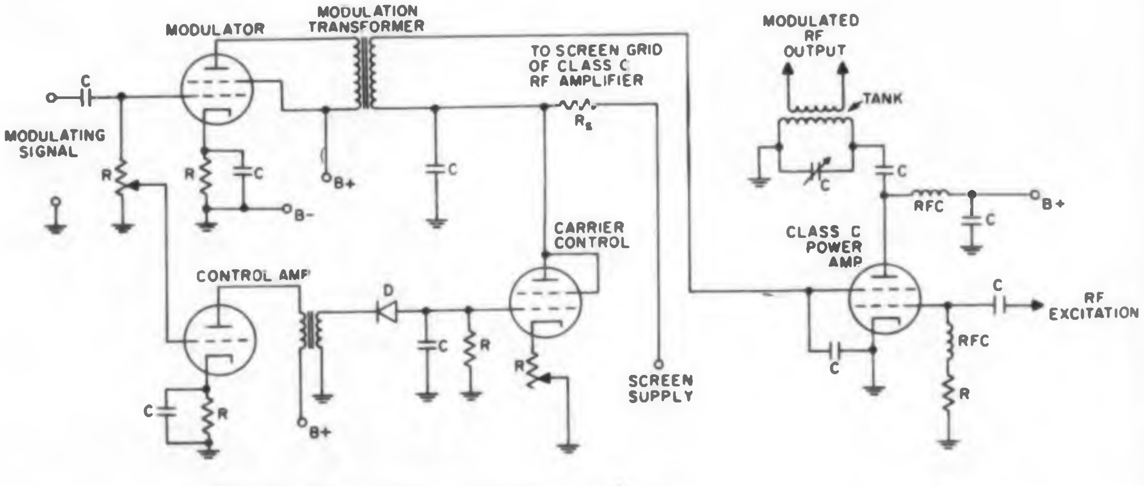


Fig. 5. Controlled-carrier modulation.

Norman Wesler (at right) and John Fokine (at left) are design engineers who feel that future communication trends will lean towards amplitude modulation techniques combined with single-sideband modes of transmission.

°N. Wesler is now principal engineer with Budd Lewyt Electronics, Inc., Long Island City, N. Y., and J. Fokine is with Loral Electronics, New York.

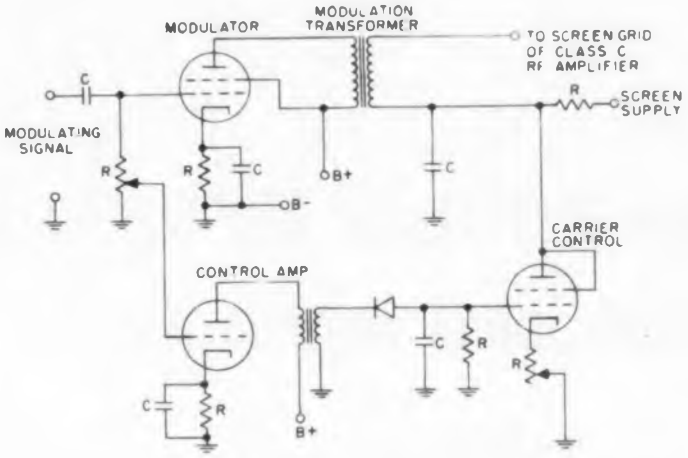


Fig. 6. Control-grid modulated stage.

Roundup of Most Popular Arrangements for Amplitude Modulation

Type of Modulation	Circuit Description	Advantages	Disadvantages
Plate (Fig. 1)	Modulating signal is coupled to the rf load through the modulation transformer.	High plate efficiency	1. Large amount of modulator power required. 2. Bulky, expensive modulation transformer necessary.
Plate-Screen (Fig. 2)	Screen grid is fed from modulation transformer common to plate.	Improved linearity over plate modulation.	Same as plate modulation system.
Screen-Grid With Modulation Transformer (Fig. 3.)	Plate fed from dc supply. Modulation applied to screen electrode through modulation transformer.	1. Relatively low modulator power required. 2. Tank circuit tuning requires simple adjustment.	Low plate efficiency.
Screen-Grid With Clamp Tube (Fig. 4)	Clamp tube acts as dual modulator amplifier and coupling device. Modulating signal varies effective resistance of tube, which, together with resistor R_d, determines the screen potential.	1. Eliminates modulation transformer — savings in size and expense. 2. Applicable to wideband transmission.	Low plate efficiency.
Controlled-Carrier (Fig. 5)	A portion of the modulating signal is fed to the control amplifiers, which rectify, filter and apply to the screen a dc voltage proportional to the modulation level. With no modulation, screen voltage is at a minimum.	1. Low modulator power required. 2. Power is conserved during periods of no intelligence.	1. Low plate efficiency. 2. Additional components compared other screen grid methods.
Control-Grid (Fig. 6)	Modulation transformer secondary varies control grid voltage.	1. Exceptionally low modulation power required. 2. Commonly used in TV transmitters where low power, wide bandwidth signals are handled.	1. Tuning adjustments critical. 2. Low efficiency.

How To Design A Voltage Divider Network Having Constant Input Impedance

Gerald Lang
Electronic Engineer
Airborne Instruments Laboratory
Long Island, N. Y.

Gerald Lang has been engaged in transistor circuit design since he joined Airborne Instruments Laboratory. This article is based on some of the work he has done there.

A VOLTAGE-divider network that provides a constant-input impedance can be designed (for many types of equipment) using a one-pole, one-deck, multi-range switch. The input-energy source connected to this network will be unaffected by load variations, and a linear voltage division will result when the switch is moved from range to range.

The switching circuit for n ranges is shown in Fig. 1. When designing the n^{th} range, however, Fig. 2 is a more generalized diagram.

The input impedance seen by the source E is.

$$Z_{in} = r_n + \frac{R_N\,(R - RN + Z)}{R + Z} = r_N + R' \quad (1)$$

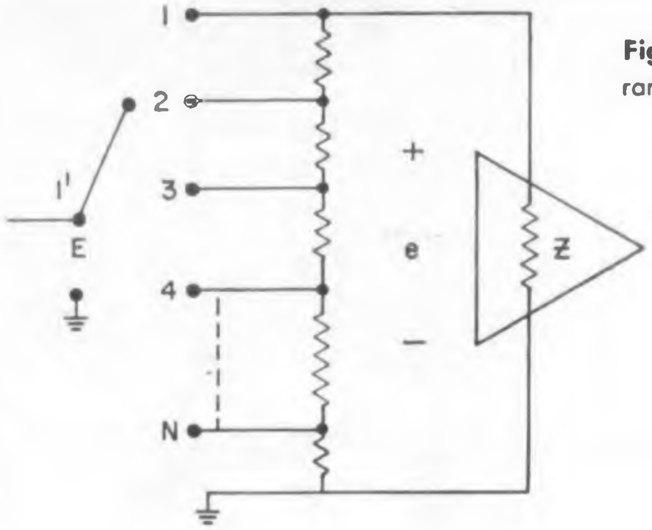


Fig. 1. (left) The switching-range for n ranges.

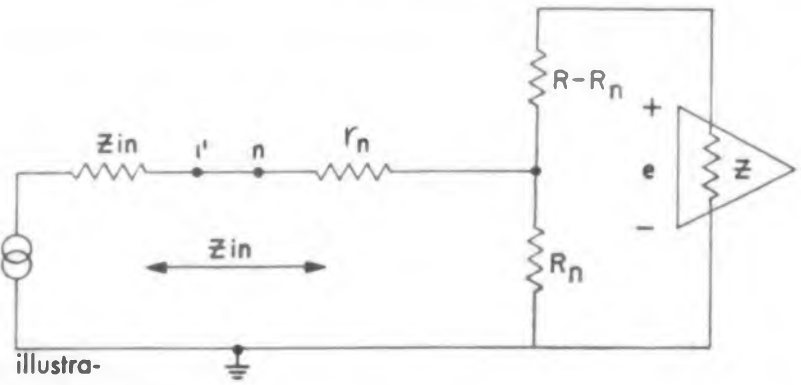


Fig. 3. (right) In the illustrative example, a switch feeds a transistor amplifier.

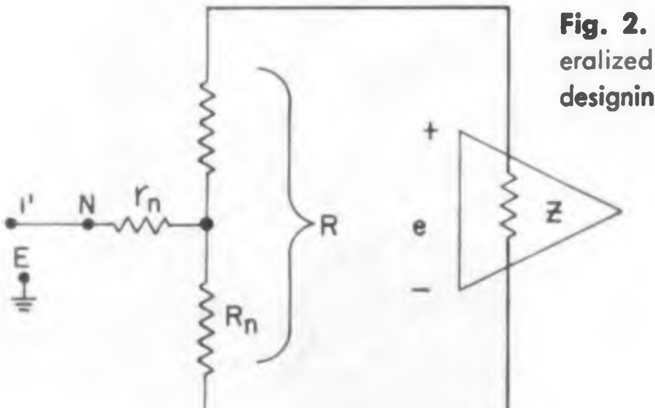


Fig. 2. (left) This is the generalized diagram used when designing the n^{th} range.

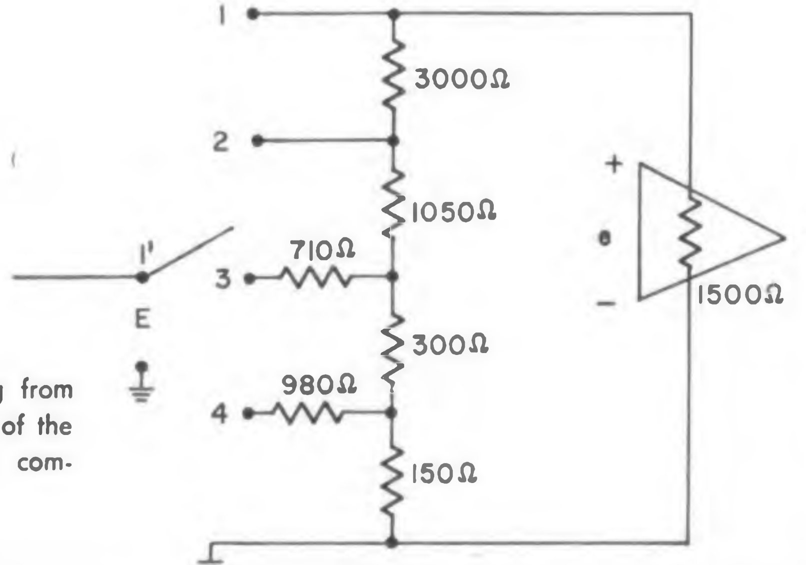


Fig. 4. (right) Working from Table 1, the remainder of the switch parameters are computed and listed here.

where

$$R' = \frac{R_N\ (R - RN + Z)}{R + Z}$$

If the following substitutions are made,

$$\alpha = \frac{R}{Z},\ \beta = \frac{R_N}{Z}\ \text{and}\ \delta = \frac{r_N}{Z} \qquad (2)$$

then in normalized form:

$$\frac{Z_{in}}{Z} = \frac{r_N + R'}{Z} = \delta + \left[\frac{\beta\ (1 + \alpha - \beta)}{1 + \alpha}\right]$$

On the most sensitive range (contact *1'* connected to contact *1* in Fig. 1), the normalized impedance seen looking into the range switch is:

$$\frac{Z_{in}}{Z} = \frac{R}{R + Z} = \frac{\alpha}{1 + \alpha} \qquad (3)$$

Since the same impedance is desired for any of the *n* ranges, Eqs. 2 and 3 must be equated. Therefore:

$$\frac{\alpha}{1 + \alpha} = \delta + \left[\frac{\beta\ [1 + \alpha - \beta]}{1 + \alpha}\right] \qquad (4)$$

Normalizing the input voltage to the transistor amplifier,

$$\frac{e}{E} = \frac{R'}{r_N + R'} \times \frac{Z}{R - R_N + Z} \qquad (5)$$

where e/E will be called $1/q$.

Solving Eqs. 4 and 5, the values of β and δ can be found. They are:

$$\beta = \alpha/q \qquad (6)$$

$$\delta = \frac{\alpha - (1 + \alpha - \alpha/q)\ \alpha/q}{1 + \alpha} \qquad (7)$$

These equations are valid only if $q \geqq \alpha$. If this inequality does not exist, then δ is negative and the solution is an absurdity.

For a four-position range switch with $\alpha = R/Z = 3$, the pertinent equations are solved and the normalized results are listed in Table 1.

Example

Suppose this switch is feeding a transistor which has the following hybrid parameters: $h_i =$ 1600 ohms, $h_r = 2.1 \times 10^{-3}$, $h_o = 50$ micromhos, $h_{fe} = 50$ and feeding a load of 1000 micromhos. The input impedance and current ratio into the base of this stage (common emitter configuration) are respectively:

$$Z = h_i - \frac{h_r\ h_{fe}}{h_o + G_L}\ \text{and}\ \frac{i_b}{i_s} = \frac{R_s}{R_s + Z} \qquad (8)$$

With reference to **Fig. 3,**

$$R_s = \frac{(Z_{in} + r_N)\ R_N}{Z_{in} + r_N + R_N} \qquad (9)$$

SYNCHRONOUS D.C. MOTOR

Globe Industries has developed a control circuit for our d.c. permanent magnet motors which causes the motor to run synchronously with a reference frequency while getting full power from a d.c. source. Thus now you can have, in one package, the high torque per weight and size advantage of our d.c. motors combined with precise speed regulation. The system does not disturb the speed-torque performance of the motor even during starting.

The control is fully transistorized. No contacts or other moving parts are used, so that long reliable speed regulation is assured.

One version of this control, in a two cubic-inch package, provides speed regulation of +.1%/−.5% over load and/or voltage variations. (The motor runs in exact synch with the built-in reference frequency but the frequency generator also has a .1% error over the range −20°C to 50°C.)

Speed regulation with accuracy measured in parts per million is being approached through development of a very stable separate frequency generator to be fitted into a five cubic-inch package.

We are ready to discuss your application problems. Our wide experience in making motors for literally thousands of military applications—involving the fullest range of environmental requirements—assures you of a quick solution to specific problems. Globe Industries, Inc., 1784 Stanley Avenue, Dayton 4, Ohio, Telephone BAldwin 2-3741.

GLOBE INDUSTRIES, INC.

PRECISION MINIATURE A.C. & D.C. MOTORS, ACTUATORS, TIMERS, STEPPERS, BLOWERS & FANS, MOTORIZED DEVICES

GLOBE

CIRCLE 78 ON READER-SERVICE CARD


RADIO RECEPTOR

MINIATURE

SELENIUM RECTIFIER BRIDGE

Excitingly New!

another achievement of General Instrument Corporation

the industry's most practical package

reduced to 1/10 conventional size... and priced as low as 63¢!

Here is the most convenient and reliable selenium bridge ever made. Check it over feature by feature and you'll see why...

SIZE	13/16" x 7/8" x 15/32" making it the smallest bridge available—1/5 to 1/10 the size of conventional devices.
PACKAGE	Flat, compact and incredibly sturdy, it has a twist-on lug for solid and simple mounting.
RELIABILITY	The selenium cells have no artificial barrier layer thereby reducing aging and high voltage drop.
VERSATILITY	Designed to operate off line voltage, the bridge is rated at 155V rms max., 90 ma D.C. Size, shape and dependability make it ideal for many commercial applications.
PRICE	Only 63¢ in production quantities, the bridge is practical for many types of equipment where half-wave circuits are now used.

Further technical data is available upon request to Section ED-3

RADIO RECEPTOR COMPANY, INC.
Subsidiary of General Instrument Corporation
240 Wythe Avenue, Brooklyn 11, N. Y., EVergreen 8-6000

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

Visit us at the IRE Show, Booth 1218-24

CIRCLE 79 ON READER-SERVICE CARD

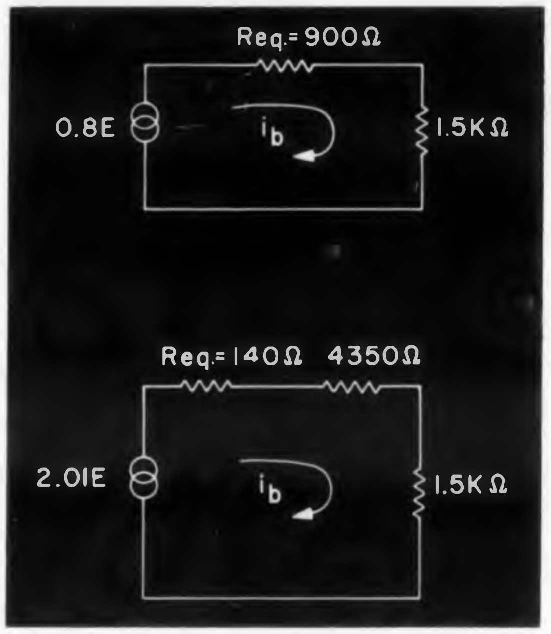


Fig. 5. Thévenin equivalent circuits. Range 1 is shown above, Range 2 is shown below.

For the typical small signal transistor selected,

$$Z = 1600 - \frac{2.1 \times 10^{-3} (50)}{(50 + 1000)\ 10^{-6}} = 1500\ \Omega$$

This means $R = 4500$ ohms in this example. Working from Table 1, the remainder of the switch parameters are computed. These values are shown in Fig. 4.

The current going into the base is determined from Eq. 8. Although the value of R_s changes for each range, the value of i_s correspondingly changes to keep the base current the same. This is seen in the two Thevenin equivalent circuits of Fig. 5, for ranges *1* and *4*.

Of major concern is how this circuit would function if a transistor with a different β was substituted in the amplifier. Let us assume a β variation of ±50 per cent and see how much error this introduces. With a β of 75,

$$Z = 1600 - \frac{2.1 \times 10^{-3} (75)}{1050 \times 10^{-6}} = 1450\ \Omega$$

Table 1. For a 4-position range switch (with $\alpha = R/Z = 3$), the pertinent equations are solved and the normalized results listed here.

Range	q	$\beta = \frac{Rn}{Z}$	$\delta = \frac{rn}{Z}$
1	1	3	0
3	3	1	0
10	10	0.3	0.4725
30	30	0.1	0.6525

Table 2. **The pertinent changes due to β variation are shown here.**

		β Values		
		25	**50**	**75**
Range 1	Zin	1150	1125	1095
	$\frac{\Delta Z_{in}}{Z}$	2.22%	0	2.66%
	q	1	1	1
	Δ E	0.012E	0	0.014E
Range 2	Zin	1130	1125	1120
	$\frac{\Delta Z_{in}}{Z}$	0.445%	0	0.445%
	q	2.94	3	3.07
	Δ E	0.004E	0	0.C04E
Range 3	Zin	1127	1125	1126
	$\frac{\Delta Z_{in}}{Z}$	0.17%	0	0.085%
	q	9.8	10	10.25
	Δ E	±0	0	±0
Range 4	Zin	1125	1125	1125
	$\frac{\Delta Z_{in}}{Z}$	0	0	0
	q	30	30	30
	Δ E	0	0	0

and with a β of 25,

$$Z = 1600 - \frac{2.1 \times 10^{-3}\ (25)}{1050 \times 10^{-6}} = 1550\ \Omega$$

Due to the feedback term, for a ±50-per cent β variation, the input impedance has a variation of only ∓3.3 per cent.

In Table 2, the pertinent changes due to β variation are recorded. The largest change in *E* due to a change in transistor input impedance is 1.4 per cent and this occurs in Range *1*. The values listed in this table are all within slide-rule accuracy and show that the magnitude of the errors introduced decrease as the number of switching stages are increased. ■ ■

Reprints of this series will be available from Paul Wrablica Associates, 120 E. 56th St., New York 22, N. Y.

An Industrial Designer Discusses . . .

CASES and HOUSINGS

Functional and attractive styling in cases and housings externally reflect the aesthetic touch of the industrial designer. Clever internal schemes, sometimes overlooked, are illustrated and discussed. (Knobs were discussed in the February 17th issue of ELECTRONIC DESIGN, *p 56, Panels in March 2, p 32.)*

Paul Wrablica
President
Paul Wrablica Associates
New York, N. Y.

Fig. 1a. The control knob of this thermostat tester is rather close to the heat unit, an undesirable operation factor.

Fig. 1b. By placing the control to the side, operator safety is achieved. An opening in the self-contained handle provides storage for the thermometer during transit.

LABORATORY and production equipment, concealed from all but the engineer and technician, have only recently emerged from the grim, "black-box" look to the sophisticated and functional package which proudly reflects the intricate circuit design enclosed. Consumer-product devices, on the other hand, have been housed in attractive enclosures for some time due to pressures exerted by furious competition.

Major efforts by industrial designers are responsible, to a great extent, for the "new look" in production and laboratory equipment.

Industrial Design Targets

Prime targets for the industrial designer faced with an assignment involving equipment housing are:

- Clean, distinctive styling.—A neat, uncluttered appearance inspires confidence to an unskilled or newly-assigned technician. It also conveys a sense of prestige to the manufacturer as well as the purchaser.
- Convenient accessibility to internal components.—In the event replacement, repair, or calibration is required, enclosure removal should be rapid and simple.
- Minimum tooling and production costs.—By carefully weighing the feasibility of mass-production techniques, thereby reducing assembly steps and hardware required, substantial cost savings can be realized.

To illustrate typical problems submitted to the industrial designer, several case histories are presented with "before and after" comparisons.

Thermostat Tester

Consider the assignment originally calling for a stainless-steel enclosure to serve as a carrying case for a thermostat tester manufactured by Spencer Thermostat Div., Metals and Controls Corp., Attleboro, Mass.

Minimum tooling costs, ease of assembly, and provisions for the storage of a glass thermometer were the original project goals. After careful study, a completely redesigned product housing was proposed which eliminated the need for a separate carrying case and, at the same time, fulfilled the original requirements.

All existing components were retained but regrouped for improved operator handling. As shown in Fig. 1a, the control knob in the original

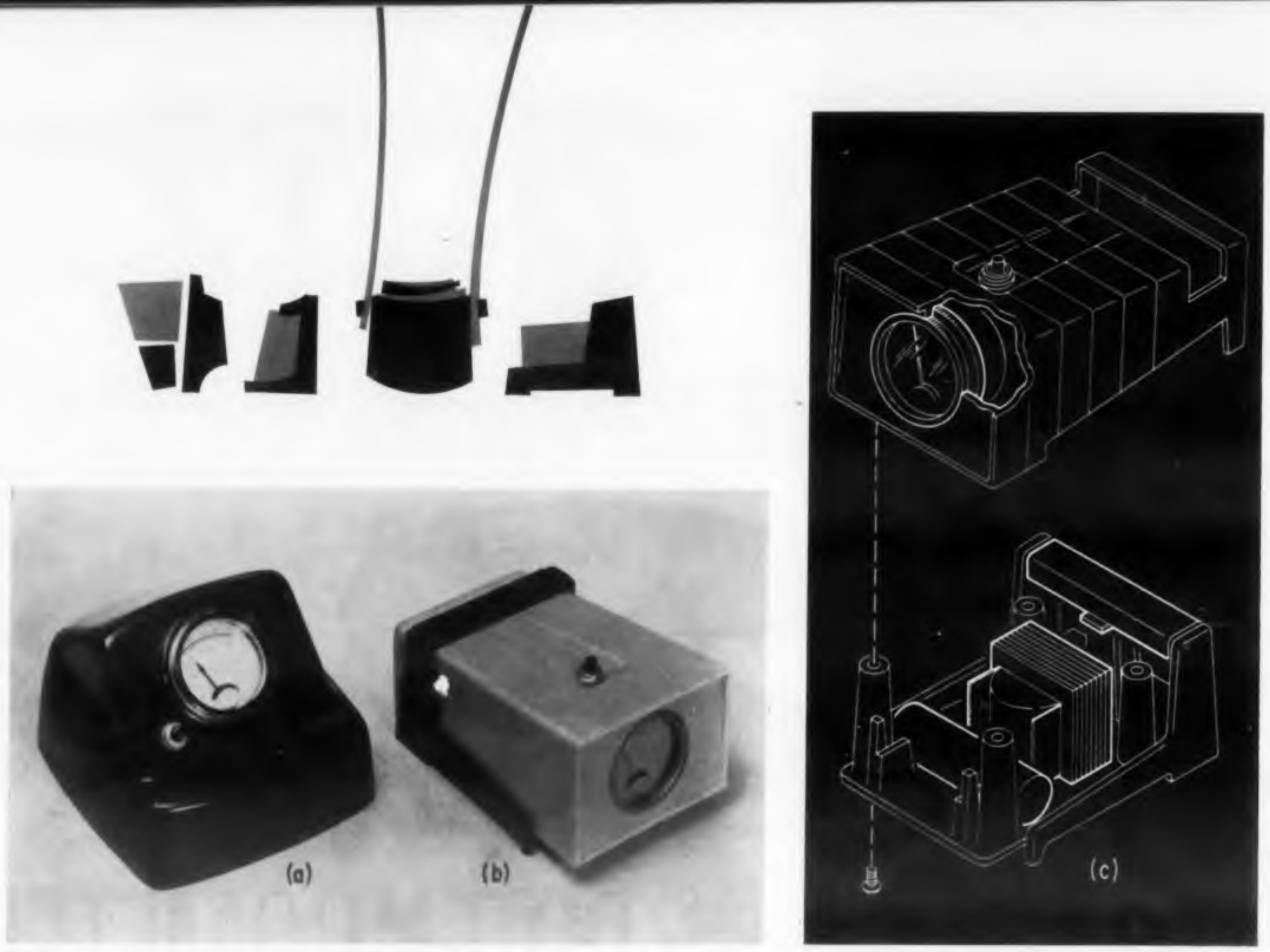


Fig. 2. The original antenna rotator control (a), has been redesigned (b) for ease in assembly (c) as well as styling.

Fig. (4a)

design was not conveniently accessible and was located rather close to the heat unit. By transferring the control to the side of the case, as shown in Fig. 1b, simpler and safer operation is achieved.

The handle of the new housing is an integral part of the assembly and the hole in the upright provides the protective storage for the accessory thermometer. All wiring is routed through one side of the unit for an improved, uncluttered appearance.

The curve at the top of the housing permits reduction of over-all package height without sacrifice in adequate gripping space. Perforations are included for ventilation.

Antenna Rotator

An antenna rotator control, (Fig. 2a) manufactured by Crown Controls Corp., New Breman, Ohio, was judged to be unattractive, costly to assemble, and poor in terms of accessibility for repair purposes. Industrial designers were consulted for overall package redesign.

Since the unit is intended for home use rather than laboratory or factory service, a two-tone color scheme in neutral shades of ivory-cream and terra cotta was selected to harmonize with most natural furniture woods.

The dial for the new design, Fig. 2b, is located so as to provide maximum visibility over a wide field of view. The face of the dial is decorative and non-technical to avoid confusion by the housewife and the company name has been given a distinctive and functional appearance. In addition, the new shape is easy to grasp and carry and offers a light, airy appearance when contrasted against the original styling.

Economy and convenience in production and assembly were effected by molding (1) an inexpensive bakelite cradle to support the internal components, Fig. 2c, and (2) a plastic cover permitting rapid accessibility and assembly.

Portable Power Pack

Field technicians complained of aches and bruises inflicted by a poorly packaged power pack. Constructed of heavy-gage metal, the uncompromising metal box, Fig. 3a, bounced uncomfortably against the body during transportation and was awkward to grip.

Goals for redesign included improved appearance, convenience and comfort for the operator, and elimination of the dangling electric cord.

As shown in Fig. 3b, the newly styled case is molded of vinyl-type plastic in a modified kidney-shape to conform to the body's contour. No screws

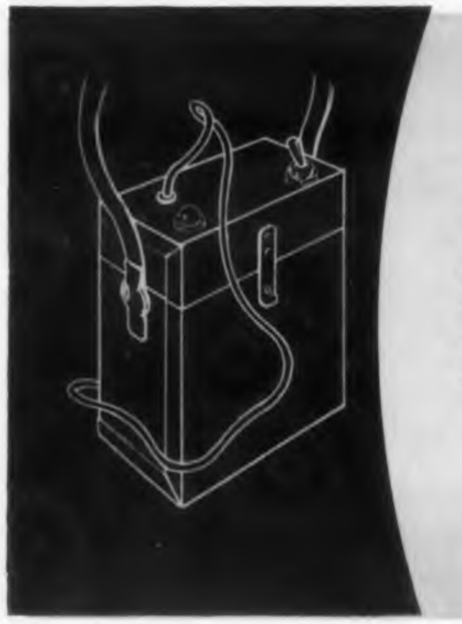


Fig. 3. By shaping the power pack of (a) (left) to follow the body contour, as shown in (b), (right) portability was improved.

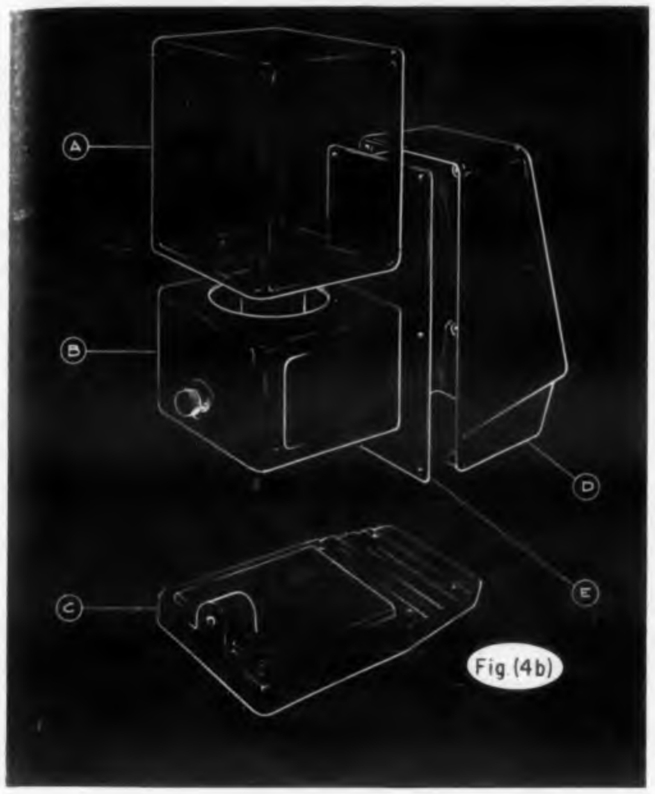


Fig. 4 (a) and (b). The ultrasonic cleaner shown is suitable for display in a factory or atop the counter of a fine jewelry store.

are needed for assembly—parts snap together securely. The feed cord is neatly wrapped around a spool included as an integral part of the case.

Ultrasonic Cleaner

The final case history illustrates the redesign of an enclosure for an ultrasonic cleaner and drier maker by Acoustica Associates, Plainview, N.Y.

Although primarily intended as an instrument for factories and repair shops engaged in jewelry and metal work, it was nevertheless decided that the finished product should be attractive enough to look well on the counter of a fine jewelry retail shop.

Since cleaning solutions must be replaced regularly without danger of spilling, it was mandatory to consider rapid and simple accessibility to internal components.

As shown in Figs. 4a and 4b, a three-section housing was conceived with the following sections:

(1) A base casting with ventilation slots.

(2) A casting for the control chamber, with a removable cover plate. All electrical components are mounted to the cover plate as a separate subassembly. The cover plate is then simply attached to the control chamber casting.

(3) A sheet metal wrap-around base firmly holds the cleaning solution jar and acts as a selfsupporting unit when removed from the equipment. ■ ■

HUGHES
FAMILY OF
DIRECT-VIEW
STORAGE TUBES

World's most complete line
of storage tubes!

TONOTRON® TUBE: displays full range of grey scale images for daylight viewing. Ideal for weather radar, PPI presentations, "B" scan projections and other complex radar systems.

MEMOTRON® TUBE: displays successive transients until intentionally erased. Permits direct comparison and analysis of wave forms without photography.

TYPOTRON® TUBE: displays any combination of 63 symbols or characters at speeds to 25,000 per second. Retains presentation until intentionally erased.

STORAGE TUBE CHARACTERISTICS

	SCREEN DIAMETER	STANDARD PHOSPHOR	DEFLECTION
TONOTRON TUBES			
H1021	3"	P1	Electrostatic
7221	5"	P20	Electrostatic
7222	5"	P20	Electrostatic
7033	5"	P20	Electromagnetic
H1044	21"	P20	Electromagnetic
H1028	4"	P1	Electrostatic
H1033	10"	P20	Electromagnetic
H1034	10"	P20	Electrostatic
H1041	7"	P20	Electrostatic
H1042	7"	P20	Electromagnetic
MEMOTRON TUBE			
6498	5"	P1	Electrostatic
TYPOTRON TUBE			
6577	5"	P1	Electrostatic

10 additional TONOTRON tubes and 4 additional TYPOTRON tubes available.

For full and complete information on how Hughes storage tubes may fill your particular needs and applications, write or wire: HUGHES, Vacuum Tube Products Division, 2020 Short Street, Oceanside, California.

For export information, write: Hughes International, Culver City, California.

Creating a new world with ELECTRONICS

HUGHES

© 1960, HUGHES AIRCRAFT COMPANY
®Trademark of Hughes Aircraft Company
VACUUM TUBE PRODUCTS DIVISION


H1021


7221


7222


7033


H1044


H1028


H1033/1034


H1041/1042


6498


6577

CIRCLE 82 ON READER-SERVICE CARD

How a Digital Servo Loop Operates

Many times, fellow engineers have asked Hayes B. Steinhouser about the digital servo that he is developing. He concluded that a basic description of just how one of these sampling servos operates would be of wide interest. In this article, Mr. Steinhouser considers a shaft angle repeater. Such a system might be part of a radio repeater link by which aircraft instrument readings could be simultaneously observed at a ground station.

Hayes B. Steinhouser
Eclipse-Pioneer Div.
Bendix Aviation Corp.
Teterboro, N. J.

A DIGITAL servo converts a digital number or code group into a corresponding position of an output shaft. This is accomplished by a servo loop which is partly analog (shaft position controller) and partly digital (special purpose computer serving as the comparison element of the loop).

In this device, digital data, representing the desired position of an output shaft, is received and compared with locally generated data representing the actual position of the shaft. The comparison allows control of the output shaft to make its actual position correspond with the desired position.

Actual and Desired Positions Are Compared Digitally, Adjustment Is Made by Analog Drive

In brief, register *1* (Fig. 1) receives and temporarily stores a binary code group representing the desired position of the output shaft. Register *2* performs the same function for the actual position of the output shaft. Adder *3* produces a binary number which is the difference between the two. This difference is temporarily stored in the result register *4*.

The digital number in register *4* is converted into an equivalent voltage by a digital-to-voltage converter *6*. Polarity control *5* makes sure that the polarity of this output from unit *6* corresponds to the polarity of the digital difference stored in register *4*.

The analog voltage from *6* is then amplified in servo amplifier *7* in order to drive servo motor *8*. This motor rotates the load and the digital shaft encoder *9* in a direction to make the position of output shaft *10* coincide with the command position, closing the loop.

Command and Actual Shaft Position Encoded at Sampling Rate

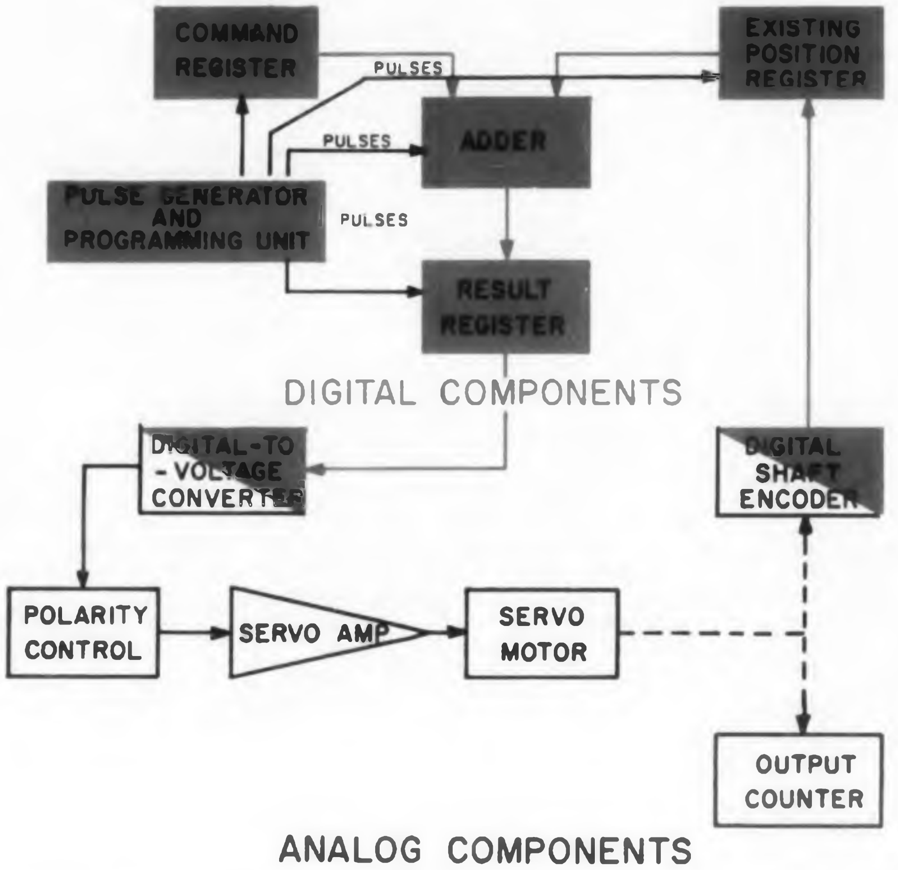
Let us look more closely at the operation of the special purpose digital computer that forms part of this servo system. The digital command received by register *1* is in the form of a natural binary code group. The code group of digital signals recurs at a chosen sampling or repetition rate. This sampling rate is governed by programming pulses. The register is thus periodically cleared to receive and temporarily store successive code groups. Each digital signal corresponds to an instantaneous position of the command.

Similarly register *2* receives and stores for an interval successive code groups of digit signals, each corresponding to an instantaneous position of the output shaft. The digit signals received from the digital shaft encoder might be either in natural binary code or in the cyclic binary code. The cyclic binary code (or a gray code) is frequently used when encoding a shaft position to reduce reading errors. In this code, an additional unit for translating from cyclic into natural binary coding is required. The number in register *2* must be in natural binary, since the computer operations are performed in natural binary.

Difference is Determined by Adding The Complement of Actual Shaft Position

The difference between two numbers could be obtained in adder *3* either by subtracting the second from the first or by adding the complement of the second to the first. However, the process of addition is simpler to accomplish in a computer than that of subtraction. Consequently, an adder is used in unit *3*, and the number required in register *2* is the complement of the binary number representing the output shaft position.

One way of obtaining this complement would be by reading out of the digital encoder *9* the binary number representing the output shaft position and then complementing this number by an operation in a computer. However, it is usually simpler to arrange the shaft encoder *9* to read out the complement of the number representing output shaft position so that no additional complementing operation is required. Simply reversing the direction of rotation of the shaft encoder will give a complement read out.



Digital servo loop is partly special-purpose digital computer, partly analog drive.

The addition operation is initiated and carried out by program pulses supplied to the adder and to registers *1*, *2*, and *4*. The difference or result produced by adder *3* is in the form of a code group of digits in natural binary code. This result is received by register *4*.

The result represents the numerical value of the difference between the numbers which were in registers *1* and *2* at the start of the operation. The result is next transferred to a storage register in the digital-to-voltage converter (unit *6*). This unit produces an output voltage proportional to the numerical value of the binary digital input fed into it.

Polarity Is Determined By The Most Significant Digit in the Difference

How the polarity is determined can be seen from two numerical examples. First let the number in the command register be 11 which corresponds to 1011 in the natural binary code. Let the number which represents the output shaft position be 6. This is 0110 in natural binary. In this case, the command number is larger than the shaft position number.

Because the number required in register *2* is the complement we take the complement of the output shaft position 0110. This is done in binary arithmetic by changing all ones to zero, all zeros to ones and adding one as follows:

$$\begin{array}{r}1001\\0001\\\hline 1010\end{array}$$

This is the number which appears in register *2*.

We next add the numbers in register *1* and register *2* to obtain a result for register *4* as follows:

$$\begin{array}{r}1011\\1010\\\hline 10101\end{array}$$

The numerical value of the result is obtained from the first four digits (starting from the right or least significant digit). In this case it is 0101 which corresponds to 5 in the decimal code, the correct difference between 6 and 11.

The left hand or most significant digit in the result is a 1 in this five-bit word. A 1 always occurs in the furthermost left digit when a positive result occurs, corresponding to a command position higher than the shaft position number.

Difference Must be Complemented When Negative Result Is Indicated

For the second example let the number in the command register be 6 (0110) and the number representing output shaft position be 11 (1011). Here the command number is lower than the shaft

number. We complement 1011 as follows:

0100
0001
0101 as the binary number in register *2*.

No wadding the numbers in register *1* and register *2* as follows:

0110
0101
01011

In this case, the left hand or most significant digit is a 0. This indicates that the result is negative. It also means that the number represented by the four digits to the right must be complemented to obtain the correct numerical value of the result.

Complementing the right hand or least significant digits 1011 as follows:

0100
0001
0101 as the result which corresponds to 5 in the decimal code.

A 0 always occurs in the farthest left (or carry) position when the result is negative, corresponding to a number less than the shaft position number. Note that whenever the result is negative, we must take the complement of the number in the result register *4* in order to obtain the correct numerical value of the difference.

There must always be one more digit in the result than there are in the numbers being added. For instance, if four digit numbers are being added, the result must have five digits. If eight digit numbers are added the result will have nine numbers. The additional digit is to accommodate any carry over that may occur from the addition. It is this additional left hand digit which is called the carry position and is the one used in determining polarity of the result.

Polarity Control Reverses Voltage and Complements Difference for Negative Results

A polarity control circuit *5* is operated by the digit in the result carry position. Whenever a 1 is present in the carry position the polarity control remains inoperative. When a 0 occurs in the carry position the polarity control operates to reverse the polarity of the voltage out of the digital-to-voltage converter *6*.

When a 0 is present in the carry position of the result, the polarity control also operates to cause programming pulses to complement the number in the result register before sending it to the digital-to-voltage converter. This complementing operation may be done in a separate unit inserted between the result register *4* and the digital voltage converter *6*.

Alternatively the complement may be obtained by merely inverting all digits in the result register, (all 1's to 0's and all 0's to 1's) without adding a 1. The 1 is then added effectively by inclining an additional voltage equivalent to one unit in the output of the digital voltage converter whenever the converter output is negative.

Shaft Position is Sampled, Corrected to One Significant Digit at Sampling Rate

In the special purpose digital computers, then, we have produced a voltage output which is proportional to the difference between the command position and the output shaft position, and whose polarity depends on whether the command position and the output shaft position and whose polarity depends on whether the command position number is greater or lesser than the shaft position number. This voltage, amplified servo amplifier *7*, drives servo motor *8*. The motor turns the digital shaft encoder *9* and the output shaft *10* in a direction to correspond with the command. The complete program of operations is repeated at the chosen sampling rate. Typically this rate might be twenty times a second.

The command and existing positions are therefore compared say twenty times a second and a correcting voltage developed corresponding to their difference. As long as an error of even one least significant digit exists between the command and existing positions, a voltage is produced which will cause the servo to drive towards coincidence.

Shaft Encoder Reconverts Shaft Position To Digital Form for Computing

The digital shaft encoder *9* is geared to the output shaft which is being controlled. It represents shaft position by a digital number which varies from 0 to the 0 deg position up to a maximum number (just prior to the 360 deg shaft position) which is dependent on the number of digits used.

With eight digits this maximum is 255, since with eight digits there are 2^8 or 256 different increments or shaft positions and these are numbered from 0 to 255 (rather than 1 to 256). Similarly with a nine digit system ($2^9 = 512$) the maximum number would be 511. The command number varies between the same limits as the indicated shaft position.

In a typical system the servo amplifier *7*, servo motor *8*, and digital shaft encoder *9*, might be packaged in an instrument case with the indicator dial mounted on the output shaft *10*. The remaining units shown in Fig. 1 would be part of a special purpose computer. Time sharing techniques are usually employed so that one computer may be used to close the loop for digital servos. ■ ■

RFI

A Methodology for Interference Prediction

Since joining the Melpar Research Division in 1956, Bill Floyd has been concerned with the design and evaluation of communication, sonar and Civil Defense systems. He is currently involved with studies of interference problems plaguing airborne weapons systems.

W. B. Floyd
Branch Leader of Systems Research and Evaluation
Melpar, Inc.
Boston, Mass.

A description of a methodology for defining interference, constructing a model, and then utilizing coarse data as a means of predicting interference.

THE ULTIMATE goal of interference-prediction techniques is to foresee the occurrence or absence of man-made interference in a system, prior to its development and construction, by evaluating its design characteristics. An ideal interference-prediction technique should provide design and system engineers with a set of rules for placing devices in space and frequency and controlling their operation so that an interference-free situation results. Although the current capability of interference specialists fall somewhat short of this target, several promising approaches, one of which is described, are being developed and steadily improved.

Definition of Interference

In attempting to predict the extent of interference which may occur in a system (or device), it is first necessary to determine an adequate definition of what is meant by the occurrence of interference in that system. A widely accepted general definition is that interference occurs at a particular point in a system when the performance at that point is degraded more than some tolerable amount. This basis for defining interference inherently involves some measure of system performance, so that there may be many different measures of interference which could be utilized in a given situation.

In a binary digital communication system, for instance, a conventional measure of performance is the probability of error in a single digit, and when this probability reaches a certain level, say 10^{-3}, interference may be said to have occurred.

Once an acceptable definition of interference has been determined, it is convenient conceptually (if not mathematically) to construct a model of the system in terms of parameters which reflect the way in which the system behaves and its performance in the expected environment.

For a system of transmitters and receivers, the problem of determining this model could take the following general form. A function, f_k, of certain system and environmental characteristics, x_1, x_2, . . ., x_n, must be determined such that if f_k takes on any value within a region R_{kI}, then interference occurs in the k^{th} receiver; otherwise interference does not occur in the k^{th} receiver. In symbols,

$$f_k(x_1,x_2,..,x_n)\begin{cases}\epsilon R_{kI} = \text{Interference occurs in the } k^{\text{th}} \text{ receiver} \\ \epsilon' R_{kI} = \text{Interference does not occur in the } k^{\text{th}} \text{ receiver}\end{cases} \qquad (1)$$

Each region of interference, R_{kI}, can be determined, as mentioned, from a designation of intolerable system degradation due to the presence of undesired signals at the output of the k^{th} receiver. The characteristics $\{x_i\}$ ($i = 1, 2, . . ., n$) are parameters which describe portions of a system of transmitters, receivers, antennas, or the environment in which the system is operating. For convenience, the function f_k can be determined so that R_{kI} consists of values of f_k less than some threshold, A_k. The parameter A_k is sometimes called the "performance threshold," or "interference criterion."

Initial Prediction Steps

The parameters $\{x_i\}$ are the fundamental building blocks of the model and must be sought as soon as an acceptable definition of interference is determined. This quest must be conducted carefully; otherwise it may produce only a paper prediction capability, that is, a capability of answering interference questions only if certain things are known, which are never known in practice.

According to the example given above for a digital communication system, it is only necessary to determine the probability of single digit error and compare this figure with the performance threshold. Thus, the error probability is the only

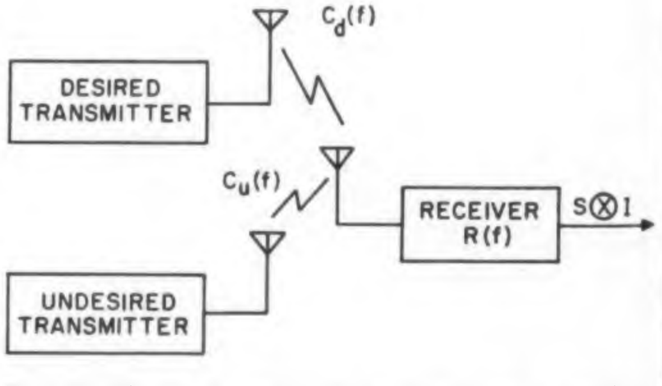


Fig. 1. Idealized model of an interference problem encountered in a communications system.

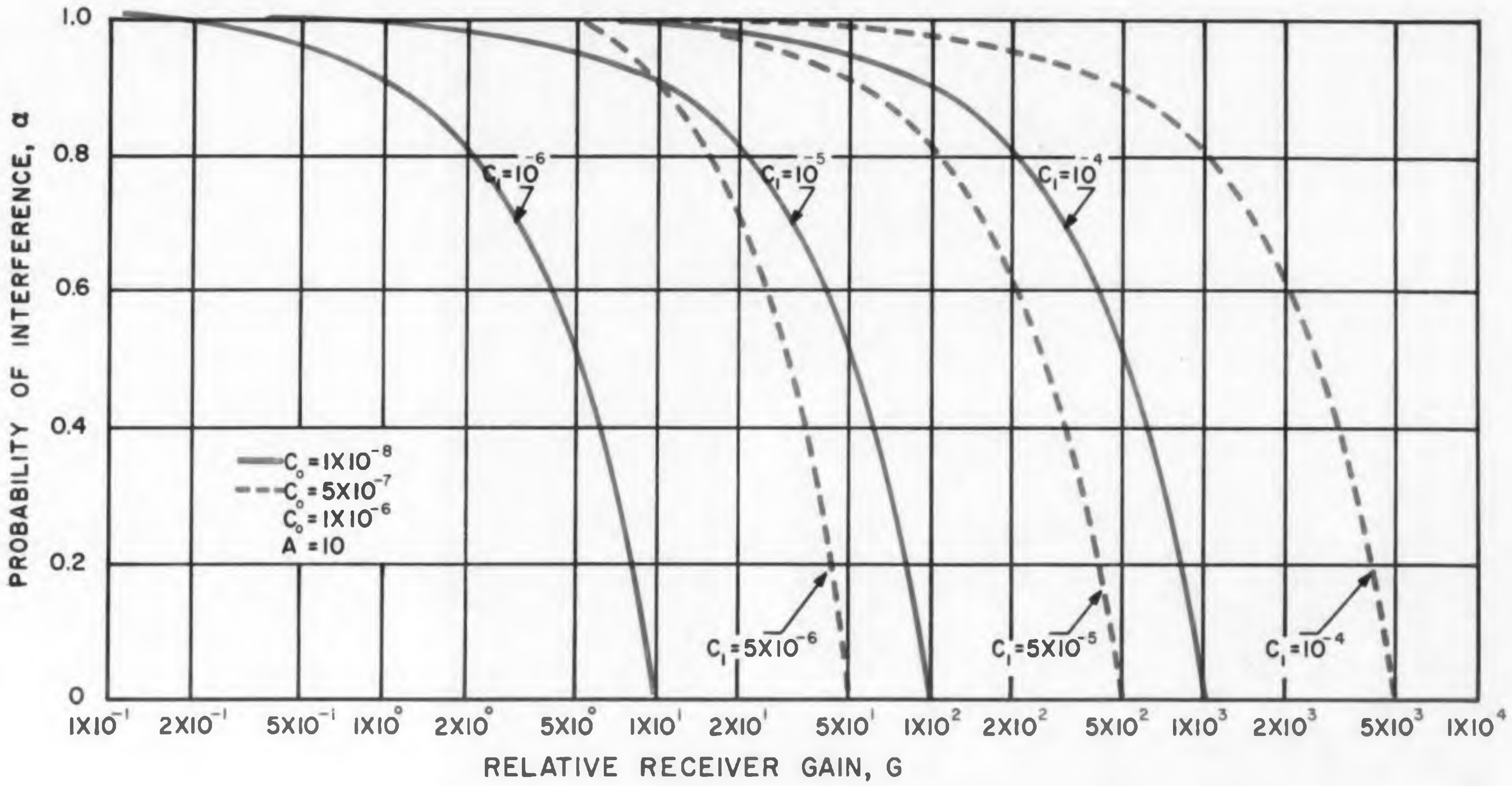


Fig. 2. Probability of interference as a function of relative receiver gain.

parameter required for predicting interference. Naturally, this parameter is not known per se and therefore the search for parameters, the x_j's in Eq. 1, must proceed under certain constraints; namely, each of the x_j's should be determinable through either theoretical calculations, estimation on the basis of past experience, or measurement through some known technique. These "conditions of adequacy" which must be satisfied are many times quite difficult to meet.

Usually a detailed design of the system must be studied, and a long list of characteristics set up before the performance of the system can be determined. In addition to intimate knowledge of the way in which a system handles desired (and undesired) inputs, a rather detailed description of the undesired signals which could lead to interference must be obtained.

Idealized Model

As an illustration of a rather idealized model, consider the diagram in Fig. 1 which depicts a communication system consisting of a transmitter, transmitting antenna, receiving antenna, and receiver. Also shown in the diagram is an undesired transmitter with its antenna. Assume, for example, that interference will occur at the receiver whenever the total power measured at the output of the receiver, with the desired transmitter turned off, exceeds by some stated amount the total output with the desired transmitter turned on. This definition of interference is widely used and can be expressed in symbols as

$$\frac{S \otimes I}{I} < A => \text{Interference Occurs} \qquad (2)$$

where

$S \otimes I$ = the power at the receiver output with the desired and undesired transmitters turned on.

I = the power at the receiver output with the desired transmitter turned off.

A = the threshold which defines the interference region.

As with the probability of single digit error, this power ratio can conveniently be learned prior to installation of the communications system in the presence of the undesired transmitter only through measurement or calculation of other subordinate parameters. If the passage of signals from the output of the two transmitters to the output of the receiver can be considered a linear operation, then the interference model in Eq. 2 can be written as

$$\frac{S}{I} < A => \text{Interference Occurs} \qquad (3)$$

where

$$S \begin{cases} = \text{the total receiver output power with only the desired transmitter turned on.} \\ = \int S_D(f) C_D(f) R(f) df \end{cases}$$

$$I \begin{cases} = \text{the total receiver output power with only the undesired transmitter turned on.} \\ = \int S_u(f) C_u(f) R(f) df \end{cases}$$

The functions $S_D(f)$ and $S_u(f)$ denote desired and undesired transmitter output spectra, $C_D(f)$ and $C_u(f)$ denote the coupling between the output terminals of the receiving antenna and the input terminals of the desired and undesired transmitter antennas, respectively, and $R(f)$ represents the gain and selectivity curve for the receiver.

For many situations, these functions will be known or determined as a matter of course in system design. Of course, the assumption of linearity everywhere is a severe departure from reality and therefore subject to question. For instance, most receivers inherently involve nonlinear stages for detection. However, for certain types of undesired signals, the output signal-to-noise ratio will very nearly be the same as that of the last if stage, since this stage is narrow band. Therefore the linear model can reasonably be applied in some situations.

Classification of Data

Unfortunately, even when an adequate description of a system, its interference susceptibility and environment, are available in terms of appropriate parameters, the timely prediction of interference may still constitute a large problem. Some of the parameters, while determinable at some time in the development of a system, may not become known precisely until a short time before interference would actually be experienced, that is, too late to be of value except to indicate the points at which the interference could be controlled. It is important, therefore, to utilize whatever information may be available in the way which provides the best current estimate of the interference to be expected at any stage of design.

In order to simplify the treatment of equivocal or exiguous data, it may be possible to classify the different ways in which any member of the set of parameters $\{x_i\}$ may be known. One method is to partition the possible information which may be obtained on each of the parameters into three types:

(1) The value of the parameter given exactly.
(2) Probability distribution of the parameter given.
(3) Several (or a range of) possible values of the parameter given.

Once the type of data available on each parameter is known, it is possible to state the questions which may be answered using this data. If considerable Type 1 information is available on the $\{x_i\}$ in a complicated model, then most questions dealing with interference (concerning the extent, transmitter source, particular transmitter harmonic, etc.) can be answered. If only Type 2 data is available, then questions can only be answered in probabilistic terms. Type 3 information, on the other hand, could be used to obtain accurate answers, but would require considerable effort to examine all possible combinations of values for the $\{x_i\}$.

In the design stage, mostly information of Types 2 and 3 is available; sometimes, decisions are reached on the basis of average or extreme values, using these values as if they actually represent Type 1 information. The use of conservative "worst case" values, or the well known "educated guess" for nominal parameter values is not uncommon at all. This approach has many pitfalls, notably the fact that the average value of a function of random variables is not the same as the function of the average values of the variables. Also the use of worst values can easily result in costly over-design. It is possible, however, to retain, and indeed emphasize, the equivocation of data when presenting an answer to a problem based on this data.

An estimate of a parameter, x_j, when accompanied by the estimated accuracy, sometimes constitutes enough information to ascribe to the true value of the x_j a particular random behavior. Once the particular random variation can be established for each x_j represented by Type 2 information, in principle the random variation in the function f_k can be determined. A probability of interference can then be obtained by noting the percentage of cases f_k exceeds the threshold, A_k.

As an illustration, consider again the linear model described by Eq. 3, with the assumptions

$$\begin{aligned} C_D(f) &= C_D \\ C_u(f) &= C_u \\ B_D &= S_D(f)R(f)df \\ B_u &= S_u(f)R(f)df \end{aligned}$$

Eq. 3 can now be rewritten as

$$AB_uC_u > B_DC_D => \text{Interference Occurs} \quad (4)$$

Suppose, for example, that the parameters A and C_D are known precisely, only the maximum and minimum values (C_1 and C_o) of C_u are known, and it is desired that minimum value of the relative gain in the receiver, $G = B_D/B_u$, be determined such that the probability of interference is no more than α. Presuming that all values of C_u between C_o and C_1 are considered equally likely to occur, then the probability of interference α, can be written as

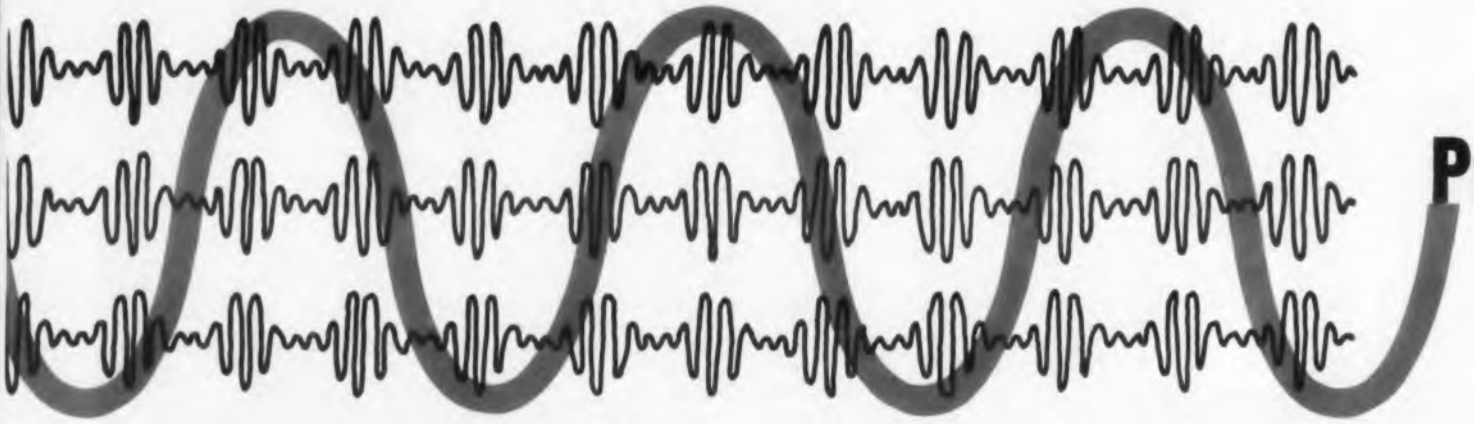
$$\alpha \begin{cases} = P_r\left\{C_u > \dfrac{C_DG}{A}\right\} \\ = 1 \text{ if } C_o > \dfrac{C_DG}{A} \\ = 0 \text{ if } C_1 < \dfrac{C_DG}{A} \\ = \dfrac{1}{A}\left(\dfrac{AC_1 - C_DG}{C_1 - C_o}\right) \text{ if } C_o \leqslant \dfrac{C_DG}{A} \leqslant C_1 \end{cases}$$

The minimum acceptable relative gain in the receiver, G_m, can therefore be written as

$$G_m = \frac{A}{C_D}\,[C_1(1-\alpha) + \alpha\, C_o].$$

The curves in Fig. 2 show the relationship between the probability of interference and the relative gain in the receiver for certain values of the maximum and minimum undesired antenna coupling. The uncertainty attached to the parameter C_u is reflected in the way these curves answer the interference question initially stated.

This example, while idealized, serves to illustrate the methodology of defining interference, constructing a model, and utilizing coarse data as a means of predicting interference. Its application to several communications and radar systems has pointed up the current lack of adequate models for describing the passage of signals through devices and the predominance of equivocal and sketchy data on environment. Both of these areas are receiving more attention, and the current anxiety over potential interference problems will very likely be alleviated through the development of new tools for analysis and description. Meanwhile, coarse techniques such as the one outlined above can be used to avoid many situations in which interference could arise. ■ ■



Prediction Of Receiver Intermodulation From Simple Measurements

W. M. Rogers, H. L. McKinley, C. E. Blakely
Georgia Institute of Technology
Atlanta, Ga.

Nonlinearities in the input stages of a receiver produce intermodulation products when undesired signals are picked up. By inserting data from simple measurements into the nomographs presented, the frequency and tolerable limits of undesired signals can be determined to aid in the selection of operating frequencies for communication systems.

INTERMODULATION is one of the most serious forms of internally generated interference in communications receivers. The seriousness of the problem results from the fact that reception of a desired signal may be obscured by the intermodulation of other signals which are several channels away. Therefore, the possibilities of intermodulation should be considered whenever operating frequencies are being selected for communications equipment, especially if the portion of the frequency spectrum under consideration is already crowded.

Theory and Prediction

Whenever two or more signals are mixed in a nonlinear device, additional frequency components are generated. The input stage, or stages, or a radio receiver usually have sufficient nonlinear action to produce these new frequency components, or intermodulation products, from undesired signals entering the receiver. If the frequency of one of these products falls at the tuned frequency of the receiver, it is amplified and detected in exactly the same manner as if it were a cochannel signal. It is evident that an intermodulation product falling at or very close to the frequency of desired reception may render reception impossible due to heterodynes and cross-modulation with the desired signal.

The general frequency relationship that is fulfilled when intermodulation occurs at the tuned frequency of the receiver is

$$f_o = |mf_a \pm nf_b \pm pf_c \pm \ . \ . \ .|, \qquad (1)$$

where f_o is the tuned frequency; $f_a, f_b, f_c, \ . \ . \ .$ are the frequencies of the interfering signals present at the input; and the coefficients $m, n, p \ . \ . \ .$ are integers (*0, 1, 2, 3,* etc.). The order of the intermodulation product is defined as the sum of the coefficients $(m + n + p \ . \ . \ .)$.

Intermodulation caused by only two signals is by far the most prevalent type. Furthermore, only second- and third-order intermodulation have been found to cause significant receiver interference, and these are significant only for the negative sign in the frequency expression shown above. Then the most important forms of intermodulation are defined by

$$f_o = f_b - f_a \text{ (second order), and} \qquad (2)$$

$$f_o = 2f_a - f_b \text{ (third order).} \qquad (3)$$

In these expressions f_b is taken to be the higher of the two interfering signal frequencies. The second-order expression shows that either f_a or f_b, but not both, may be close to f_o; but for third-order intermodulation it can be seen that both f_a and f_b may be near f_o.

Measurement Setup

The conventional laboratory test for receiver intermodulation uses the setup shown in Fig. 1. With the receiver tuned to a certain frequency, f_o, the signal generators are tuned to a pair of frequencies, f_{a_1} and f_{b_1}, which fits Eq. 2 or 3. Then the generator output voltages, E_a and E_b, are adjusted to produce a specified receiver output indication. E_a and E_b are maintained equal for the measurement. The measurement may be repeated

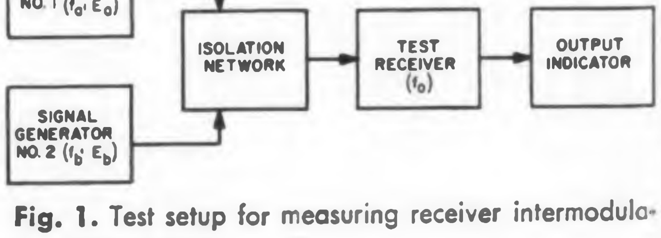


Fig. 1. Test setup for measuring receiver intermodulation characteristics.

for various frequencies f_a and f_b, with the specified receiver output indication as a fixed parameter. The set of points obtained defines a curve which indicates the intermodulation characteristics of the receiver as a function of the separation between the interfering signal frequencies and the receiver-tuned frequency.

It is necessary in making these measurements to insure that the signal generators themselves are not contributing to the intermodulation. Most commercial generators, when their outputs are connected directly in parallel, have large enough internally generated intermodulation products to cause erroneous test results. For this reason it is advisable to provide rf isolation between the two generators.

In the frequency range below vhf, a bridge network may be used as an isolation device. For vhf and uhf, a tuned transmission line device, such as a hybrid ring, would be used. Either the bridge or the hybrid ring can provide as much as 40 to 60 db of isolation with a 6- to 10-db insertion loss. The hybrid ring has a disadvantage, however, that it is a narrow-band device and can be used only over a limited frequency range.

Typical Curves

Fig. 2 shows second- and third-order intermodulation curves that are representative of those obtained by the procedure described. The output parameter for these curves is a 6-db audio $(S + N)/N$ ratio, but the curves would be identical in shape even if some other output parameter had been chosen. To obtain these data, one signal generator was unmodulated, and the other was modulated 30 per cent at 400 cps.

A large number of hf and vhf receivers, both am and fm, of various types have been tested, and it has been found that all have smooth intermodulation curves of the characteristic shapes illustrated in Fig. 2. The absolute voltage levels, of course, vary from set to set, and the slopes of the curves of two different receiver types may be somewhat different.

Fig. 3 represents a typical plot of the intermodulation characteristics of two different receivers tuned to the same frequency. It is seen that receiver "A" is more susceptible to intermodulation at small values of Δf than receiver "B." However, the "close-in" slope of the curve for receiver "A" is steeper, and receiver "A" is less susceptible for large Δf than is receiver "B." It would logically be concluded that receiver "A" is the better of the two with respect to intermodulation, other things being equal.

In the practical use of curves of this type to predict intermodulation characteristics for a particular receiver or to compare receivers in this respect, a consideration of the close-in slopes and asymptotic levels is generally sufficient. These are indicated in Fig. 3 by dashed lines. It is necessary to measure only three points on each curve to adequately define its slope and asymptote. For example, the slopes and asymptotes of the second- and third-order curves of Fig. 2 could have been defined by points measured at $\Delta f = \pm 500$ kc, and ± 4000 kc.

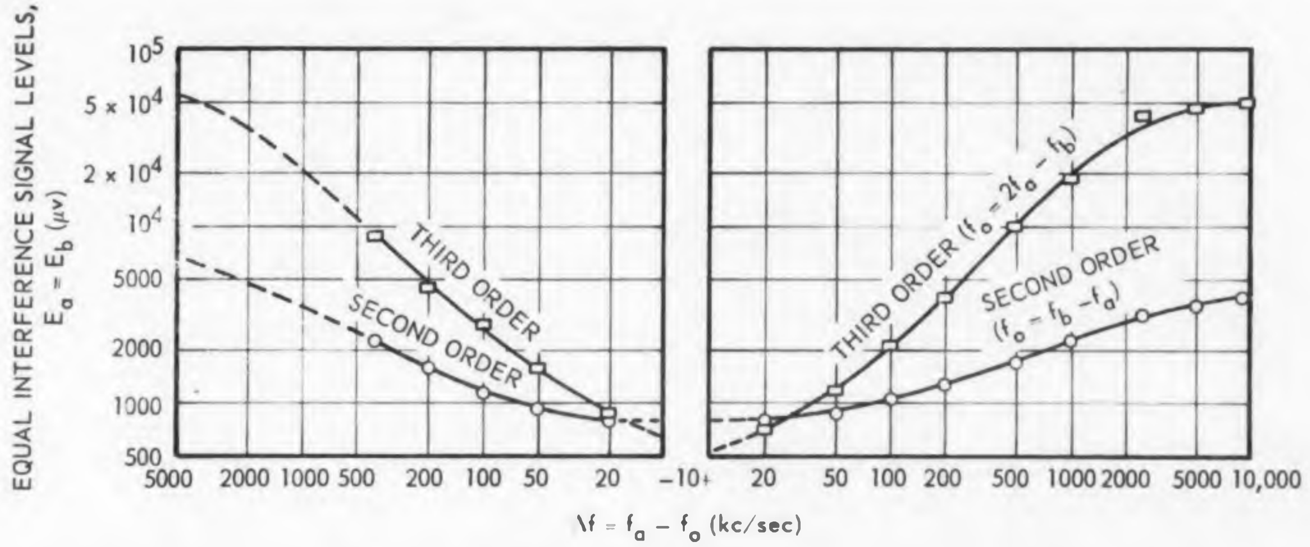


Fig. 2. Receiver intermodulation for 6 db $(S+N)/N$ ratio for an am receiver tuned to $f_o = 10.000$ mc.

It has also been found that the intermodulation characteristics of a particular receiver vary little over a wide range of tuned frequencies. Thus, if the characteristics of a set as measured at a tuned frequency of, say, 10 mc, these data may be applied to estimate the characteristics from perhaps 5 to 20 mc with good accuracy.

The single set of curves obtained for equal interfering signal levels can also be used to estimate the effect of unequal signal levels. A second-order intermodulation product is produced almost entirely by the second-order or square-law nonlinearity of the vacuum tube, or tubes, in which it is generated. (Higher even orders of nonlinearity also make contributions, but these are usually negligible.) Similarly, third-order intermodulation is contributed mainly by the third-order nonlinearity, although negligible contributions are made by higher odd-order nonlinearities. Therefore, to excellent approximations,

$$E_2 \propto E_aE_b \text{ (second order), and} \quad (4)$$

$$E_3 \propto E_a^2E_b \text{ (third order),} \quad (5)$$

where E_2 and E_3 are the second- and third-order intermodulation product voltages, respectively, and E_a and E_b are the voltages of the signals f_a and f_b.

The equations given above are borne out very

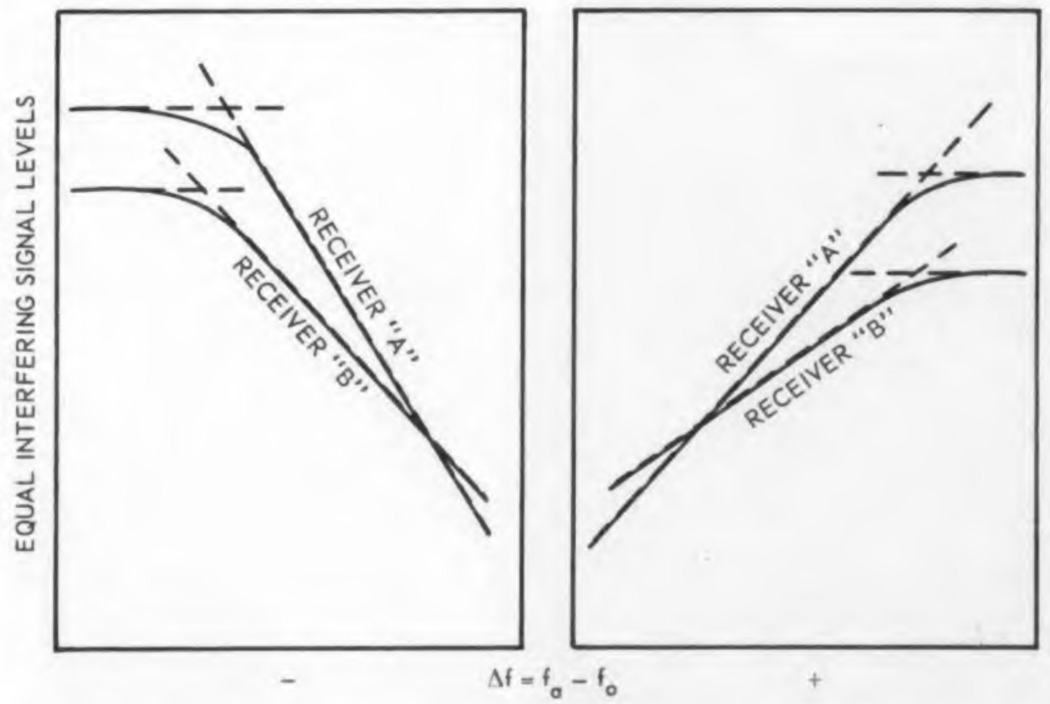


Fig. 3. Comparison between intermodulation characteristics of two different receivers.

well experimentally, except in exceptional cases where one of the interfering signals is strong enough to cause desensitization of the receiver, or otherwise change the operating point of the stage, or stages, in which the intermodulation is generated.

It is a simple matter to use an extrapolation technique based on these equations. The nomographs of Fig. 4 are a graphical representation of the equations and are a convenient aid in applying them. Power scales as well as voltage scales are included on the nomographs for convenient reference and use. The two sets of scales are directly compatible if the impedance level is 50 ohms.

Practical Examples

The following numerical example is an illustration of one possible use of the nomographs. Suppose that it is desired to receive a signal at 11.42 mc whose estimated mean signal strength i 100 µv. Assume that Fig. 2 represents the maxi-

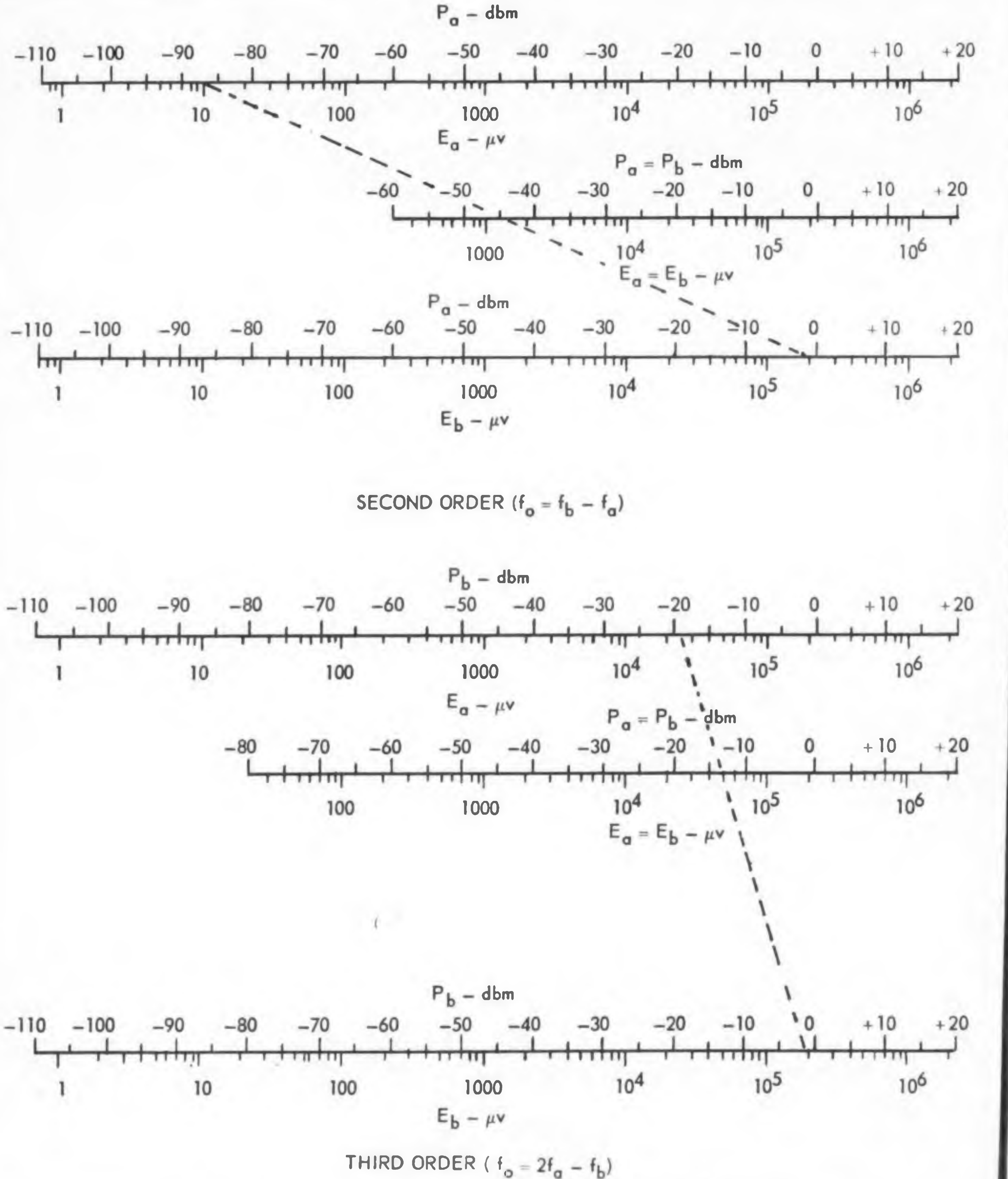


Fig. 4. Nomograms offer a rapid and simple solution to intermodulation prediction problems. Power scales as well as voltage scales are included to further decrease calculation time.

mum tolerable amount of intermodulation interference to a desired signal of 100 μv level, at a receiver tuned frequency 10.000 mc. (This set of data is sufficiently accurate since the tuned frequency of interest is close to 10 mc.) Now suppose that a strong nearby transmitter operating at 23.140 mc supplies a 200,000 μv signal into the receiving antenna.

The problem is to determine (1) the frequencies of signals in the range below 30 mc which, when combined with the strong local signal, would produce second- and third-order intermodulation products at 11.420 mc; and (2) the level of each of these signals that would produce the maximum tolerable amount of intermodulation interference.

To solve the problem, first consider second-order intermodulation. Substituting $f_o = 11.420$ mc and $f_b = 23.140$ mc into Eq. 2, $f_a = 11.720$ mc. The next step is to use the graph to find the equal-signal level that produces the specified amount of intermodulation. For $f_a = 11.720$ mc, $\Delta f = f_a - f_o = 300$ kc. The curve shows the level for this value of Δf to be 1400 μv. Now, referring to the first nomograph of Fig. 4, line up with the points $E_b =$ 200,000 μv and $E_a = E_b = 1400$ μv, and find the third point to be $E_a = 10$ μv.

Proceeding through the same steps for third-order intermodulation, it is found that (1) $f_a =$ 17.280 mc, (2) $\Delta f = f_a - f_o = 5860$ kc, (3) $E_a = E_b = 50{,}000$ μv, and (4) $E_a = 25{,}000$ μv.

Summarizing the results: (1) when mixed with the local signal, a signal of 10 μv at 11.720 mc produces the maximum tolerable level of second-order intermodulation at f_o; (2) a signal at 17.280 mc of 25,000 μv amplitude produces the maximum tolerable level of third-order intermodulation.

The preceding example not only serves the purpose of illustrating a technique; it also illustrates that intermodulation of a serious nature may be caused by a weak signal, even weaker than the signal of desired reception, in the presence of a strong companion signal. It is therefore apparent that intermodulation should be considered in any comprehensive study of receiver information. ■ ■

Acknowledgements

The methods presented are the result of the contributions of many people. Specific thanks are due to Mr. H. H. Jenkins and Mr. R. N. Bailey. Most of the work presented here was done on Department of the Army Contracts DA-36-039-SC-74855 and DA-36-039-SC-78243.

References

1. Final Report Project A-312, "Investigation and Study of Communications Interference Reduction Techniques," R. E. Meek, H. L. McKinley, et al, Air Force Contract No. AF-30-(602)-1638, (ASTIA No. AD-148844), 31 January 1958.

2. Technical Report No. 1, "Study Program for Investigation to Air in Reduction and Prevention of UHF Interference," F. P. Holder and H. W. Mauldin, Jr., Air Force Contract No. AF-30-(602)-673, 1 March 1955.

Prediction Of Transmitter Intermodulation From Simple Measurements

The radiated intermodulation spectrum from a transmitter, due to another nearby transmitter, can be determined before an installation is made. By using data from a few simple measurements to predict interference levels, expensive relocation and reassignment of transmitters can be avoided.

R. N. Bailey and C. E. Blakely
Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Ga.

THE RADIATED intermodulation spectrum from a transmitter, due to another transmitter operated in close proximity, is often a severe interference source. Intermodulation products generated in a transmitter are a function of circuit parameters such as tube characteristics, output passband, tube bias, B-plus voltage, and interfering signal frequency and level.

Accurate prediction of intermodulation product amplitude on a theoretical basis would be extremely difficult since there are many variables involved, most of which will vary with transmitter type. However, if intermodulation levels for a particular transmitter type are known for a few frequency spacings (spacing between the desired signal and the interfering signal) for each odd product at two different interfering signal levels, constants may be computed or curves constructed from which the levels of intermodulation products may be determined for any interfering signal level. Even-order-products are not considered since, in general, they are considerably removed from the transmitter passband and negligibly small in amplitude.

Intermodulation-Product Generation

Mixing and intermodulation may occur in any nonlinear device. Power output stages in a transmitter are usually nonlinear devices thereby becoming efficient generators of intermodulation products. Because of the variation of parameters in this stage from transmitter type to transmitter type, it is difficult to utilize theoretical considerations alone for IPL (intermodulation-product level) prediction. However, experimental measurements have shown that it is feasible to utilize a small amount of experimental information to predict the intermodulation-product frequency and IPL with reasonable accuracy.

Types of Intermodulation Products

Intermodulation products of two types may be generated within a transmitter output stage. The first type, which may be called primary–mix intermodulation, is generated by the mixing of fundamentals and harmonics of the *DS* (desired signal) and the *IS* (interfering signal) which already exist. The second type is produced by the mixing of fundamentals and harmonics generated within the *DS* transmitter, or by the mixing of harmonics of the *DS* transmitter and harmonics of the *IS* transmitter both of which are generated in the output stage of the *DS* transmitter.

Either or both of these types may be identified by

$$f_I = f_d + \frac{(N+1)}{2}(f_i - f_d) \qquad (1)$$

or

$$F_I = f_d + \frac{(N-1)}{2}(f_i - f_d) \qquad (2)$$

where f_I is the intermodulation product frequency, f_d is the desired or carried frequency, f_i is the *IS* frequency and N is the product order. These equations will yield two products for each order, one of which is greater in frequency than the *DS* and one which is less in frequency than the desired signal *DS*.

Intermodulation Measurement

Serious difficulties may be experienced in transmitter intermodulation measurements if the receiver used has unsatisfactory intermodulation and desensitization characteristics. This difficulty is less serious if a receiver with a small bandwidth and a large dynamic range is used. Even a receiver of this type may have undesirable characteristics; however, the difficulty may be overcome by determining the signal level at which serious desensitization and/or intermodulation occur in the receiver. An attenuator is then used at the receiver input to prevent exceeding the signal level thus determined. It is then simply a matter of adding the attenuation used to the measured level of the intermodulation product in order to obtain the true intermodulation-product level.

In order to use the high value of attenuation required, it is necessary to couple a high-level signal into the *DS* transmitter which is sufficient to produce high-amplitude intermodulation products.

A block diagram of a test arrangement which is convenient to use for these measurements is shown in Fig. 1. As previously discussed, the equipment used in the setup determines the value of coupling used; the IPL generated must be high enough so that the dynamic range of the test receiver will permit measurements with large attenuation in the receiver input line. Tests performed on equipment used in this setup showed that essentially no errors were introduced in intermodulation measurements when the *IS* level coupled into the *DS* transmitter was 40 db or less below the desired signal. Greater attenuation, however, resulted in too little attenuation in the receiver signal lead; this caused some error due to receiver desensitization and/or intermodulation within the receiver.

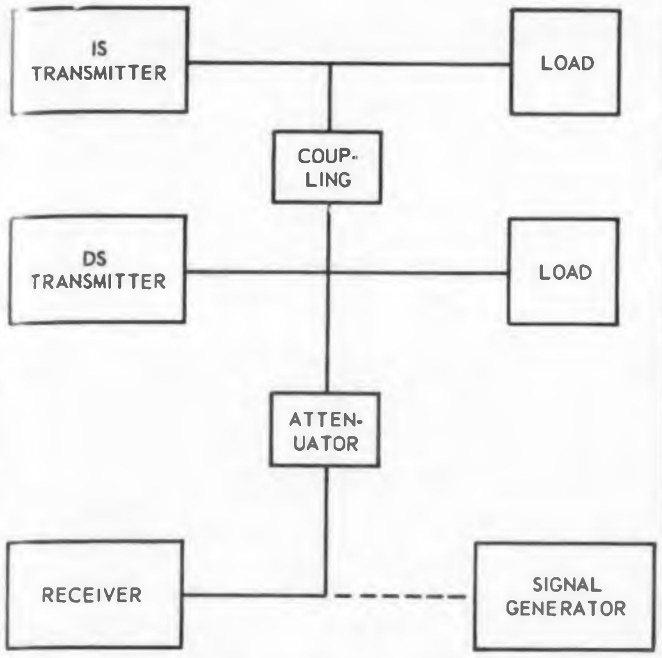


Fig. 1. Block diagram of test setup for measuring transmitter intermodulation.

Prediction of IPL

Experimental results have shown that amplitudes of odd-order intermodulation products bear a linear relationship with the *IS* level when plotted on a log-log scale. However, they do not bear the same relationship for each transmitter type, or for different signal spacings. This is understandable since the IPL will depend on circuit parameters and the output passband.

The average curve of third-order IPL (P_I) versus interfering signal level (Pi) for different transmitter types will have the same slope. That is, the third-order product on the low side (where $f_I < f_d$ and $f_i > f_d$) has essentially the same slope for all transmitter types tested. The third-order product curves on the high side (where $f_I > f_d$ and $f_i > f_d$) have essentially the same slope for all transmitter types tested; however, the slope of the low third-order product curve is different from the slope of the high third-order product curve.

Unfortunately the fifth, seventh, etc. products are not so well behaved. However, in many cases the third-order product is the only one of importance since the level of higher order products is usually 60 db or more below the desired signal.

The amplitude of odd-order intermodulation products may be described by

$$P_I = C_I + k\,P_i, \qquad (3)$$

where P_I is the intermodulation-product level in dbm, C_I is the intermodulation constant in db, and k is the above mentioned slope. This constant k for third-order product on the carrier side is usually equal to 1, and for the third-order product on the *IS* side is usually equal to 2. The value of k for higher order products varies appreciably.

(continued on following page)

LOWER YOUR PRODUCT COST, INCREASE YOUR PRODUCT RELIABILITY

Substitute a

RAYTHEON VOLTAGE REGULATOR

FOR COMPLICATED REGULATION CIRCUITRY

. . . A wide variety of designs with a wide range of capabilities providing an economical and reliable source of constant output voltage. Both PF ±3% plate-filament units and standard ±½% models are available.

For special requirements, contact the Raytheon field applications engineer nearest you or write to the address below.

±3% "PF" VOLTAGE REGULATING PLATE-FILAMENT TRANSFORMERS

Model	Catalog No.	Input Voltages	Average DC Input Volts to Filter	Filament Windings 6.3 Volts	5.0 Volts	Style	Dimensions in Inches H	L	W	Ship. Wt. Lbs.
Plate & Filament	PF-50	100/130	275 V, DC @ 50 MA	2.5 Amps. CT	2.0 Amps.	PF	4 13/16	3⅛	3 3/16	5
	PF-110	100/130	385 V, DC @ 110 MA	3.0 Amps. CT	2.0 Amps.	PF	4 13/16	3⅛	3 13/16	8
	PF-250	100/130	380 V, DC @ 250 MA	#1 4.0 Amps. #2 8.0 Amps. unregulated	3.0 Amps.	PF	7	4½	5	19

STYLE PF

STYLE D

±½% STANDARD VOLTAGE REGULATORS

Model	Catalog No.	Output Capacity Volt-Amps.	Voltages Input	Output	Style	Dimensions in Inches L	W	H	Approx. Ship. Wt. in Lbs.
Standard[1]	VR-6110	15	95-130	115	F	6¼	2 3/16	3	4
	VR-6111	30	95-130	115	E	7½	3⅜	4⅛	5
	VR-6112	60	95-130	115	E	7½	3⅜	4 3/16	6½
	VR-6113	120	95-130	115	E	7½	3⅜	5 13/16	10½
	VR-6114	250	95-130	115	E	12⅜	5	7⅝	27
	VR-6115	500	95-130	115	E	12⅜	5	9⅛	45
	VR-6116	1000	95-130	115	H	13 3/16	14 1/16	9⅝	96
	VR-6117	2000	95-130	115	H	36¼	14⅝	10⅛	243
Isolated Secondary	VR-6931	60	95-130	115	E	7½	3⅜	4 3/16	8½
	VR-6827	120	95-130	115	E	7½	3⅜	5 13/16	23
Harmonically Filtered (Harmonic Content Less than 3%)	VHF-6114	250	95-130	115	H	14 1/16	13 3/16	9⅝	56
	VHF-6115	500	95-130	115	H	14 1/16	13 3/16	9⅝	85
	VHF-6116	1000	95-130	115	H	29⅛	14⅜	10¼	220
230-Volt Output[3]	VR-6221	30	190-260	230	E	7½	3⅜	4⅛	5
	VR-6222	60	190-260	230	E	7½	3⅜	4 3/16	6½
	VR-6223	120	190-260	230	E	7½	3⅜	5 13/16	10½
	VR-6224	250	190-260	230	E	12⅜	5	7⅝	27
	VR-6225	500	190-260	230	E	12⅜	5	9⅛	45
	VR-6226	1000	190-260	230	H	13 3/16	14 1/16	9⅝	96
	VR-6227	2000	190-260	230	H	36¼	14⅝	10⅛	243
Filament	VR-6101	30	95-130	6.0/7.5	E	7½	3⅜	4⅛	5
	VR-61F0	15	95-130	6.3	F	5¾	2⅝	4 3/16	6½
	VR-61D0[2]	15	100-130	6.3	D	3 1/16	2⅝	4 13/16	5½
	VR-6710	25	95-130	6.0	W	7⅝	3⅛	3⅜	4

1. 50-Cycle Models also available with these specifications. 2. Regulation ± 1%. 3. 230-Volt Models not generally stocked.

STYLE E

STYLE F

STYLE H

STYLE W

Specials can be designed to meet a variety of electrical and mechanical specifications. Write Raytheon Company, Applications Engineering Department, Manchester, New Hampshire stating your requirements.

RAYTHEON

Excellence in Electronics

Raytheon also manufactures a complete line of power supplies, ultrasonic impact grinders and precision resistance welders.

RAYTHEON COMPANY
87 South Bedford St., Manchester, N. H.

See us at the IRE Show—Booths 2604-2614

CIRCLE 91 ON READER-SERVICE CARD

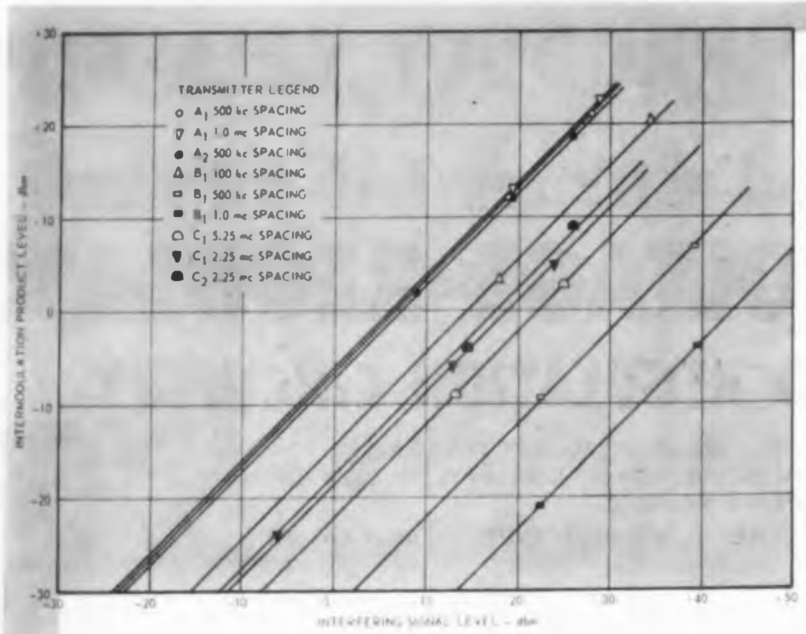
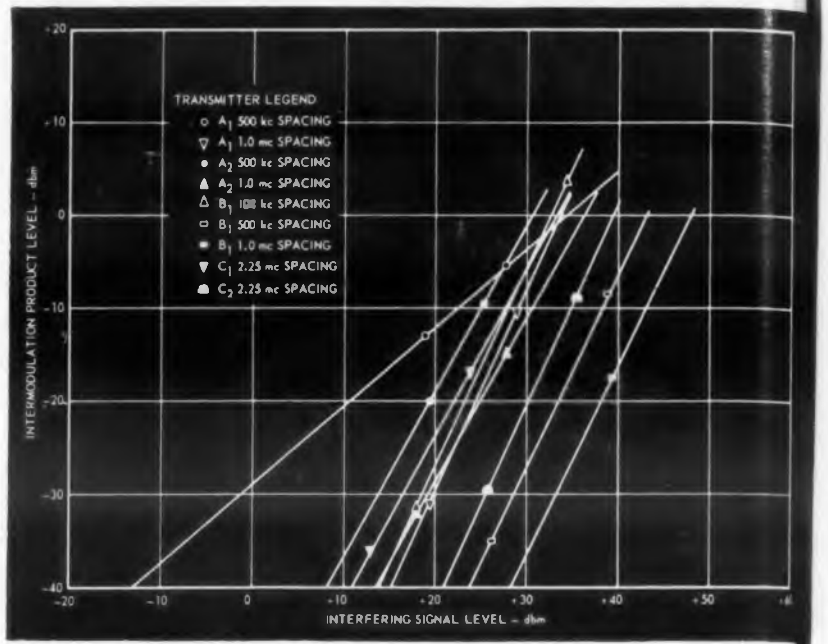


Fig. 2. (left) Intermodulation product level vs interfering signal level (third order low).

Fig. 3. (below) Intermodulation product level vs interfering signal level (third order high).



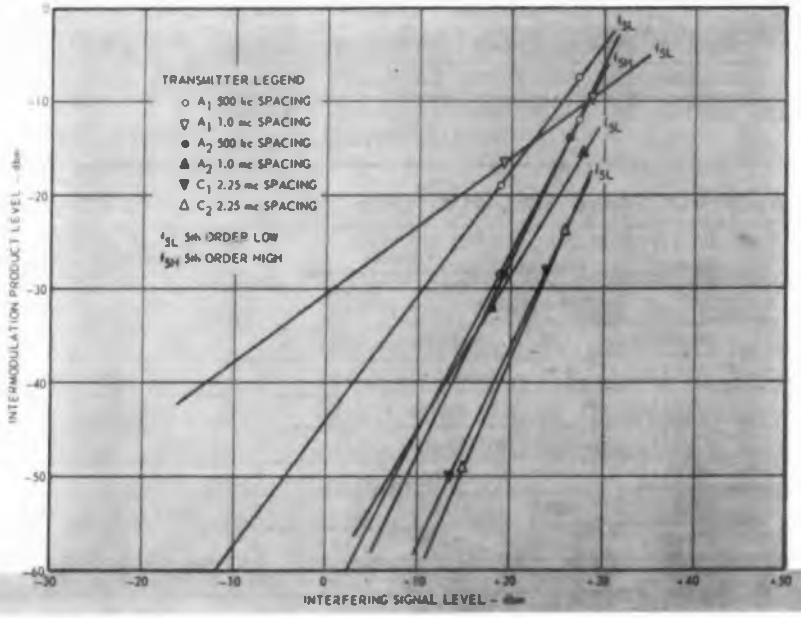


Fig. 4. (left) Intermodulation product level vs interfering signal level (fifth order).

Table 1. Typical values of transmitter intermodulation constants.

Transmitter	P_d (dbm)	P_i (dbm)	Spacing	Third Order Low		Third Order High		Fifth Order Low		Fifth Order High	
				C_I (db)	k	C_I (db)	k	C_I (db)	k	C_I (db)	k
10 mc											
A_2	59.5	26.5	500 kc	−7	1.0	−49.3	1.5	−68.8	2.07	—	—
A_2	59.5	19.5	500 kc	−7	1.0	−49.3	1.5	−68 8	2.07	—	—
A_1	59.5	29.0	1000 kc	−6.5	1.0	−73.1	2.16				
A_1	59.5	19.5	1000 kc	−6.5	1.0	−73.1	2.16				
B_1	56.6	34.5	100 kc	−15.2	1.03	−70.0	2.13				
B_1	57.9	18.0	100 kc	−15.2	1.03	−70.0	2.13				
B_1	59.0	39.3	500 kc	−31.1	0.965	−90.4	2.08				
B_1	57.8	22.5	500 kc	−31.1	0.965	−90.4	2.08				
B_1	56.8	39.5	1000 kc	−43.5	1.0	———	——				
B_1	57.8	22.7	1000 kc	−43.5	1.0	———	——				
161 mc											
C_1	43.7	23.9	2.25 mc	−18.2	0.955	−59.0	1.77				
C_1	43.7	12.9	2.25 mc	−18.2	0.955	−59.0	1.77				
C_2	43.5	25.9	2.25 mc	−22.5	1.22	−83.9	2.1				
C_2	43.5	14.6	2.25 mc	−22.5	1.22	−83.9	2.1				

Average k for 3rd Order Low = 1.02
Average k for 3rd Order High = 1.96

Since C_I and k vary for each transmitter type and for each signal spacing, useful prediction of IPL requires the evaluation of these constants for each transmitter at each signal spacing likely to be encountered in their operation. Evaluation of k requires the measurement of the IPL for at least two known interfering signal levels for each signal spacing. The value of k is then determined by using the following equation

$$k = \frac{\Delta P_I}{\Delta P_i} = \frac{(P_I)_1 - (P_I)_2}{(P_i)_1 - (P_i)_2}. \qquad (4)$$

Using k thus calculated, C_I may be determined by using the relationship

$$C_I = (P_I)_1 - k\ (P_i)_1. \qquad (5)$$

These constants may then be used to determine the IPL with any *IS* level for the particular signal spacing associated with them.

Calculated values of constants associated with several different transmitter types for various signal spacings are shown in Table I. Graphs of the data, which indicate typical trends, are shown in Figs. 2, 3 and 4.

The third-order product on the carrier side, that is, the third-order product nearest the carrier, is always the highest in level regardless of whether the *IS* is higher or lower in frequency than the *DS*.

Typical Problem

The following example will illustrate the prediction method for a typical transmitter.

Data obtained from tests on transmitter C_I will be used in these calculations, where

$$(P_i)_1 = 23.9, \qquad (P_i)_2 = 12.9,$$
$$(P_I)_1 = 4.6, \qquad (P_I)_2 = -5.9,$$
$$f_i = 163.25 \text{ mc} \quad \text{and} \quad f_d = 161 \text{ mc}$$

Then

$$f_I = 161 - (3-1)(161-163.25) = 165.5 \text{mc (high)}$$

and

$$f_I = 161 + (3-2)(161-163.25) = 158.75 \text{mc (low)}$$

using Eqs. 1 and 2. These are the third-order product frequencies high and low. The intermodulation product levels used in this example are third-order low (third order on the *DS* side).

Eq. 4 gives

$$k = \frac{4.6 + 5.9}{23.9 - 12.9} = \frac{10.5}{11} = 0.995.$$

Eq. 5 gives

$$C_I = 4.6 - 0.995\ (23.9) = -18.2.$$

Now assume an *IS* of 1-dbm level at 163.25-mc frequency, and it is desired to calculate the intermodulation-product level. Using Eq. 3

$$P_I = -18.2 + 0.995\ (1) = -17.2 \text{ dbm}.$$

Reference to Fig. 2 will show that the value is a good approximation of the intermodulation-product level. ■ ■

Acknowledgements

The information contained in this paper was obtained with Contract DA-36-039-SC-74855, between the U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J. and the Georgia Institute of Technology, Engineering Experiment Station, Atlanta, Ga., during the period 1 July 1957 to 30 June 1959.

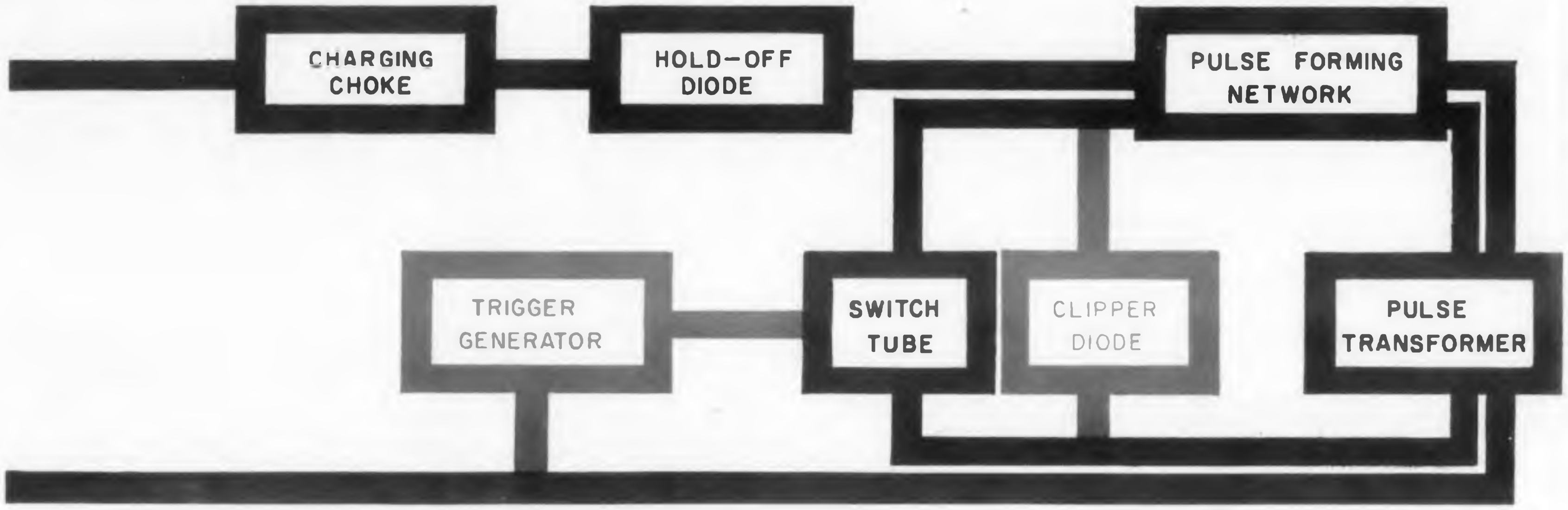
I wish to thank W. R. Free and H. L. McKinley for the help they gave me in the preparation of this paper.

References

1. Firestone, W.L., "SSB Performance as a Function of Carrier Strength," *Proc. IRE*, Vol. 44, p. 1839, Dec. 1956.
2. Motorola, Inc., "Nontactical Radio Equipment System Study, Final Engineering Report," Air Force Contract AF-30(602)1251, pp 130-139, 1 Nov. 1957.

How to Design a Line-Type Modulator

Part III—Associated Circuitry



*The preceding articles of this series (*ED*, Feb. 17 and March 2, 1960), determined the major components of a line-type modulator, given only the microwave power required, pulse width and pulse repetition rate. Choice of the clipper diode and the trigger source have been left for this final article.*

Igor Limansky[*]
Electronic Research and Development Section
The Martin Co.
Baltimore, Md.

THE BASIC modulator is depicted in Fig. 1a, and its equivalent circuit in Fig. 1b. The presence of an arcing load, such as a magnetron, can be represented by the closing of switch S_2. When this takes place, a severe mismatch occurs between the load and the pulse-forming network (PFN). This mismatch results in the application of a large amount of inverse voltage to the thyratron and PFN (dotted line in Fig. 1c).

Because the process is cumulative[1], if no means exists to remove this inverse voltage, the final network voltage may be as high as seven times the power supply voltage. Voltage breakdown of the PFN, charging choke, pulse transformer and hydrogen thyratron can be the consequences of an unprotected line-type modulator. This is obviously a situation that should be avoided by the inclusion of a circuit designed to discharge the inverse voltage left across the PFN after a short-circuit in the load. The clipper- or shunt-diode circuit performs this function.

Only vacuum diodes are considered here, although other methods have been proposed[2]. The analysis of M. H. Zinn[3] is used as a basis in finding a suitable diode. We shall continue the example begun in Part I, *ED* Feb. 17, 1960, p 42, for illustrative purposes.

Four factors are pointed out in Mr. Zinn's report as important in the choice of a diode for clipper service:

1—Peak inverse voltage
2—Peak current (under shorted load conditions)
3—Plate dissipation
4—Rms cathode current

Diode Peak Inverse Voltage

Inspection of Fig. 1 shows that the peak inverse voltage which the diode must withstand will simply be the peak forward voltage across the thyratron. The current through the diode will depend in part upon the diode resistance R_t, in part upon the series resistance R_s, and in part upon the inverse voltage e_{px1}, which the diode sees as forward voltage. The peak inverse voltage in turn, will depend upon the degree of mismatch between the PFN and the load. In the event that the load arcs during operation, the PFN must dissipate all its energy in the equivalent internal impedance R_m, of the modulator switch tube, and the stray circuit resistance. The relation (7),

$$e_{px} = e_{py} \frac{Z_L - Z_N}{Z_L + Z_N}$$

given in Part I therefore becomes:

$$e_{px1} = e_{py} \frac{R_m - Z_N}{R_m + Z_N} \qquad (1)$$

since Z_L is zero, and is replaced by R_m.

Diode Peak Current

The value of peak current through the clipper

---

[*] Now with Air Arm Division, Westinghouse Corp., Baltimore, Md.

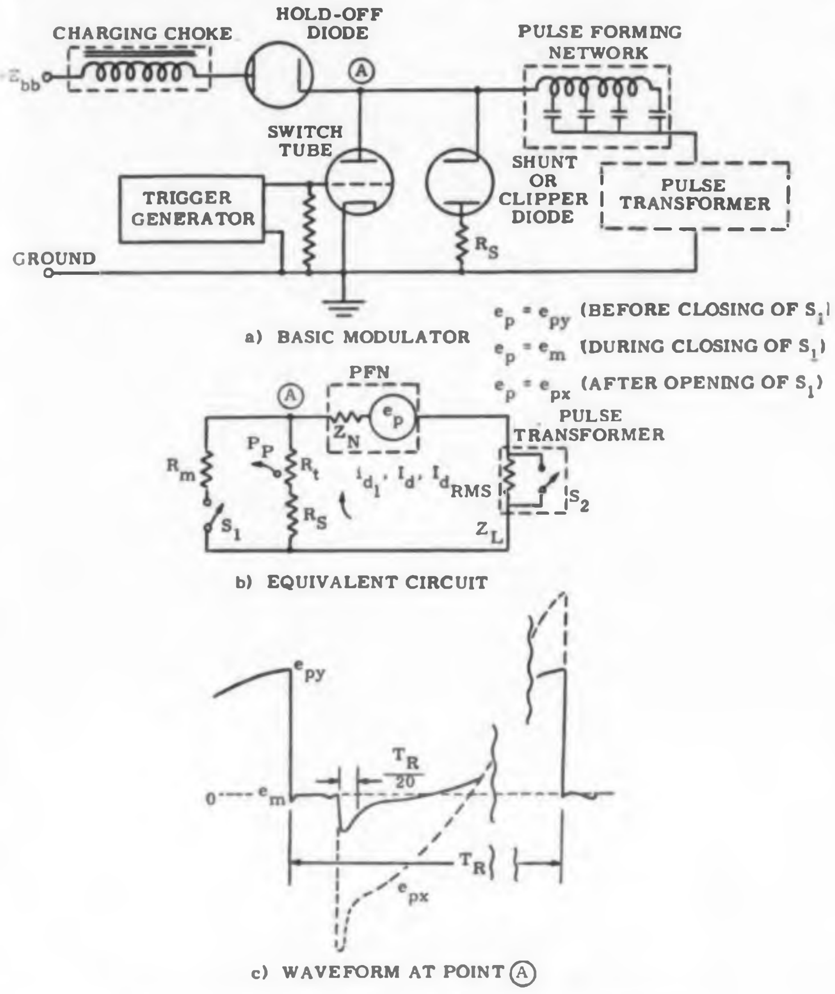


Fig. 1. Basic modulator circuit and its waveforms.

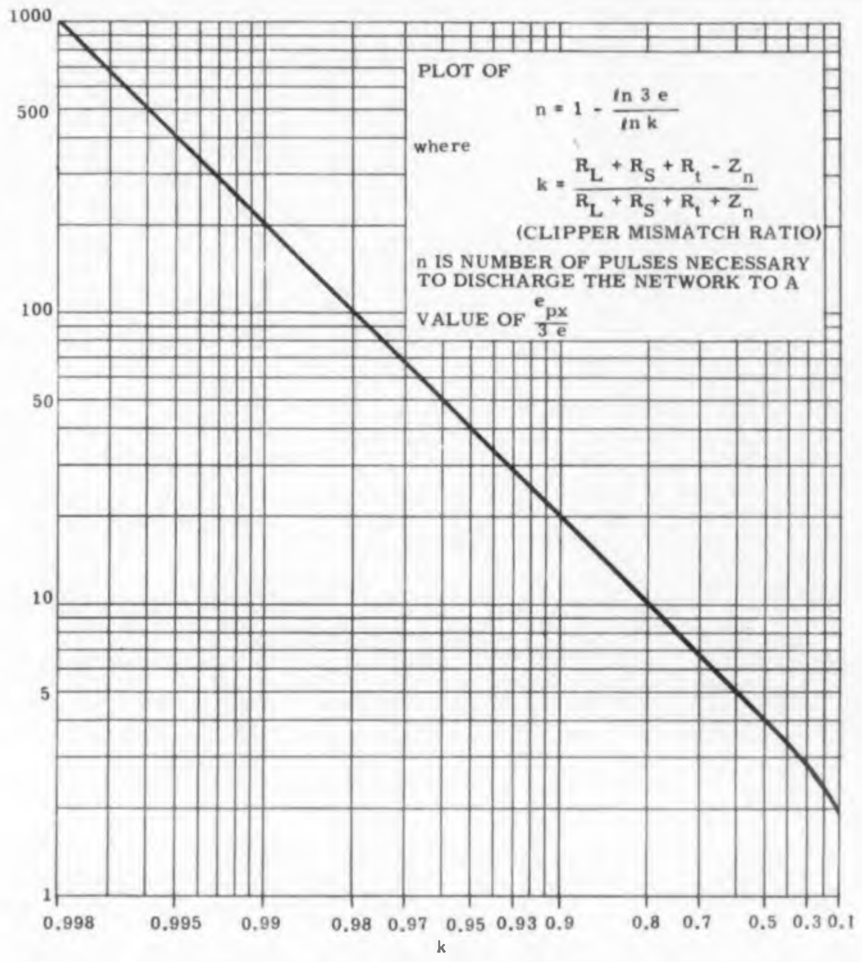


Fig. 2. Use this chart to find the limiting value of mismatch ratio *(k)* knowing the number of discharge pulses *(n)*.

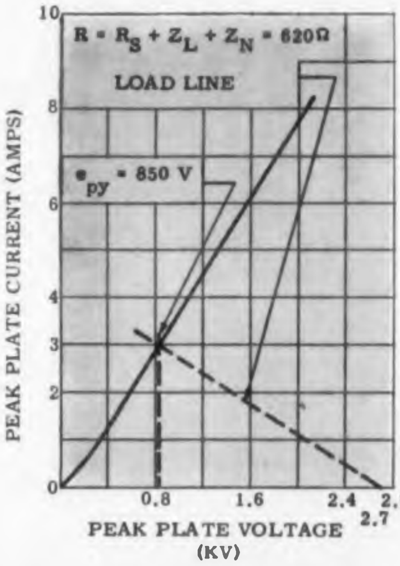


Fig. 3. Current-voltage characteristics of type 589 clipper diode.

diode i_{d1}†, for the first applied pulse can be expressed by the relation:

$$i_{d1} = \frac{e_{px1}}{R_s + R_t + Z_L + Z_N} \qquad (2)$$

where R_t must be determined for the particular tube used. The value of i_{d1} must be calculated for the worst, or arcing, condition.

The first step consists of finding a limiting value of clipper diode mismatch factor *k*, where

$$k = \frac{(R_s + R_t) + Z_L - Z_N}{(R_s + R_t) + Z_L + Z_N} \qquad (3)$$

This will determine the maximum value of $(R_s + R_t)$ for the clipper diode circuit, and an approximate value of clipper diode peak current i_{d1} necessary for a choice of tube.

A limiting value of *k* may be found by assuming that the network is to be discharged through the clipper diode circuit, to a value of 1/3*e* of e_{px1}, in a time corresponding to 1/20 of the pulse repetition period. Since this discharge occurs in discrete pulse steps of duration t_p, the number of steps required to discharge the PFN is

$$n\,t_p \leq \frac{1}{20}\,\frac{1}{prr}, \text{ or} \qquad (4)$$

$$n \leq \frac{1}{20\,du}$$

In the example, since du = 0.00175

$$n \leq \frac{1}{20\,(0.00175)} = 29$$

From Fig. 2, the value of *k*, for *n* equal to 29 is found to be 0.93, and since:

$$(R_s + R_t)_{max} = \frac{1 + k}{1 - k}\,Z_N - Z_L \qquad (5)$$

for this case:

$$(R_s + R_t)_{max} = \frac{1 + 0.93}{1 - 0.93}\,55 - 0 = 1.5 \text{ k}.$$

Further, if the switch tube impedance R_m, is taken as one ohm, from Eq. 1,

$$e_{px1} = 2.8\,\frac{1.0 - 55}{1.0 + 55} = 2.7 \text{ kv}.$$

Under these conditions, the peak current that the clipper diode passes is therefore:

$$i_{d1} = \frac{2{,}700}{1{,}500 + 0 + 55} = 1.7 \text{ amp}$$

from Eq. 2.

A diode that is capable of passing at least twice this amount of peak current, and withstanding the peak forward voltage e_{py} (which will appear as inverse voltage across the diode), may be chosen. The current rating should be twice that based upon the inverse voltage e_{px1}. This is because the so-called "inductive spike" is thought to be due to excessive inductance in the first section of the PFN[4], and is a significant contributor to hydrogen thyratron plate dissipation.

Selecting a Diode Type

From these approximate ratings of the diode required, the 589 diode might be chosen. Its peak current-peak voltage characteristics are shown in Fig. 3. By limiting the current through the clipper diode to 3 amp under the worst condition ($Z_L = 0$), a factor of safety of 5 amp will be available to take care of the "inductive spike." This follows because the 589 can safely pass a peak cur-

---

†The subscript "d" refers to "diode". Zinn's notation is i_{b1}.

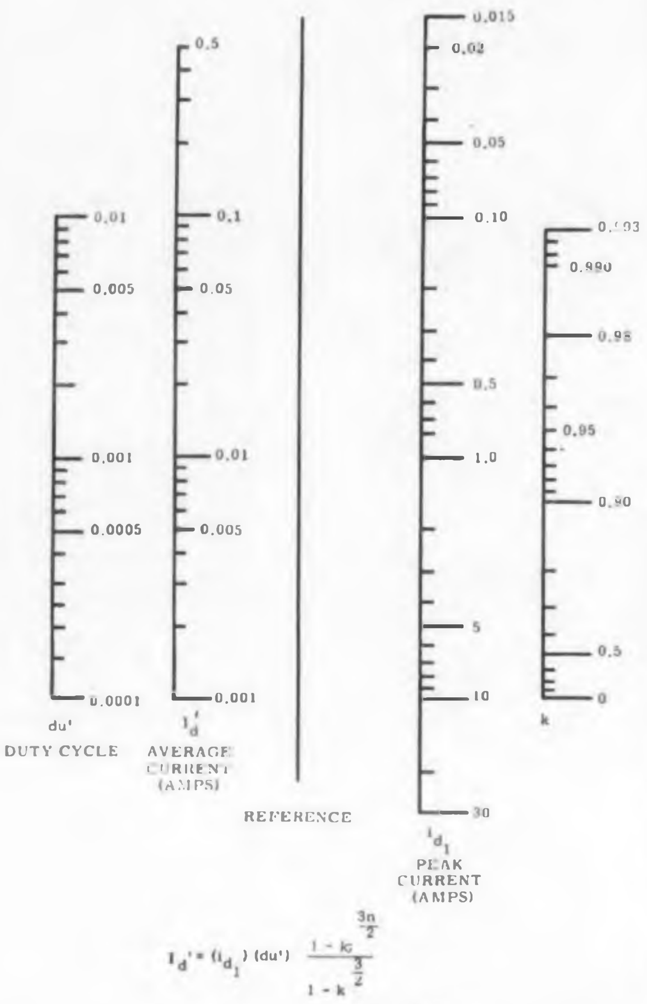


Fig. 4. Use this nomograph to determine average diode current (I_d'), knowing k, du' and I_{d1}.

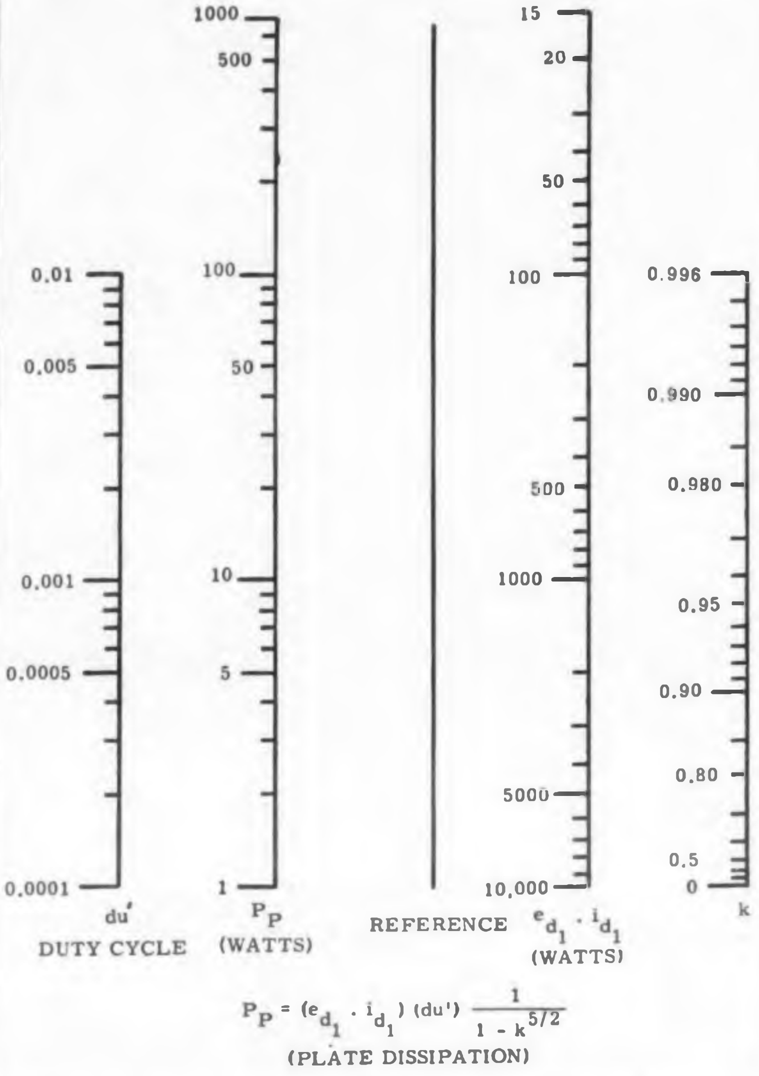


Fig. 5. Use this nomograph to determine plate dissipation.

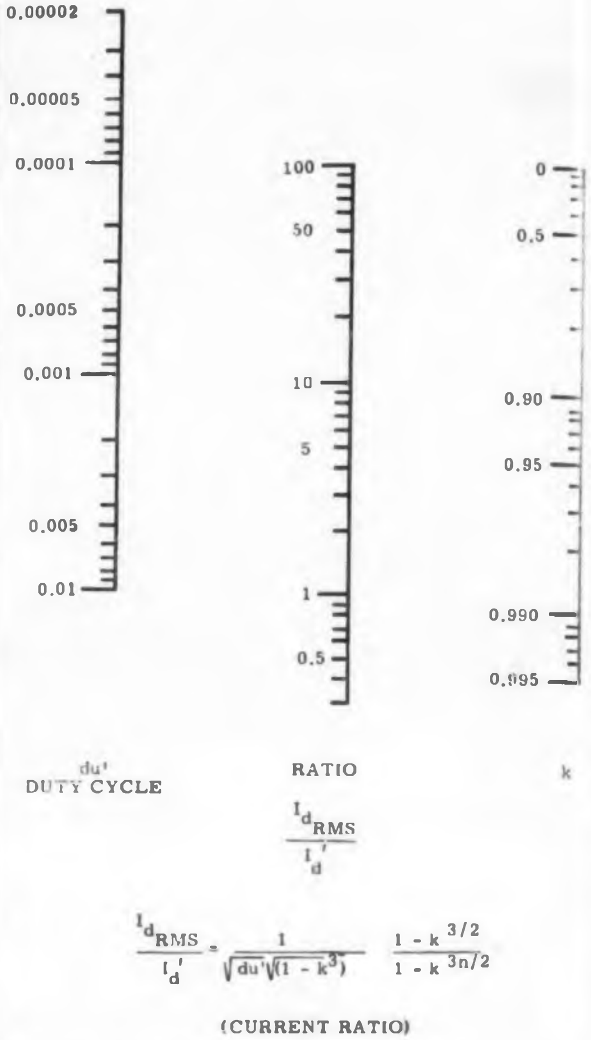


Fig. 6. Use this nomograph to determine rms diode current.

rent of 8 amp. Choosing i_{d1} to be 3 amp, from Fig. 3, the value of e_{d1} will be 850 v. The diode resistance R_t, will be:

$$R_t = \frac{e_{d1}}{i_{d1}} \qquad (6)$$

so that

$$R_t = \frac{850}{3} = 280 \text{ ohms}$$

The load line for the diode, from Fig. 3 will be:

$$R = \frac{e_{px1} - e_{d1}}{i_{d1}} = R_s + Z_L + Z_N \qquad (7)$$

which in our case becomes:

$$R = \frac{2{,}700 - 850}{3} = 620 \text{ ohms}$$

Since arcing conditions are implied from Eq. 7:

$$R_s = R - Z_L - Z_N = 620 - 0 - 55 = 565 \text{ ohms}$$

The designer may wish to adjust R_s slightly, to conform to commercially-available values. This will require redrawing the load line R in Fig. 3, picking off new values of i_{d1}, e_{d1}, and recalculating R_t. This step will be omitted for simplicity's sake, and 565 ohms will be used for R_s.

Plate Dissipation, RMS Current

The next step consists of recomputing the value of clipper diode mismatch factor, using Eq. 3, based upon the circuit constants determined above. The remainder of the diode operating conditions may then be found: I'_d, using Fig. 4; the plate dissipation P_p, using Fig. 5; and the ratio of I_{drms} to I'_d, using Fig. 6.

In our example, we have:

$R_s = 565$ ohms $Z_L = 0$ (arcing condition)

$R_t = 280$ ohms $Z_N = 55$ ohms

so that,

$$k = \frac{565 + 280 + 0 - 55}{565 + 280 + 0 + 55} = 0.88$$

Fig. 6 follows the general rules for using nomographs. Figs. 4 and 5 are three-variable nomographs requiring two lines. One line drawn from the outermost scales will determine a point on the reference axis. The second line drawn through this point to a value upon one of the innermost scales will intersect the other innermost scale at the value sought.

In Fig. 4, a line is drawn from $k = 0.88$ to $du' = 0.00175$**. A second line is drawn from the intersection of the first line with the reference axis, to $id_1 = 3.0$ amp. The value of I'_d is therefore 29 ma††. In Fig. 5, the value of e_{d1} x i_{d1} must be computed, and is 2550 w. As before, $du' = 0.00175$ and $k = 0.88$. The reader may verify that the plate dissipation of the clipper diode P_p, is now 16 w. In Fig. 6, a single line drawn from $k = 0.88$ to $du' = 0.00175$ will suffice: it will intersect the I_{drms}/I'_d axis at 8.0. The rms clipper diode current I_{drms}, is therefore 230 ma.

**This represents the worst condition, continuous arcing of the load (i.e. $du' = du$). Ordinarily, du' is based upon the arcing characteristics of the load, and is much smaller than the operating duty cycle, du.

††I'_d is used to compute the value of I_{drms} and should not be confused with the Average Current I_d. The latter may be computed with the formula: $I_d = (e_{px1})\ (du')/2Z_N$, but is not of primary importance in the choice of the clipper diode.

Comparison of the above data with the manufacturer's ratings in Table 1, shows that the 589 diode is operating well within its ratings if it is liquid cooled. If a value of *k* equal to 0.93 is used, corresponding to the limiting case, where $(R_s + R_t) = 1.5\ k$, the reader may verify that $I_{drms} = 165$ ma.

Higher Powered Circuits

The clipper diode protective circuit has been determined with deceptive ease for our modulator example. The reader should be forewarned that clipper diode circuits for the higher-powered modulators result in unusual demands upon clipper diode performance.

For example, a modulator requiring an e_{py} of 20 kv, and operating at a duty cycle of 0.0005 will have a limiting k of 0.98, and an $(R_s + R_t)$ max of 2.5 *K*. Under arcing conditions, with Z_N equal to 25 ohms, e_{px1} approximates 20 kv so that the peak current the diode must pass is at least 79 amp, neglecting the factor of safety for the "inductive spike" contributions. Since this modulator is in the medium-power range, and the higher powered modulators require clipper diode currents of 200 amp, one can see the reason for employing gas tubes as clipper diodes.

If the arcing characteristics of the load are known, a lower value of *du'* may be specified, thereby easing the requirements for plate dissipation and rms current for the tube chosen. If this is done, however, it would be wise to protect the clipper diode itself, by the use of a thermal relay that would be placed in series with the diode circuit, and would remove high voltage from the modulator upon excessive arcing.

Trigger Generator

Although the major components and associated circuitry have been determined, it is important that the trigger generator requirements receive careful consideration. No attempt will be made to specify the design of the trigger generator in detail, since this will depend upon the particular operating conditions of the modulator switch tube.

The MIL-E-1C specifications for the 3C45 hydrogen thyratron read as follows with respect to the trigger source:

> "Note 3: Driver pulse, measured at tube socket with thyratron grid disconnected: $e_{gy} = 175$ v(min), time of rise $= 0.5$ μsec (max), grid pulse duration $= 2.0$ μsec (min), Impedance of Drive Circuits $= 1500$ ohms (max)."

The rise time of the trigger pulse is arbitrarily defined as the time between the 26 per cent and 70.7 per cent points on the leading edge of the pulse, when the trigger generator is unloaded. The pulse width is taken at the 70.7 per cent level of the trigger pulse, when the trigger generator is loaded by its characteristic impedance. The drive circuit impedance may be measured by placing a variable resistor having good frequency characteristics across the ouput of the trigger generator, and varying it until the peak pulse voltage, as measured across the resistance, is half the open-circuit peak pulse voltage. The resistance value of the variable resistor will then be equal to the output impedance of the drive circuit.

TABLE III-1

	Calculated Value	Manufacturer's Data Type 589 Diode	
		Liquid Cooled	Radiation Cooled
Inverse Voltage	2.7 kv	10 kv	10 kv
Peak Current	3.0 a	8.0 a	8.0 a
Rms Current	230 ma	300 ma	150 ma

The values given in the MIL-E-1C specifications are the limiting values permissible. There are great advantages in providing a trigger source well-within these values. For example, a high rate-of-rise trigger pulse will do much towards decreasing the time jitter and anode delay time of the switch tube, as will a low drive circuit-impedance. Two precautions must be noted, however. First, the trigger pulse width must not be too great, otherwise the thyratron will not de-ionize. Second, excessive grid dissipation must be avoided for the same reason.

It may be assumed that the application of the modulator dictates good stability. For the 3C45, a peak trigger voltage e_{gy}, of 250 v, having an 0.1 μsec rise time, and a loaded pulse width of 2.5 μsec, out of a driver having an output impedance of 500 ohms will suffice. ■ ■

References

1. G. N. Glasoe, J. V. Lebacqz, *Pulse Generators*, M.I.T. Rad. Lab. Series, Vol. V, McGraw-Hill Book Co., 1948, pp 423-425.
2. G. Taylor, *Use of Hydrogen Thyratrons As Clippers*, Technical Minutes, Third Hydrogen Thyratron Symposium, May 27-28, 1953, pp 68-81.
   A. J. Moses, *Research Study and Development of Clipper Tube, Gas-Filled*, Report to Signal Corps Supply Agency by Chatham Electronics, Livingston, New Jersey, Phase I, Feb. 15, 1955 to Sept. 30, 1956.
3. M. H. Zinn, *Analysis of Clipper Diode Conditions*, Evans Signal Lab Memorandum Report, SIGEL-PST-6P, File 413.44 VT, dtd March 16, 1954.
4. S. Goldberg, *Research Study on Hydrogen Thyratrons*, Vol. II, Edgerton, Germeshausen and Grier, Inc., pp. III-13.

I am most grateful for the help, criticism and encouragement of Mr. Mortimer H. Zinn of the Evans Signal Laboratories, Fort Monmouth, N. J.

Design Miniature Ovens With Close Temperature Control

Frank J. Cheli
Bulova Watch Co.
Woodside, N. Y.

In designing small ovens, most engineers depend on a hit-and-miss procedure. According to Frank Cheli, this most often results in a "direct miss." Close temperature control requires careful design.

DESIGNING a temperature controlled oven involves construction of a prototype that meets physical specifications, testing, modifying, and retesting until performance is satisfactory.

Application of the methods suggested here will facilitate the design of lower cost, longer lived, and more closely controlled ovens. Although the ovens described are used for quartz crystals, they may also be used for other applications, such as maintaining transistors at a constant temperature when high stability is required.

Factors Affecting Oven Accuracy

Designing a miniature oven for one degree control is no great problem under static ambient and load conditions, but the problem becomes much more difficult when the ambient range is spread over 135 deg C, as in military applications. The design problem is further complicated by the small mass and size required in such units. The small mass provides little heat storage, consequently little smoothing of small change in heat balance.

Compared with larger heated systems, small ovens respond more readily, and with larger variations, to such factors as imbalance between heat input and heat demand, non-uniform heat distribution, localized heat losses, and speed of thermostat response.

Because of this thermal hypersensitivity, details of design and construction, selection and placement of components, the types of materials used, and even the method of testing the oven have a critical effect on control accuracy.

A well designed oven must have adequate heat input, uniform heat distribution, rapid controller response, and minimum heat transfer between the system and its surroundings. To accomplish these objectives the designer must take into account the size and placement of the heat source, the mass, shape and materials, type and placement of the thermostat, and type, quantity and placement of insulation and thermal buffers.

Designing the Heat Source

The oven heater is usually made of Nichrome wire with a triple layer of silicone-glass insulation. It is wound in a single layer, if possible, to prevent abrasion of the insulation due to contraction and expansion.

The wire is wrapped around the oven shell, or around the crystal holder, in such fashion as to cover as much of the surface as possible. This is to provide uniform heat distribution. Further, the heater is wrapped directly onto the metal surface to assure rapid heat transfer into the oven, and to minimize wasted heat.

Since the coil develops heat along its entire length, it is extremely important that the "tail" leads from the heater be in contact with the heat dissipating mass. If the leads are connected to the terminals across an air gap they may overheat and burn out.

The heat source must do two jobs. First, it must bring the oven up to control temperature within a specified time interval after a cold start. Second, it must supply heat for maintaining the oven at a specified temperature after initial warm-up.

The minimum wattage is that required to control the oven at the lowest ambient temperature specified. Determining this wattage requires some cut-and-try, since it is affected by the individual oven design, but the usual range is ten to twenty watts. The heater must be designed 10 to 20% larger than the bare minimum so that the heater will not be on continuously at low temperatures.

The heater should not be too large, since temperature control becomes more difficult as the heater wattage increases with respect to the thermal mass of the oven. During cooling, after current is cut off, the heater continues to add heat to the system. If the heater is too large for the mass of the system, repeated temperature overshoots will occur.

This effect is particularly troublesome if the

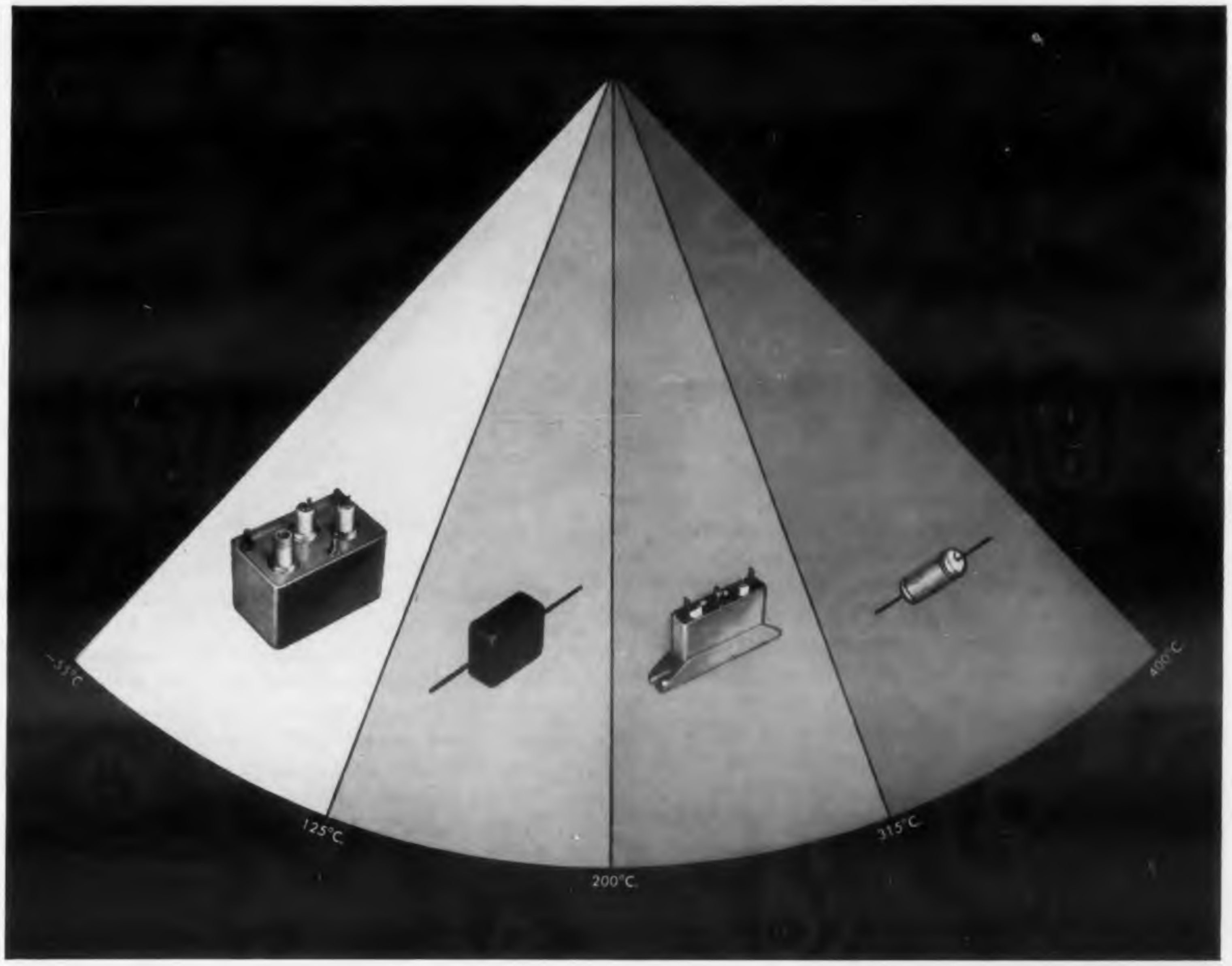
Fig. 1. Two concentric metal rings conduct heat from the coils on the outside of the cylinder. Heat is distributed uniformly among the 15 radially-arranged crystals. The oven is closed by the cap at right and the entire unit housed in the can at left.

ambient temperature is almost as high as the control temperature, because the excess heat cannot be dissipated rapidly. Minimizing heater capacity further improves control by decreasing the current (and thus the amount of internal heating) in the thermostat. Internal heating of the thermostat impairs its sensitivity by adding to the amount of heat it "sees." Excessive heater wattages also shorten the life of the thermostat contacts.

If the mass of the oven is high, considerably more heat is required for warm-up than for maintaining the control temperature after warm-up. The temperature control circuit must provide maximum heat for rapid warm-up, then reduce heat for normal operation.

A convenient method is to use two normally-closed thermostats controlling a tapped heater coil. One thermostat, set at the control temperature, is connected in series with the full heater and supplies heat for normal operation. The second thermostat, set about ten degrees below the control temperature, is in series with a shorter length of the heater coil, thus providing the increased wattage required for warm-up.

In an oven requiring 20 watts for control, and 35 watts to achieve a three minute warmup, the control thermostat is in series with the entire length of the soil, and the warm-up thermostat



taps the coil at a point 3/7 of its length.

When the wattage differential between control and warm-up is small, special heater wire having a large positive temperature coefficient may be used. The resistance increase with rising temperature automatically reduces heater output as the oven approaches control temperature, permitting the circuit to be controlled by one thermostat set at the control temperature.

Distributing the Heat Uniformly

Since the oven is enclosed, very little air circulation can occur. Every design technique must be used to achieve uniform heat distribution and minimize thermal lag. Winding the heater around the largest possible amount of oven surface is essential to uniform heat dispersion. A cylindrical oven is preferable because it has no corners to form thermal deadspots. Aluminum, copper, silver, and their alloys have high thermal conductivity and low specific heat. Their use permits minimizing thermal lags and temperature gradients.

Conducting devices can improve heat distribution and minimize gradients among components in the oven. In the oven shown in Fig. 1, which contains 15 crystals in a radial arrangement, the conducting device is a pair of concentric beryllium-copper rings. The crystal cartridges are between the two rings, and in intimate contact with them.

The rings provide a thermal conducting path between crystals, reducing temperature variations from crystal to crystal. Arranging the cartridges in an evenly spaced circle also helps distribute the heat uniformly among them.

Increasing the mass within an oven provides "thermal inertia," making the oven less sensitive to transient effects, and buffering the internal temperature against rapid change. If the mass is made too large however, the system's recovery from falling temperature is slowed, larger heaters are required and, of course, the weight increase may be undesirable.

In the oven shown in Fig. 2, thermal inertia is provided by the half pound brass chassis on which 11 crystals are mounted. This unusually massive chassis serves as a heat reservoir, buffering against abrupt temperature changes.

Fig. 2. Brass chassis provides thermal inertia to control crystal temperature closely.

Fig. 3. These tiny Fenwal Thermoswitches can control to within 1/2 deg C.

Controlling the Temperature

An oven thermostat must have rapid response, minimum size, and low mass to minimize its own thermal inertia. Additionally, it must have high sensitivity to small temperature changes. The thermostat must operate reliably under the wide range of physical conditions to which the oven is subjected and should be hermetically sealed to prevent contact contamination and sticking.

A typical oven control, shown in Fig. 3, is the Thermoswitch[*]. This 1/4 ounce, hermetically sealed unit requiring less than 0.14 cubic inch of mounting space, can control within 0.5 deg C provided good design procedures are followed.

One of these thermostats installed in a production oven, and tested under field conditions, has operated for 1.5 million cycles and is still maintaining the temperature within specified tolerances.

For close control the thermostat must be located where it can respond to temperature change as soon as it occurs. The most desirable location is between the heater and the crystal, and as close as possible to both (Fig. 4). Proximity of the thermostat to the heater increases the cycling frequency, improving control by adding heat in short bursts which minimize overshoot.

If the electrical load is kept small, frequent cycling does not appreciably reduce contact life. Proximity of the thermostat to the crystal permits close sensing of the crystal temperature. When this is impractical the control may be placed adjacent to the heat sink, where heat loss to the surroundings is most rapid (Fig. 5), enabling it to follow cooling tendencies before the oven temperature drops excessively.

Regardless of location, the thermostat must be in intimate contact with some metal part of the oven. Close control is possible only if the thermostat can respond to the temperature of a mass in the oven, rather than to the air, or insulation having poor heat transfer properties. To assure good permanent thermal contact, the thermostat should be secured by tabs formed from the metal part, or soldered in place.

The problems of sparking and radio interference can be reduced by wiring a capacitor in series with a resistor across the contacts. Reduction of sparking also extends contact life.

Preventing Heat Loss

The final step in the design of a well controlled oven is the measure to conserve heat. The object is to deliver all the wattage produced by the heater to the oven, and this implies as little loss as possible to the surroundings. Conservation of heat minimizes heater capacity, reducing the magnitude of temperature cycling in the oven.

The devices for preventing heat loss are dead air gaps and bright reflecting surfaces. In ovens with an inner and outer shell, the air space between shells provides a good thermal barrier. Bright plating on the surfaces of the outer shell reflects escaping heat back into the oven, and reflects away external ambient heat at elevated temperatures. All openings must be closed with silicone rubber gaskets, plastic spacers, or fiber glass insulation.

The oven should be checked to determine the best amount and placement of insulation. Insulating materials must not be used indiscriminately. This involves some cut-and-try. For example, insulation absorbs heat, and thus can reduce efficiency.

Over-insulation in relation to heater wattage

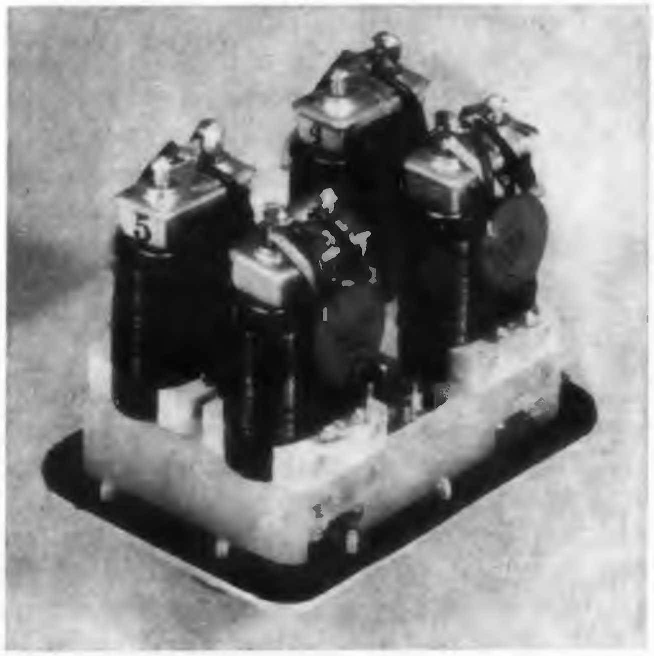


Fig. 4. Packing crystal, heater, and thermostat as close together as possible yields optimum control. In this assembly, each crystal is enclosed in its own separate heater with a thermostat mounted directly above and in intimate contact with the heater.

---

[*] Fenwal Inc., Ashland, Mass.

Fig. 5. If the control cannot be placed close to the crystal and heater, it should be mounted on a large mass in the oven. The mirror shows the control mounted on the base of the oven where it will respond quickly to cooling tendencies.

can cause the oven to overshoot. Burying the thermostat under insulation produces a heat pocket, raising the thermostat to a higher temperature than actually exists within the oven cavity. It is necessary to cut a hole in insulation in the vicinity of the control to enable it to respond rapidly to the oven temperature.

Testing Oven Performance

Because of many factors that can affect temperature, even between closely-spaced points in an oven, special procedures are required to measure the actual temperature of the crystals or other components when the oven is operating. Checking the oven wall with a thermocouple probe and extrapolating to obtain crystal temperature gives inexact results due to lead losses, variations in probe placement, and other factors. Other measurement procedures are complex and time consuming.

A convenient temperature test uses a thermistor sensing probe which duplicates the shape and mass of the actual component, and replaces it in the oven during test. For example, in crystal ovens a dummy crystal cartridge containing the thermistor is wired to the existing terminals, and measures the temperature right at the crystal. The probe signal is transmitted through the existing connectors to an external temperature indicator, where it is read to 0.1 deg C. Additional probes can be installed to indicate the temperature at various locations simultaneously.

Use of the thermistor plug-in probes reduces oven checking time materially, and gives extremely accurate results. Employment of these techniques has resulted in production ovens with closer tolerances, and lower rejection rates. ■ ■

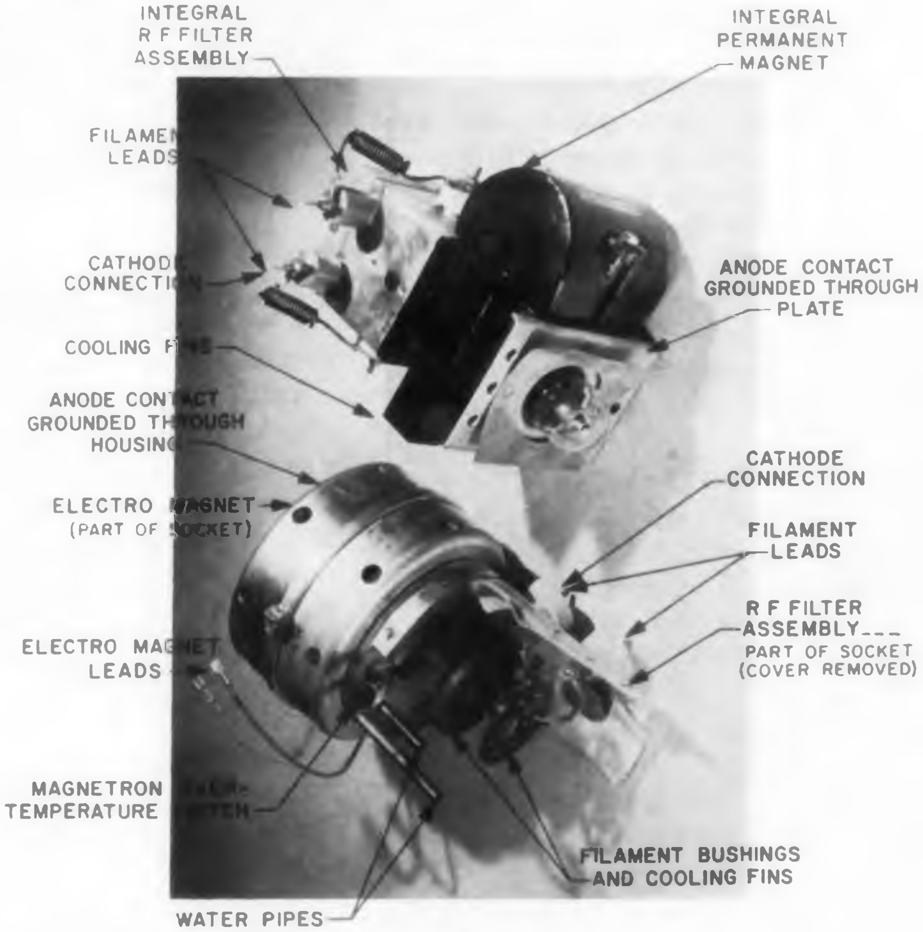
Liquid Cooling and Simpler Circuits Shrink Cost of Microwave Oven

STARTING with the magnetron and redesigning outward, Raytheon engineers lopped $480 off the $2975 price tag on their Radarange* Microwave Oven. In the face of rising costs of labor and materials, this was quite an achievement.

At Raytheon's Radarange Dept. in Waltham, Mass., Brone M. Walunas and Louis H. Schall were responsible for the redesign of the oven. To start, they replaced the permanent-magnet type QK-390 magnetron with a QK-707 using an electromagnet.

By routing the anode current through the electromagnet, they were able to provide plate regulation without using the traditional magnetic amplifier circuit in the primary of the plate transformer. Thus they used the electromagnet as a series field just as old-time radios used the field coils of dynamic speakers as power-supply filters.

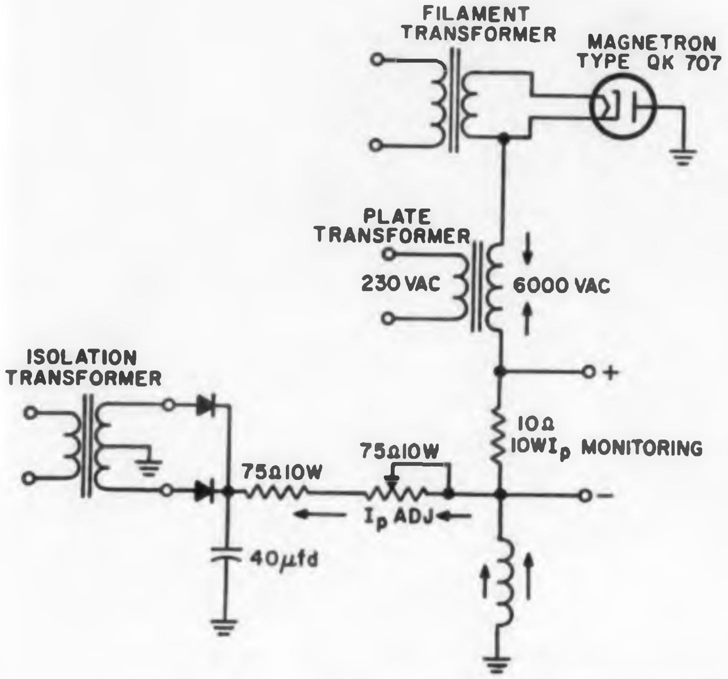
As another important cost-saver, they powered the magnetron from raw ac as a



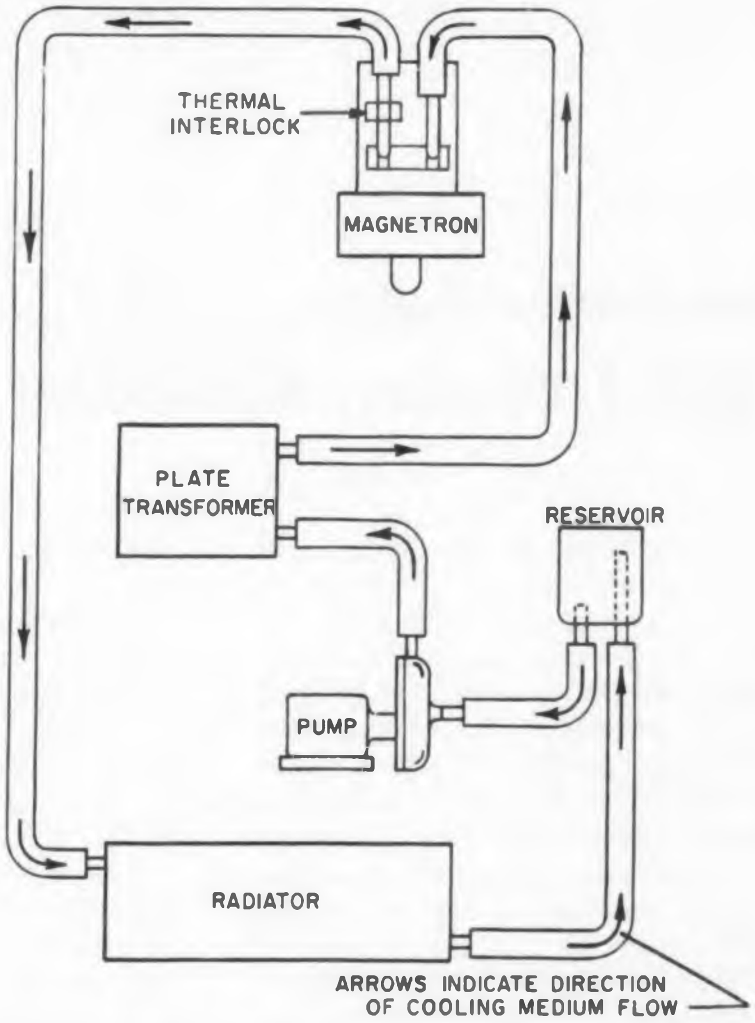
Previously used QK-390 magnetron (upper half of photo), and new QK-707 magnetron shown assembled within its electromagnet and filter assembly. The QK-707 tube and its water pipes are field replaceable.

---

*Radarange is a registered trademark of Raytheon Co. for its microwave oven. (A microwave oven has been defined as a device for making millisecond steaks instead of minute steaks).



Magnetron field and anode current circuit showing how the electromagnet is used to help regulate the plate current. The selenium rectifier supply at the left powers the electromagnet field coil and a relay in a field detection system.

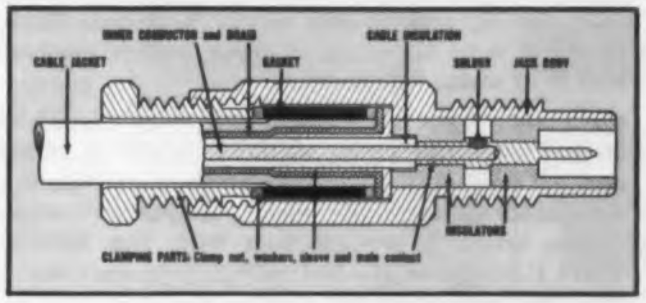


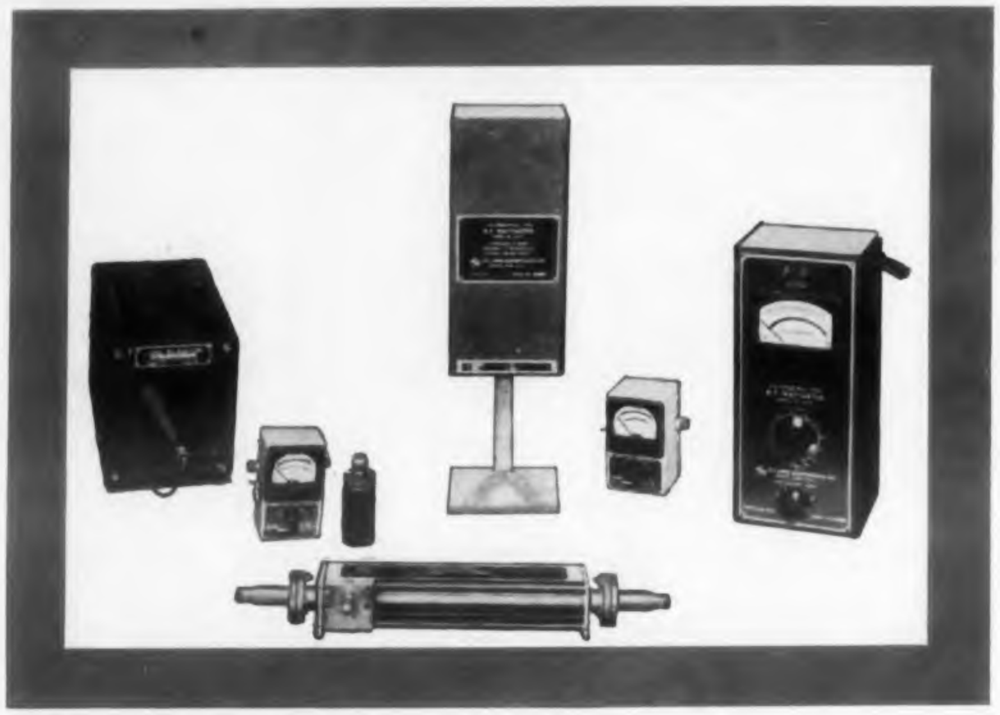
Self - contained cooling system for the QK-707 magnetron and the high-voltage plate transformer.

self-rectifier pulsed at a 60-cycle rate. This eliminated the high-voltage rectifier components required with earlier systems using dc pulsed at 120 cps.

A further change: they cooled the magnetron with liquid instead of air. The new magnetron has a water jacket and adapting pipes which replace the air-cooling fins formerly used. The heat-exchange system, using a 30-per-cent solution of ethylene glycol and water, cools the high voltage plate transformer as well as the magnetron.

Comprising a pump, radiator, fan, and expansion chamber, the liquid cooling system eliminates the noise due to high velocity air blowers and increases the cooling efficiency. Another advantage of the liquid system is that rf filter boxes, attached to the coil housing rather than to the magnetron, are resusable from magnetron to magnetron. ■ ■





Comb structure of 50-mc, 125-w, 10-amp power transistor provides long emitter length for high-current flow. Emitter is close to base at all points. Wiggly line in photo is not the emitter; it is the spacing between the interleaving teeth of the base and emitter.

Comb Structure Makes

High-Frequency, High-Power Transistors

TEN-AMP currents can be switched through the 0.2-ohm saturation resistance of a new transistor in less than 500 mμsec. Thanks to an unusual, comb-like emitter structure, this triple-diffused, npn, mesa transistor has an alpha cutoff of 50 mc and can dissipate 125 w.

Designed for high-speed, high-power switching, the new transistor should find wide application in power conversion, high-frequency power generation and amplification.

First in a new line of triple-diffused, high-frequency power transistors, the types PT900 and PT901 are manufactured by Pacific Semiconductors, Inc., 10451 W. Jefferson Blvd., Culver City, Calif. Hermetically sealed in a welded steel case, the transistor structure has a threaded copper stud for heat transfer to an external heat sink. At a 25 C case temperature, maximum collector-base voltage (V_{CBO}) rating for the PT900 is 140 v; for the PT901, 80 v. Collector-emitter voltage (V_{CER}) rating at $R = 10$, for the PT900 is 100 v; for the PT901, 50 v.

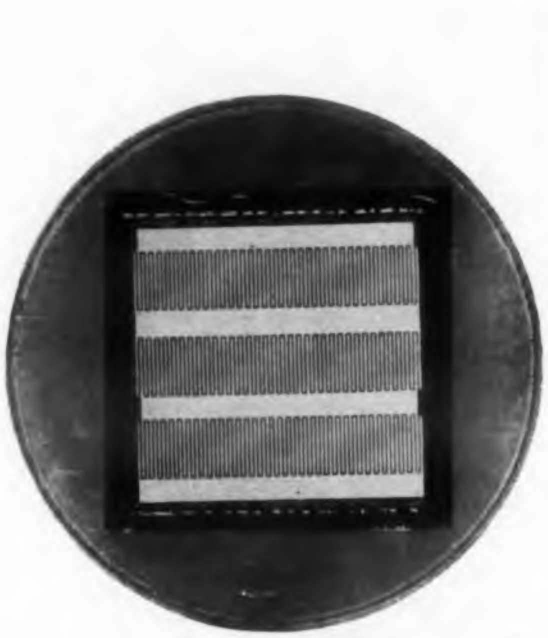
Other maximum ratings: emitter-base voltage (V_{EBO}) is 4 v, collector current 15 amp peak, junction temperature 150 C, thermal resistance 1 deg C per watt and total dissipation 125 w.

Emitter Comb Permits High Currents

Since at high frequencies a transistor only functions near the edge of the emitter, a long emitter edge is needed to get high currents. Design solution of Mason Clark, PSI's head of development, was to construct a narrow emitter stripe wiggling back and forth. This gave the emitter a long edge and brought the base lead closer to the emitter at all points. In a transistor with a large-area emitter, the base is necessarily far from the emitter center.

The photos show the comb design. The emitter comb is diffused into the silicon; to distribute current over the comb, the emitter is metalized.

Innards of a developmental 100-amp, 50-mc transistor, showing comb structure and heavy duty contacts. This type is not yet available.



Comb structure design. N-type emitter is diffused into p-type base, metalized for current flow. Transistor has four-layer construction.

A diffusion process was used instead of alloying, because with diffusion a high degree of uniformity over large areas (0.25-in. diam. silicon disk) is possible. With alloying, uniformity is difficult to obtain. The mesa structure has good high-frequency characteristics; and with diffusion techniques both collector and emitter resistivity can be controlled in production, instead of just the base layer resistivity. Mason Clark adds that the claims that alloy junction transistors inherently have higher current gain, better carrier lifetime and higher emitter efficiency than diffused junction units are "erroneous."

Dislocations Were Problem

Early in the two-and-a-half year old research the principal problem was getting materials suitable for the transistors. Good silicon—with a small number of dislocations (resistivity and lifetime were not a problem)—was not available in the sizes necessary. Now, materials are "quite good," Clark says.

They have to be. "A 100-amp transistor, for example," says Clark, "uses enough material to make 400 small transistors. A deformity in the silicon might spoil one or two of the small transistors, but you'd still have 398 good units. The same deformity might ruin the entire 100-amp transistor."

It's not quite that bad, Clark hastens to admit. With the large units such high currents are being passed that the need for microampere reverse leakage is not so critical as with smaller units.

100 Amps in Future?

PSI's 10-amp transistors are the first benefit from a research program sponsored by the Air Force under a contract monitored by the Electronic Technology Lab of Wright Air Development Division. Goal of the research was to produce 50-mc, 10-amp, 20-amp, 50-amp and 100-amp units. The latter three are still under development.

While capacitances are necessarily large—proportional to the area of the emitter—with the comb structure, input resistance is very low. RC, therefore, would be about the same in a 100-amp unit as in the 10-amp unit.

Developmental 50-amp units are constructed so they can be water cooled: 50 amp at 50 v gives 2500-w dissipation. Hundred-amp units must be force-air cooled.

PT900 and PT901 transistors are available in evaluation quantities for circuit design work. Cost is about $150 in limited quantities.

For further information about these 50-mc, triple-diffused, npn, mesa, power transistors, turn to the Reader-Service Card and circle **100**.

See the transistors at the IRE Show, Booth 2742-2744.

United Eyelets

Lowest Cost Fastener You can buy

Low initial cost per thousand, low installed cost with highly engineered high speed United Eyeleting machines, and you have an unbeatable combination you can put to work saving money. They will join dissimilar materials, can be clinched tightly to fasten, or lightly to function as a pivot.

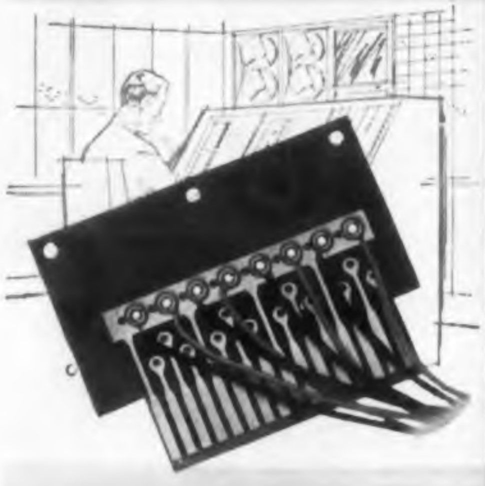
They can be used as a bearing, or as a terminal. With ceramics, plastics, and glass special machine device helps minimize fracturing. You can get them from stock in a wide range of sizes, colors, and metals. A host of special diameters, lengths, shapes can also be made to solve your individual problem.

See our catalog in Sweets' Design File or write us today to investigate the possibilities of utilizing lowest cost United Eyelets for your product.

High speed fastening of 2 eyelets simultaneously cuts costs on automotive ignition breaker point assembly.

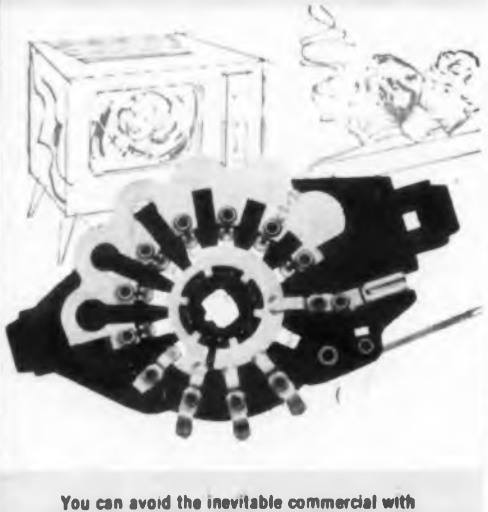
Eyelet does double duty as fastener for wind shield, bearing for spark wheel. Does both jobs well for only a fraction of a cent.

For high altitude or on the ground, funnel flange eyelets provide positive means for making reliable thru-connections on two-sided printed wiring boards.



JUST plug it in — United Standardized eyelets hold wires by compression on multi-contact computer part. Tight hold eliminates soldering time and bulk.

Before you say "hello", eyelets are working for you on our most popular method of communication. Try them on a new application — perhaps they'll prove as indispensable as your telephone.



You can avoid the inevitable commercial with the T.V. Selector Switch and still enjoy the silent utility and performance of eyelets on the switch itself.

Free Eyelet Slide Selector helps determine which eyelet you need with given grip and hole diameter.

United

UNITED SHOE MACHINERY CORPORATION
Boston 7, Massachusetts

BRANCH OFFICES: Chicago, 600 W. Jackson Blvd. • Cleveland, 740 Superior Ave., N.W. • Columbus, 487 S. High St. • Cincinnati, 407 Gilbert Ave. • Dallas, 1210 Old Gate Lane Harrisburg, 20 S. Fourth St. • Johnson City, 19 Jennison Ave. • Los Angeles, 1826 S. Hope St. • Milwaukee, 2362 N. Stanley Pl. • Nashville, 320 Main St. • New York, 1 W. 16th St. Philadelphia, 2100 Arch St. • St. Louis, 2200 Washington Ave.

CIRCLE 112 ON READER-SERVICE CARD

Nuvistor Tube Becomes

THE NUVISTOR, a thimble-sized electron tube, is now in commercial production. The tube can be used in many diverse applications ranging from data processing systems to medical diagnostic equipment. Because it has the ability to operate at any altitude, it will have important applications in miniaturized airborne apparatus and space vehicles.

Made by the Radio Corp. of America, Electron Tube Div., Harrison, N. J., the triode is priced at $1.96.

The first member of a new family of electron tubes embodying the nuvistor design concept is a general-purpose, medium-mu triode designated RCA-7586. Engineers at RCA have constructed several experimental units to test the merits of the nuvistor. Typical equipment which has been designed using nuvistors includes a television camera, a decade counter, a very-high-frequency communications receiver for aircraft, police and amateur service, and a wide variety of oscillators and amplifiers.

The nuvistor triode takes up 1/16th the volume and consumes less than one-half the power of its larger, present-day counterpart, RCA claims. Special construction techniques eliminate the need for spot welding, mica spacers and a glass envelope. Made of ceramic materials, steel, molybdenum and tungsten, the tube can withstand a high degree of shock and vibration.

Douglas A. Smith, vice president and general manager of the tube division, detailed the following features of the nuvistor triode:

- Low voltage operation
- Low heater drain
- A transconductance of 11,500 micromhos at a plate voltage and current of 75 v and 10.5 ma.
- Uniformity of characteristics from tube to tube.
- High-input impedance

Fig. 1. The first nuvistor tube being produced is the RCA-7586 industrial triode. It is a general purpose medium-mu triode of the heater-cathode type which provides high-gain with low-noise as an amplifier and excellent performance as an oscillator over a wide range of frequencies.

Commercially Available

- High perveance
- Ability to operate at all altitudes at full ratings.
- Small size and light weight. The metal shell is only 8/10 in. long, including peripheral lugs for indexing less than 1/2 in. in diameter; 1/15 oz. in weight.

For more information on this tube turn to the Reader's Service card and circle number **102.**

See the nuvistor at Booth 1602-1608, IRE Show.

Fig. 2. A "shish-kebab" containing approximately 100 nuvistors is lowered into an exhaust and sealing machine.

Microwave Component News
from SYLVANIA

Lower relay equipment operating costs with new Sylvania Klystrons

Metallurgical and processing improvements mean superior life and performance

Sylvania's research and production capabilities have produced a series of klystrons that promise to surpass earlier types in performance.

Sylvania's klystrons have the following features:

Improved high-temperature glass seal — this permits higher bake-out temperatures and gives a lower gas level. The resulting tubes have a life expectancy of 10,000 hours, 2,000 hours longer than competitive types, and better shelf life. This means lower operating costs for relay link equipment.

Purer metals and materials – the premium quality metals used in these tubes, combined with new, exacting processing techniques permit higher bake-out temperatures and result in longer trouble-free operation with low gas levels.

Superior performance – full coverage from 5925 to 8100 mc with 1 watt nominal output power. Most of these tubes have a minimum electronic bandwidth of 28 mc.

Sylvania klystrons will give you added cost savings because of their longer life and fewer early-life failures. Send for the data.

K-4160, shown approx. 1/3 actual size. Fins facilitate forced-air cooling.

K-4186, shown approx. 1/2 actual size. Flange connects to heat sink.

Forced air cooled	Conduction cooled	Frequency
K-4035	K-4189	5925-6225 mc
K-4162	K-4188	6125-6425 mc
K-4202	K-4187	6425-6575 mc
K-4161	K-4186	6575-6875 mc
K-4034	K-4185	6875-7125 mc
K-4160	K-4184	7125-7425 mc
K-4033	K-4183	7425-7750 mc
K-4036	K-4182	7750-8100 mc

SYLVANIA
Subsidiary of GENERAL TELEPHONE & ELECTRONICS

Sylvania Electric Products Inc.
Special Tube Operations
500 Evelyn Ave., Mountain View, Calif.

CIRCLE 113 ON READER-SERVICE CARD

Fast Readout Has Self-Contained Memory

RAPID READOUT of any combination of characters is available in a new display device, together with storage for the coded information which generated the display.

Manufactured by Hazeltine Corp. of Little Neck, N. Y., Randid (for Rapid Alpha-Numeric Digital Indicating Device) displays letters, numbers, and symbols in response to binary-coded input signals. The display is formed through stroboscopic illumination of a continuously rotating belt or drum.

Characters to be displayed are photographically reproduced on photosensitized mylar tape which forms the belt or drum. They appear transparent on an opaque background. The code tracks, which are similarly produced on the belt, are scanned by incandescent lamps and phototransistors. A code signal identifies the location of each character on the belt.

Hazeltine's high-speed alphanumeric readout.

CIRCLE 115 ON READER-SERVICE CARD ➤

Belt version of Randid. The neon lamps can be seen in the foreground. Code-scanning phototransistors and lamps are at the rear. In this model, two lines of characters share the same code tracks.

A particular character is illuminated at a particular position when Randid receives a binary signal corresponding to that of the selected character and display position. When the in-coming signal and the signal on the belt agree, a high-intensity neon lamp fires and stroboscopically illuminates the selected character when it reaches the correct position.

Belt speed, and thus the strobe rate of each character, are fast enough to present a flickerless display. Typical rates of 30 to 60 strobes per second result from uncritical motor speeds which can be from 1800 to 3600 rpm.

Transistorized circuitry, which can accept 4- or 6-bit binary code, and which provides storage, code comparison, and strobe drive, is housed in a separate unit which can be located remote from the display unit. The circuitry also provides selective address and erasure. It also allows Randid to accept dc or binary coded decimal information and to transfer the information to other units at a later time.

A completely new set of characters can be displayed by merely changing the belt—an operation which takes but a few minutes. Thus, input code, character size and style, number of characters per line, and number of lines per display can be changed.

Some of the applications of Randid include: aircraft panel display, digital data transmission, monitoring, card or tape reading and verifying, visual decoding, information retrieval display and computer or test equipment readout.

Price and delivery depend on specific customer requirements.

For more information on this readout device, turn to the Reader-Service Card and circle 101.

Tube Prints Directly on Non-Sensitized, Dielectric Material

DIRECT ELECTRONIC printing at high speed on non-sensitized, dielectric material can be achieved with a new tube. Similar to cathode ray tubes, the device (called Printapix) permits "simple, inexpensive" image development, according to the manufacturer, Litton Industries.

Two models of the tube have 2.75-in. printing-head widths, but tubes with up to 12-in. printing-head widths can be produced on order.

Made by Litton Industries' Electron Tube Div., 960 Industrial Road, San Carlos, Calif., the tubes are now being used in facsimile, oscillography, address labeling and television-type image reproduction equipment. Other applications will soon include: high speed computer readout, controlled information storage and erase for military tactical display maps and stock control uses, and simultaneous recording at any number of dispersed stations.

Type L-4013 tube provides a printing or writing head 0.15-in. high to accommodate writing of complete characters or symbols across the entire head widths.

Fig. 1. Model L-4016, which has a linear mosaic head, is on the right. Model L-4013, which has a rectangular mosaic array printing head, is on the left.

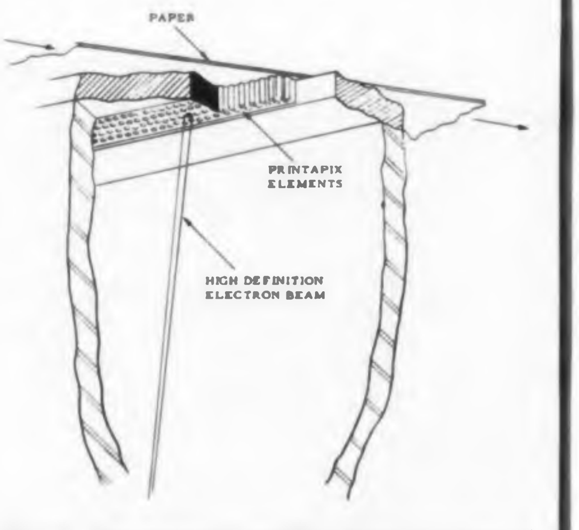


Fig. 2. The general working characteristics of the Printapix tube are outlined.

This two-dimensional head may also be used for sequential, scan line (TV type) operation. Use of this tube minimizes system requirements for setup and operation. Type L-4016 has a unidimensional conductive element array for sequential, scan-line operation. Both tubes are immediately available and will be displayed at the IRE show.

The tubes have a metallic-element, mosaic target or printing head in place of the phosphor screen usually found in cathode ray tubes. The metallic elements are 0.001-in. in diameter on approximately 0.004-in. centers, providing an element density of 62,500 conductors per sq in. With either tube, deflection of the electron beam along the printing head widths accomplishes one dimension of motion. The dielectric material is positioned immediately adjacent to the writing head; movement of this material past the tube face provides the orthogonal displacement.

Electrons in a high-intensity, high-definition beam in the tube produce a charge pattern on a dielectric surface (such as paper or plastic). The charge image, either line or continuous tone, is rendered instantaneously visible by adherence of a pigmented powder or floc. Writing rates of 0.1 μsec per element are achieved.

Image Development

Image development is an instantaneous and dry operation. One system uses a developing powder with two components, a toner and a carrier. Agitation of the combination produces a tribo-electric charging. The toner is a finely pigmented plastic material that becomes positively charged, and is thus attracted to the negative charge image on the dielectric material. (A typical carrier material is powdered iron). The developing powder is released as a cloud or fog in close proximity to the charged dielectric surface. Pigmented plastic is attracted to and retained on the charged areas by the coulomb force. The resultant image can subsequently be erased for re-use of the base material and powder, or be permanently fixed by a rapid heat cycle, pressure or other means.

For more information on this tube, turn to the Reader Service card and circle number 103.

See it at Booth 1610-1618, IRE Show.

$E=\frac{mc}{2}$

Its Amazing Relationship To the Relativity Law

More than one reader has pointed out that there is a remarkable similarity between our new physical law E = mc/2*, and Einstein's famous equation. We don't wish to appear presumptuous, but there is a relativity effect embodied in our new machine, the FR-600. Unfortunately this information has somehow leaked out and now there's the devil to pay. The marketing people got wind of it and blamed us for revealing the clue in our last paper on the Ips Corollary. It seems they think this information will play hob with their sales curve. We have committed ourselves, however, so there's nothing to do but make a clean breast of it.

As we pointed out, the FR-600, in many cases, can do the work of two machines. (Our engineering colleagues will remember that this is because the FR-600 can record 125 kc data at 30 ips, thus recording for 48 minutes on one 14-inch reel. This eliminates the need for a second stand-by machine or a dual transport in most data runs.) As you might expect, the marketing people were worried that this might cut sales in half, since one machine could do the work of two. That wasn't the half of it, however. Now it seems that the FR-600 lets all of our other analog recorders do the same thing. So, whether we like it or not, all our AR-200's, Model 800's, FR-100's and 1100's can record the same bandwidths at half the usual speeds — and record twice as long to boot. (The new engineer says this is because bandwidth is determined by the reproduce head and not the record head.)

So if you have an FR-600 to reproduce your data on you can record it at half the usual speed on all our other machines and get twice the recording time. There's no way we could stop you if we had to. As a result the marketing people are all up in arms. This will cut sales on all of our other machines in half, they say, since one machine can do the work of two. As far as we're concerned there's nothing to be done about it. The secret's out. We can only hope the profession won't abuse the privilege. A few communications from you in the field would certainly help the marketing people forget this whole ugly business.

(Regarding the answer to the trial problem in our first paper: If one of our readers has solved it would he please send us the answer in a plain envelope marked 'personal.')

---

*We still have a few extra copies of the papers on E = mc/2 and the Ips Corollary.

AMPEX

AMPEX DATA PRODUCTS CO., 934 CHARTER ST., REDWOOD CITY, CALIF.

Multi-Headed Transistors Help Miniaturize Circuits

The multi-headed transistor is a combination of any type or types of transistors now in use.

Multi-headed transistors, designed to further reduce the size of transistorized circuits, are being made by The Electronic Transistor Corp. The transistors are a combination of any type or types of transistors now in use.

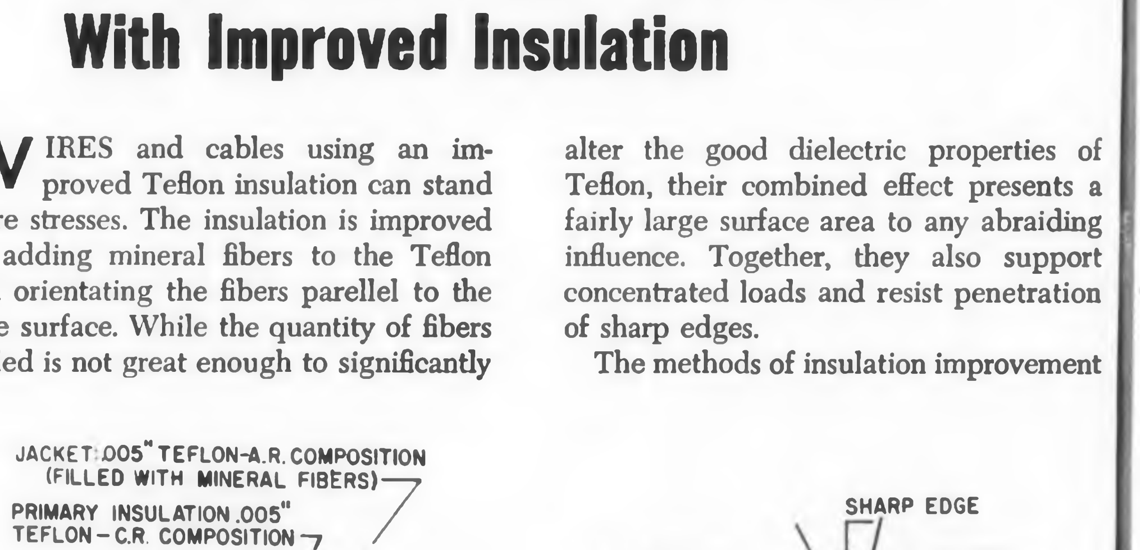
Combinations in a single package may include pnp, npn, audio frequency, amplifier, computer, and many other types reports the manufacturer (9226 Hudson Blvd., North Bergen, N.J.).

No interference is created by combining more than one transistor in a package,

Wires, Cables Take More Stress With Improved Insulation

Wires and cables using an improved Teflon insulation can stand more stresses. The insulation is improved by adding mineral fibers to the Teflon and orientating the fibers parellel to the wire surface. While the quantity of fibers added is not great enough to significantly alter the good dielectric properties of Teflon, their combined effect presents a fairly large surface area to any abraiding influence. Together, they also support concentrated loads and resist penetration of sharp edges.

The methods of insulation improvement



TYPE E WIRE IN ABRASION RESISTANT CONSTRUCTION

MINERAL FIBERS RESIST CUT THRU

By adding mineral fibers to Teflon and orientating them parallel to the wire surface, an improved insulation is achieved.

it is claimed; there is no contact between any of the transistors. Prices are 25 per cent less than the combined prices of the individual units.

The following transistor types are immediately available in combinations of two in a JEDEC 30 package: 2N428, 2N404, 2N43, 2N302, 2N482, 2N483, 2N484, 2N1372, 2N1374. All individual transistors used in the multi-headed types conform to the electrical specifications registered with EIA and are designated by EIA number.

The multi-headed units are hermetically sealed and welded, and they are designed to meet all applicable Mil specifications.

For more information on these units, turn to the Reader-Service card and circle number **106**.

and subsequent advantages were reported by W. L. Gore & Associates, Inc., (487 Paper Mill Road, Newark, Del.). Fiber particles average about 1 micron in diameter and from 500 to 1000 microns in length. More than 90 per cent of the fiber orientation is parallel to wire surface, the company claims.

Among the material's adventages, designated as Type AR compound, is its cut-through resistance—three times as great as that of standard Teflon. Its mechanical properties remain satisfactory for many hours at temperatures of 325 to 400 C. In addition, if the Teflon burns away in extreme environments, the mat of fibers continues to prevent conductor shorting.

Type AR compound is being used with the Type CR insulation (also made by Gore) to form a primary insulation with high resistance to corona stress and a jacket that is resistant to abrasion and cut-through.

A corona-stress life of 70 to 80 times greater than that of the best Teflon hook-up wire now available is claimed for the type CR insulation by Gore. Moreover, Type CR insulation over a nickel-clad copper conductor is good from a few degrees Kelvin to more than 300 C. These materials are available in a wide variety of cable and wire combinations.

For more information on these insulations, which will be on display at the IRE Show, turn to the Reader-Service card and circle number **105**.
Booth 4121.

Three-Dimensional Packaging Method Permits Quick Servicing

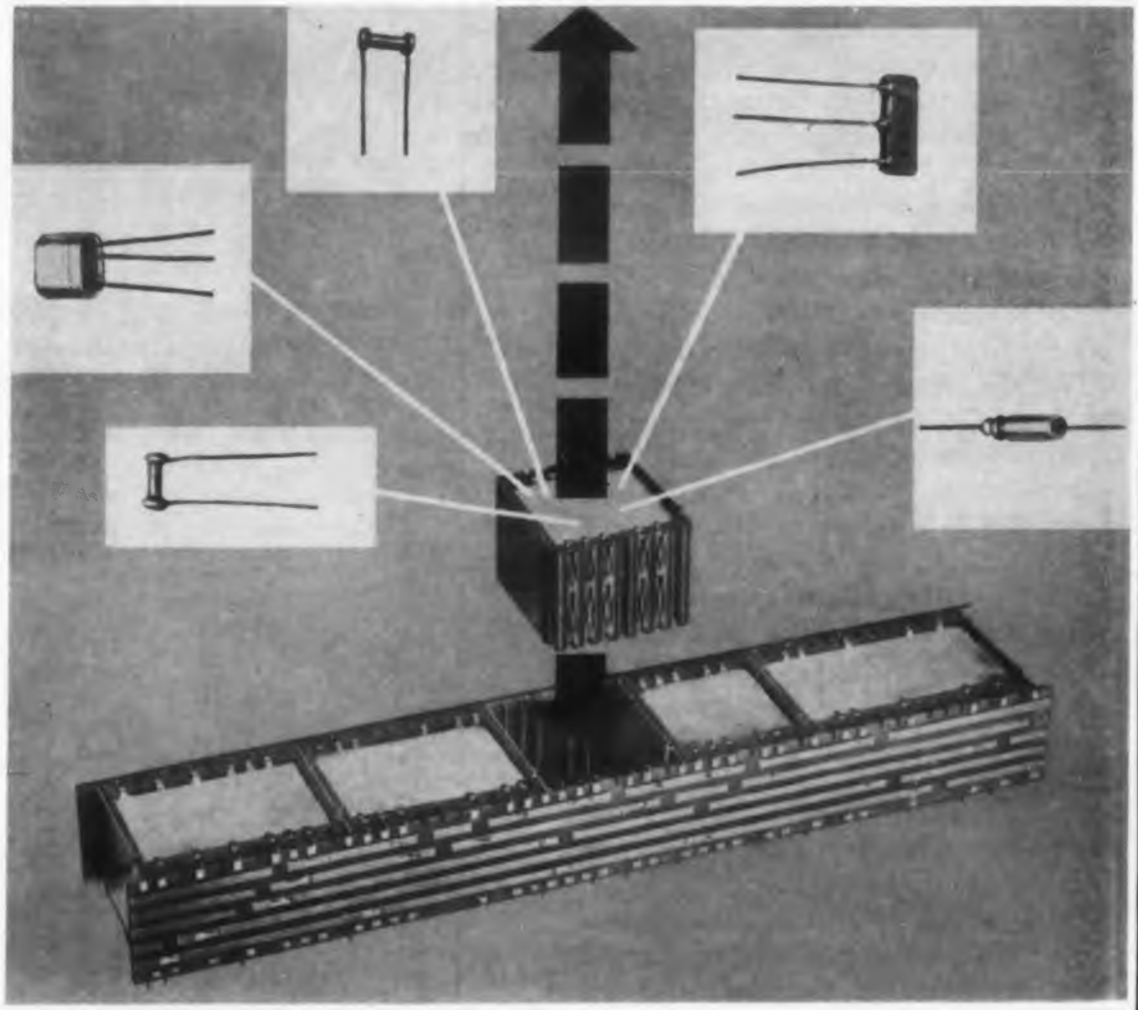
A THREE-DIMENSIONAL, printed-circuit packaging method that permits quick servicing by substitution and throw-away is now available to design engineers. The method can be used for small and large circuit programming in small or large quantities.

All components in this three-dimensional circuitry are encapsulated in replaceable AmpPlugs that are friction fitted into two parallel "walls" of printed circuit boards. Designed by Amp Inc. (Harrisburg, Pa.), the packaging method is called the Amp-Meca Program (Maintainable Electronic Component Assemblies).

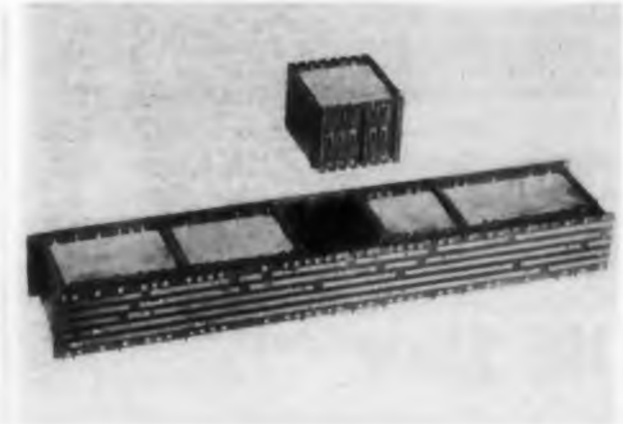
Four main advantages for this packaging method are claimed by the company. They are:

Maintainability. Each Amp-Cell, which can contain one or more component assemblies, is easily removed and replaced. Since no bonding agents are needed, highly skilled maintenance personnel are not required.

Design Flexibility. Cells can be made



All components in this three-dimensional circuitry are encapsulated in replaceable AmpPlugs which are friction-fitted into two parallel "walls" of printed-circuit boards.



The packaging method permits instant servicing by substitution and throw-away.

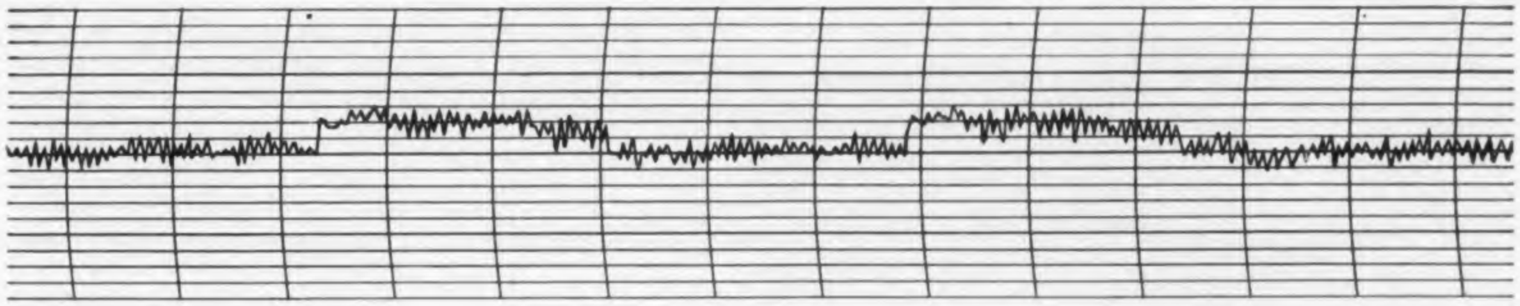
using the 0.1 and 0.2-in. grid system. The units discussed here are made with contact ribs in an 0.1-in. grid pattern. Thus, for every 0.1 in. increase in the length of a given cell, two additional contacts may be obtained (one on each side of the cell). Cell volume can be increased without adding contacts by widening or deepening the dimensions of the "walls" and the cells.

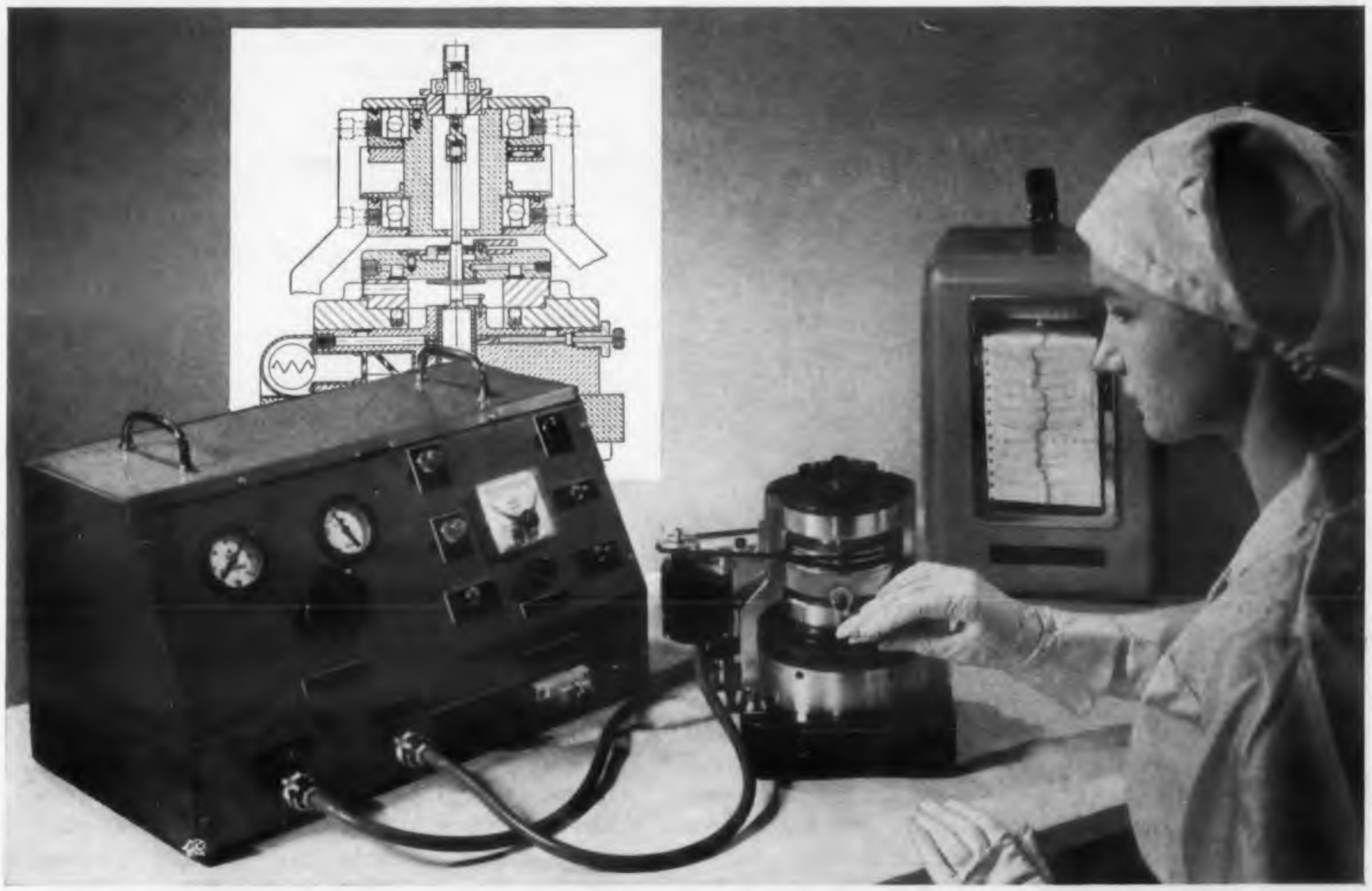
Circuit Production. Economical prototype circuit production is accomplished through semi-automated "memory type" equipment using punched cards. This is achieved without the need of drafting, art work, photographic process, etching, plating or stamping. Since the component cell is a mold in itself for encapsulating the components, separate molding fixtures in the assembly process are eliminated.

Reliability. The units are practically indestructible, since the cells have no protruding contacts. Also, the entire assembly is protected against vibration, corrosion and physical damage because the components are encapsulated in the cells —and the cells, in turn, are wholly contained in the circuit boards. The best conductivity is assured through the friction-fit wiping action between contact surfaces when the cells are inserted into the boards.

The basic AmpPlug module can be made by machining, compression, injection, or transfer molding. Thus, it can be made of any type of insulating material amenable to one or more of the above processes.

The Amp-Meca Program will be on display at the IRE Show. For more information on it, turn to the Reader-Service card and circle number **104.**
Booth 2527-31.





You're Invited To Visit
***ELECTRONIC DESIGN's* Booth**

ELECTRONIC DESIGN's editors will be waiting to talk to you about design problems you've recently solved, new products you'll be introducing, articles you'd like to write—anything that will help engineers do their job better. So visit us. You're always welcome at Booth 4404-06.

Improved Products and New Ones Await Inspection at IRE Show

Last January ELECTRONIC DESIGN *queried manufacturers who planned to exhibit at this year's IRE Show. We asked them what was "special" about the new products they would display. The answers are summarized here. For more details, see this issue's New Products Department, p 132; it contains technical data on close to 300 products, and most of these can be seen at the Show.*

L. N. Tolopko
Associate Editor

THIS YEAR'S IRE Show will be the stage for the debut of many new products and many improved versions of standard products. Responses to an ELECTRONIC DESIGN questionnaire indicates that manufacturers will be tempting design engineers with products that have more reliability, more compactness, more special features. Brief descriptions of some of these products follow.

Test Equipment

Meters. In this category are many new, automatic, and improved units. Expanded scale voltmeters that give true rms readings of ac even when their frequencies vary or when they are distorted will be shown by the Weston Instruments Div. of Daystrom, Inc. The instrument has a transducer that provides the necessary means for converting the rms value of the input to the squared value of average dc current input.

Automatic range selection is the outstanding feature of an ac vtvm made by Allied Radio Corp. Instructions for the unit read: "Just touch probes to circuit under measurement, and a motor-driven selector switch automatically turns to the proper range and turns on a pilot light on the panel to show scale multiplier."

Automation is also the key feature of several other new products. A new microwave wattmeter has a bolometer bridge that automatically adjusts the dc bias power dissipated in the external bolometer; it's made by Daystrom Inc. Hewlett-Packard's display scanner has a pen-speed stabilizer that automatically controls the pen writing speed. It thus provides uniform, detailed plots over every part of the waveform and reduces scanning time. Hewlett-Packard will also show a meter than can automatically provide a continuous noise figure presentation on most radar receivers.

Other automatic instruments include a digital deviation ohmmeter being shown by Electro Instruments, Inc. The device automatically measures resistance and presents results in percentage of deviation from a nominal value.

As for improved products, Southwestern Industrial Electronics Co. will offer a wide-range electronic voltmeter that measures ac and dc voltages from 1 mv to 100 v full scale in 14 ranges. Improvements in the unit: residual noise is now less than 20 mv on the 1 mv ac scale, and dc millivolt drift has been reduced to less than 50 µv after warmup. A rotating-coil gaussmeter capable of measuring dc magnetic fields to an accuracy of 0.1% will be exhibited by Rawson Electrical Instrument Co. Their previous units had 1% accuracy. And Systron Corp. will show an all-electronic digital voltmeter that provides auto-polarity and auto-ranging—something not available on their previous models.

Another meter that incorporates improvements is the frequency measuring unit made by Beckman Instruments, Inc. It digitally shows any frequency from 10 cps to 110 mc with an accuracy of 0.00004%. To cover this range with the same accuracy in the past, two of their instruments working in combination were necessary.

A "first" will be offered by Metronix, Inc. It will show a meter that is "believed to be the first combination ac and dc electronic voltmeter ever offered for half relay-rack mounting." It has 10 standard voltage ranges in both ac and dc up to 300 v. Another unusual claim is being made by Electronic Applications, Inc. It will exhibit a very low-range ohmmeter that will read directly the internal resistance of storage and primary batteries with and without loads. The company claims that there is no equivalent equipment on the market. As for future developments in this type of product, they say: "Somebody will try to copy it."

Testers. Several new semiconductor test units will be on display at the Show. Hickock Electrical Instrument Co. will have a transistor beta tester that tests transistors according to manufacturers' specifications. Says the company, "Beta measurements not made at the current and voltages established by the transistor manufacturers are meaningless." An automatic transistor test unit, made by Optimized Devices, Inc., is claimed to "cut manpower costs ten to one and increase test reliability."

Another automatic tester will handle diodes, capacitors and resistors at an average rate of 3500 pieces per hour. Made by Universal Instrument Corp., the machine will physically orient each axial-lead component in the direction of its polarity. A diode tester capable of generating and displaying the millimicrosecond recovery characteristics of ultra-fast switching diodes on conventional oscilloscopes is being shown by Lumatron Electronics, Inc. The unit has a test fixture for rapid, manual insertion of ccaxial lead diodes.

New equipment to test instruments will also be on exhibit. Daystrom, Inc. will show an instrument calibration unit that has 0.05% accuracy, and panel instruments featuring expanded scales. A new tester to check the operation and accuracy of voltmeters, ammeters and ohmmeters will be brought to the Show by Mid-Eastern Electronics.

Components

Semiconductors. This category will include many new products. Sylvania is bringing microwave mixer diodes with the "lowest available noise figure." They will provide a receiver system with a "realistic" 7.5 db overall noise figure at the Ku band. A total of 331 new semiconductor devices in five product categories (Zener diodes, mesa transistors, rectifiers, and alloy and power transistors) will be introduced by the Semiconductor Div. of Motorola. The company is also announcing its new quality assurance program called "Meg-A-Life." Three industrial alloy transistors are the first units made under this program. Each production lot of these transistors undergoes complete electrical, mechanical, environmental and life tests identical to those required for military approved units.

A new line of diffused silicon mesa transistors will be shown by Industro Transistor Corp. The units are designed for medium power, small-signal amplifier and switching applications.

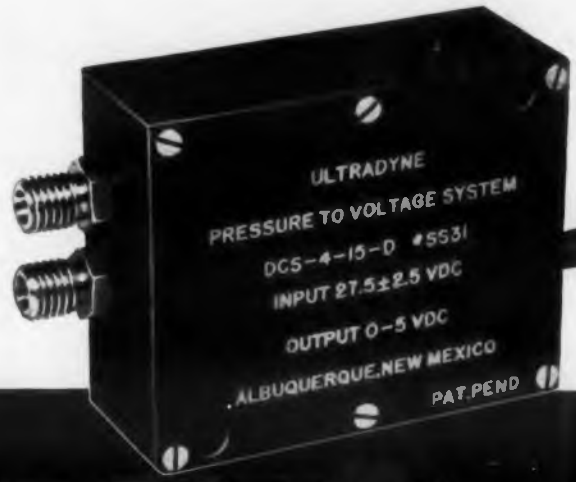
Tubes. Look for new and improved units in this category. A 5-kw cw power klystron that is claimed to have highest power available today in a single tube at X-band will be shown by Varian Associates. Varian will also show, among other things, a two-resonator oscillator klystron that is "even more compact than previous models." The "most sensational" product Alfred Electronics will show is a general frequency microwave oscillator. The power supply of this unit has a reset in the rear to insert a generator head for the frequency spectrum desired. The "plug-in" generator will include primarily a backward wave oscillator tube and solenoid with a calibrated dial chart for insertion into a front panel holder.

Other additions to the tube category include General Electric's new L-band, electronically tunable oscillator. Huggins Laboratories is showing an electrostatically focused 1-w traveling wave tube in which, they report, substantial savings in weight and size have been effected. Sperry's Tube Division is heralding a new line of medium-power, traveling wave tubes that cover the complete range of P to X bands. Small signal gain for the tubes ranges from 35 to 55 db, minimum—higher, it is reported, than provided by any other known family of tubes.

Potentiometers. Ace Electronics Associates, Inc., makes this claim about a unit they are showing: "The first 1/2-in. precision conductive plastic potentiometer in the industry." Resistance range, for the units, is 250 ohms to 150 K.

Another unit with reported special features is a wirewound, bushing-type mounting potentiometer being shown by Waters Manufacturing, Inc. The unit requires "up to 25% less space behind the panel than potentiometers having identical specifications."

New potentiometers will also be shown by several other companies. The Helipot Div. of Beck-



man Instruments, Inc., for example, will bring with them three new trimmer potentiometers. Dale Products will show a 25-turn, T-Pot unit with completely welded construction of all fixed connections and sealed construction for maximum protection against severe environmental conditions. And Chicago Aerial Industries, Inc., will have in their booth a new, extended line of all metal, precision potentiometers that are single-turn units. They have all metal construction, with glass-to-metal terminals.

As for improved units, DeJur-Amsco Corp. is showing a ball-bearing, precision potentiometer with a one-piece molded housing and complete phenolic envelope inside. It has "improved linearity and lower starting and running torque."

Relays. Response to *ED's* questionnaire shows that many new units will be offered. Guardian Electric Mfg. Co. will have a new series of miniature dc relays with 6pdt contact combinations rated at 5 amp. They'll also demonstrate a new impulse relay designed to "insure long life, trouble free operation well in excess of 1 million steps." Side mounted relays designed for printed circuit boards will be displayed by Electronic Components. The relays have an overall height not exceeding 0.4 in. Lastly, a 2-pole subminiature, crystal case relay is one of the new units being shown by the Union Switch & Signal Division of Westinghouse. One feature of the relays that is claimed to be unique, is the armature suspension system that is designed to meet a high level of vibration.

Connectors. Improvement seems to be the key here. New features have been added to the Multi-Terminal connector series made by North Electric Co. These improvements include a handy locking bolt for securing the plug to the receptacle, and an easily removable cover with a captive screw for rapid wiring or checking. Printed circuit board connectors made by Winchester Electronics, Inc. have been improved; they now conform to MIL-C-21097.

As for new units, two new printed circuit connectors will be shown by Continental Connector Corp. One is a right angle plug and socket series with 28 contacts; the other is a 28-contact test point connected with right angle pins for dip soldering to the board. Elco Corporation's new series of Varicon connectors will be shown; the microminature rack and panel units are made of hermaphroditic design.

Materials. Efforts continue here to produce material that will withstand higher temperatures. Two new high temperature laminates will be shown by Synthane Corp. They can be used at temperatures up to 500 F. One is an asbestos mat plastic, and the other is a glass fabric plastic. A fire retardant epoxy casting resin that may be cured at room temperatures will be brought by Emerson &

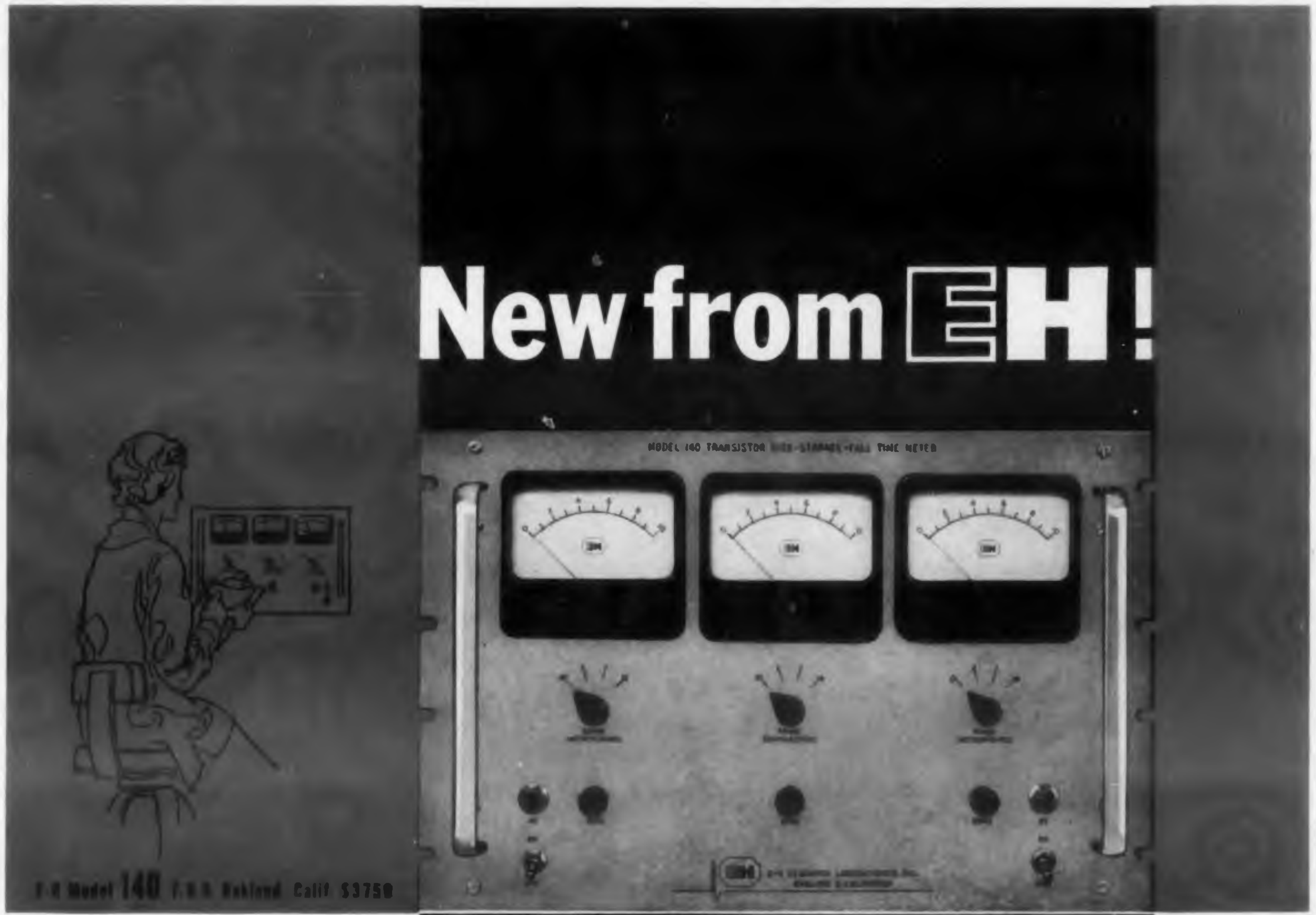
Cuming, Inc. It is designed to be stable over a emperature range of —100 to +350 F. Furane Plastics, Inc. will have insulating resins that have better dielectric properties at elevated temperatures. And Kanthal Corp. will show resistance wires that can operate continuously at temperatures up to 250 C and to 300 C for short periods of time. The wires are covered with a dual-layer insulation. The base layer consists of a thin inorganic ceramic coating; the overlay is made of Teflon.

Sub Assemblies

Recorders. A miniature airborne tape recording system, possibly the "smallest 28-channel recording device ever designed for space, air and industrial use," will be shown by the Leach Corp. It has a diameter of 6.25 in. and a length of 6.5 in.; weight is less than 10 lb. Also of interest is an eight channel direct writing rectilinear recording system being shown by Cohu Electronics, Inc. It has a 40 millimeter amplitude and a frequency response to 100 cps, features unavailable in products they've made before.

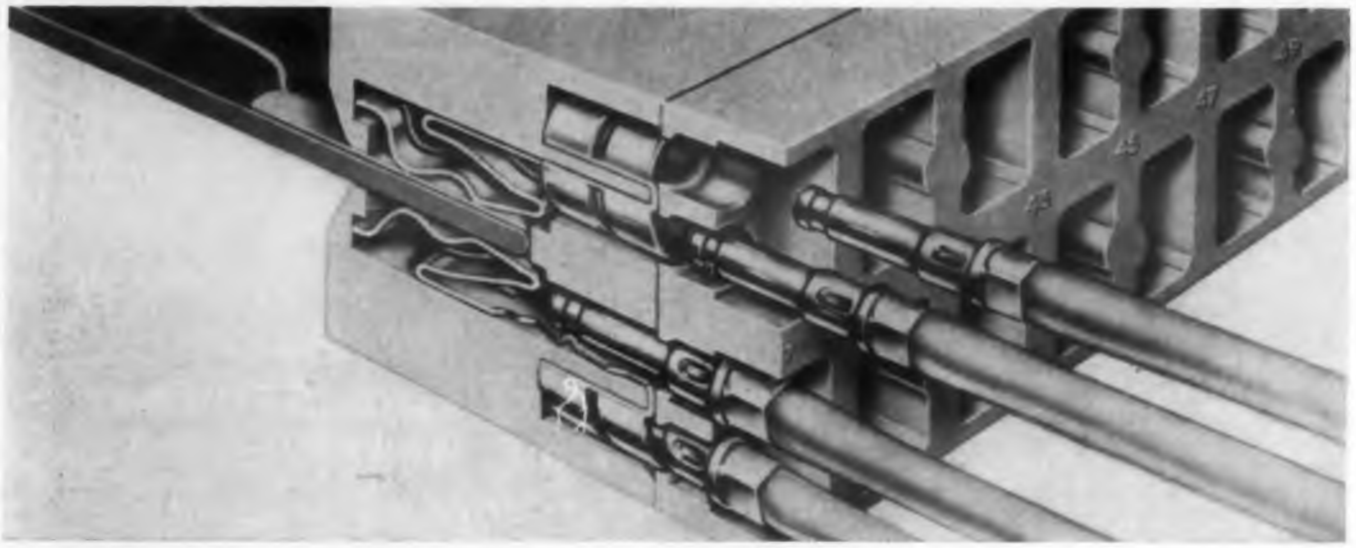
Power Supplies. Look for new units in this category. Power Sources, Inc., for example, will bring two new lines of transistor-regulated power supplies (one for low voltage and the other for high voltage applications). The units are claimed to be "half the size and weight of comparable tube-type supplies"; they are backed by a 5-yr warranty which includes all components. A series of power supplies with line regulation of 0.005%, ripple less than 500 μv, and overshoot less than 1% (unavailable in similar products made by the company before) will be brought to the Show by Mid-Eastern, Inc. Quan-Tech Laboratories is introducing a constant current supply. Unique with this instrument, they say, is that the output voltage can be read on the meter by a simple flip of a front panel switch. They will also bring with them a new series of transistorized, low voltage power supplies; big feature is a regulation of 0.01% from no load to full load.

Generators. Lots of new generators will be at the show. Rutherford Electronics Co. will have a new pulse generator with repetition rates continuously variable from 1 cps to 10 mc with a rise and fall time of less than 8 mμsec. A four-channel millimicrosecond current pulse generator that operates to frequencies above 3 mc will be shown by Electro-Pulse, Inc. A crystal frequency synthesizer that is capable of producing over 64,000 discrete frequencies with a stability of better than 1 x 10^{-8} per day will be put on display by Manson Laboratories. A transistorized, battery powered signal generator with a continuously variable frequency range from 2 cps to 200 kc and a 1 v rms output and less than 1% distortion will be presented by Southwestern Industrial Electronics Co. ■ ■



NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.



Printed Circuit Connector Has Bifurcated, Undulating Spring 585

A bifurcated, undulating spring design assures multipoint contact of this Edge-On printed-circuit connector. Use of crimp-type, snap-in Hyfen tips with insulation grips eliminates the need for insulating sleeves. The tips accommodate combinations of wire sizes as well as single wires. A closed-entry face on the board protects the spring and self-aligns warped, printed-circuit boards. Provisions are made for one or two tips for each board position on each side. Current capacity for each contact is 22 amp; working voltage is 280 v dc or 200 v ac at sea level. Continuous operating temperature is 350 F max.

Burndy Corp., Dept. ED, Norwalk, Conn.

Price: *Varies with customer specifications and requirements.*

Booth 1329-1331.

Price and Availability

PRICE AND AVAILABILITY data are now being added, whenever possible, to the New Product descriptions that appear in *ELECTRONIC DESIGN*. These data will help you to:

—Evaluate the products more intelligently.

—Decide which products to buy now and which to wait for.

—Schedule your orders wisely.

—Get an insight into prices and savings for similar products.

Most manufacturers have been very cooperative in providing us with *Price and Availability* data. Since some of the data arrived after our deadlines, it was impossible to add them to all of the products. The data represent the latest information at the time of publication.

Power Supply Provides 4 To 36 V Dc, 0 To 500 Ma 584

This transistorized power supply provides a regulated, continuously-variable output of 4 to 36 v dc at 0 to 500 ma. It includes a vernier voltage control that permits fine adjustment of the output voltage. Outputs are isolated and either terminal may be grounded or units can be stacked for higher voltage operation. Thermostatic monitoring of the transistor base temperatures prevent thermal run-away. The current limiter is also continuously adjustable. Input voltage is 105 to 125 v ac, 60 or 400 cps. Line regulation is less than 0.15% change in output for full input change. Load regulation is less than 0.05%, no load to full load. Dimensions are 4-7/8 x 5 x 6-1/4 in.

Electronic Research Associates, Inc., Dept. ED, 67 Factory Place, Cedar Grove, N.J.

Price: *$135 ea.*

Booth 2818-2820.

K-Band Magnetron Provides 0.02 µSec Pulses At 25-Kw Peak Power Output 586

Pulses of 0.02 µsec and a peak power output of more than 25 kw are provided by the type 7093 magnetron. Designed for use as a pulsed oscillator at a fixed frequency in the K-band between 34,512 and 35,208 mc, the unit weighs 4.2 lb. It is suited for use in high-definition, short-range radar systems of up to 5 mi and will allow a system resolution of 4.5 yd in range. At pulse duration of 0.02 µsec, the rate-of-rise of the voltage pulse is 600 kv per µsec, with a duty factor of 0.0001, a peak anode voltage of 13.5 to 15 kv, and a peak anode current of 12.5 amp.

Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, L.I., N.Y.

Availability: Immediately available in sample and pre-production quantities.

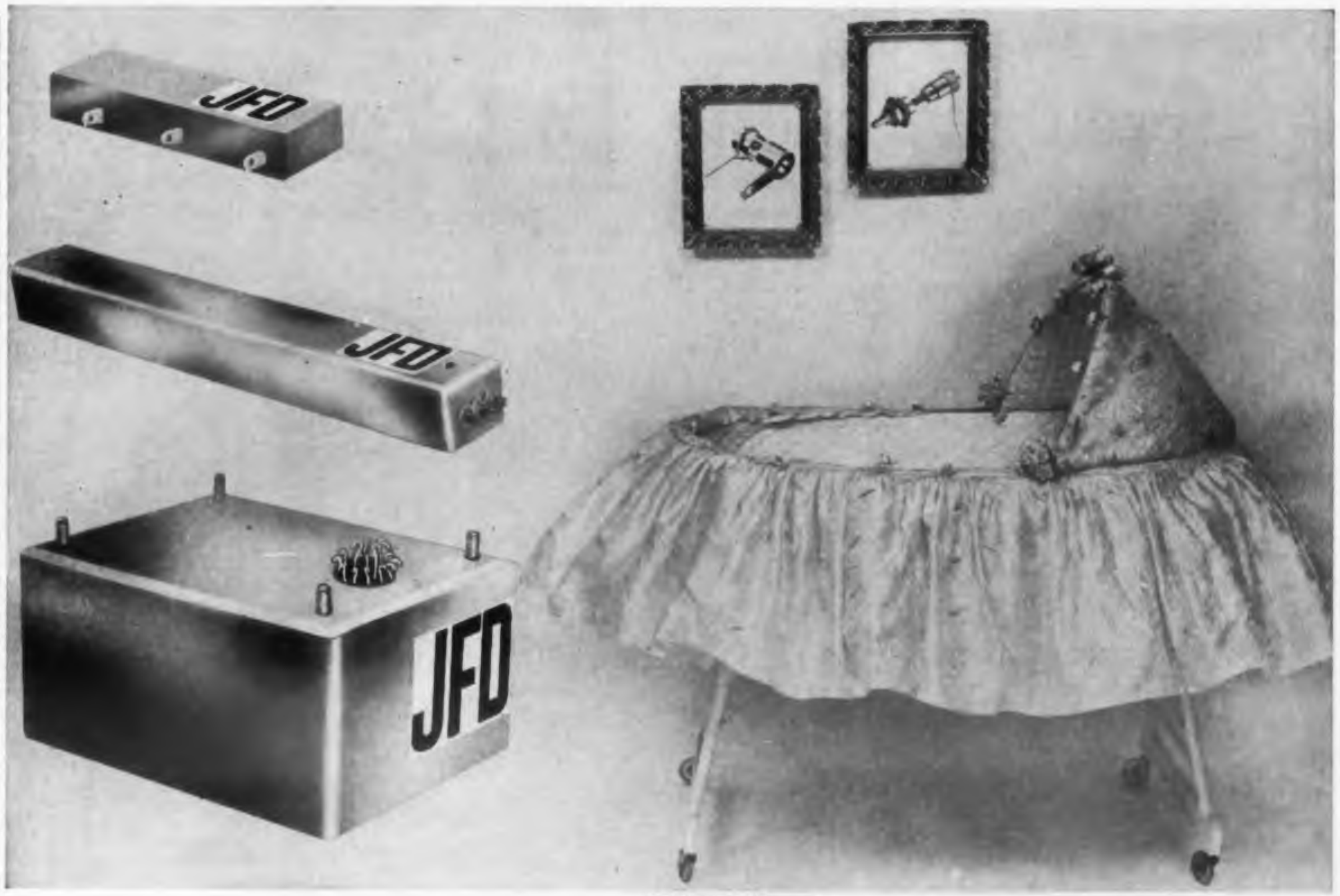
Booth 1610-1618; 1709-1717.

Cathode Ray Tube Has Built-In Shield Over Neck 587

Type VC118P1, 2-in., flat-face cathode-ray tube has a built-in magnetic and mounting shield over the neck. Both the focusing and deflecting are accomplished electrostatically. Heater voltage and current are 6.3 v and 0.6 amp, ±10%; anode voltage is 3000 v dc max. Over-all length of the tube is 7-5/8 in., ±3/16 in., and greatest bulb diameter is 2-1/16 in. Using a P1 phosphor, the tube can be mounted in any position.

Waterman Products Co., Inc., Dept. ED, Philadelphia, Pa.

Booth 3105-3106.



NEW FROM JFD LUMPED CONSTANT DELAY LINES

Meet the newest addition to the growing family of JFD precision electronic components.

Designed with compactness, ruggedness and reliability in mind, new JFD lumped constant Delay Lines upgrade your prototype or production project.

Compare the advantages of the standard JFD lumped constant delay lines:

- High delay-to-rise time ratio with minimum signal attenuation.
- Tolerance of ±5% max. on delay and characteristic impedance.
- Temperature range of –55° C to +125° C.
- Delay time thermal stability of 50 parts per million per degree centigrade.
- Up to 25 Mc bandwidth.
- Virtually linear phase shift.
- Hermetically sealed metal cases for maximum resistance to shock, vibration and humidity.
- Meet all applicable MIL specs.

Typical Standard Delay Line Characteristics

Delay Time 5 µ sec.		10 µ sec.		25 µ sec.	
Rise Time	Size	Rise Time	Size	Rise Time	Size
1.0	1⅛x1⅛x2¼	2.0	1½x1½x3	5.0	1 7/16x1 7/16x2⅞
.5	1 5/16x1 5/16x2⅝	1.0	1⅝x1⅝x3¼	2.5	1¾x1¾x3½
.3	1⅜x1⅜x2¾	.6	1¾x1¾x3½	1.5	2 7/16x2 7/16x4⅞
.15	2¼x2¼x4½	.3	2¼x2¼x4½	.75	2¾x2¾x5½

Range of characteristic impedance: 50 ohms to 2000 ohms ±5%.
Attenuation: Less than 1db per. µ sec. up to 3 µ sec. delay; 6db max. up to 50 µ sec. delay.
Temperature stability: 50 parts per million per degree C from –55° to +125° C.

Whether your application calls for standard or custom-built lumped constant or distributed constant delay lines, our engineering staff will be glad to review your needs and submit recommendations. Closer tolerance delays and impedances are available, in forms, sizes and terminal designs to match your needs. Write for Bulletin No. 213A.

JFD

Pioneers in electronics since 1929
ELECTRONICS CORPORATION
1462 62nd Street, Brooklyn, New York

JFD International, 15 Moore Street, New York, New York
JFD Canada Ltd., 51 McCormack Street, Toronto, Ont., Canada

CIRCLE 126 ON READER-SERVICE CARD

Toroidal Inductors 693

For use in severe environments

Types ATE 11, 0, and 4 toroidal inductors are designed to withstand high acceleration, shock and vibration. The units are slotted for screwdriver adjustment, are fully encapsulated, and meet MIL-E-15305 A, MIL-T specs 27, grade 4, class R. Type ATE-11, having a maximum inductance of 5 h, measures 3/4 in. in diameter and 13/16 in. in height. It weighs about 0.75 oz. Type ATE 0 has a maximum inductance of 0.5 h, weighs 1.5 oz, and measures 1-1/16 in. in diameter and 1 in. in height. Type ATE 4 has a maximum inductance of 15 h, weighs 3.5 oz, and measures 1-5/16 in. in diameter and 1-3/16 in. in height. All units have a useful range of 500 to 100,000 cps.

Burnell & Co., Dept. ED, 10 Pelham Parkway, Pelham, N.Y.
Booth 2909-2910.

DC Drive Choppers 684

Both spdt and dpdt types

These dc drive choppers are available in either spdt or dpdt types. The units have a low noise figure and a chopping rate of 94 cps. Suitable for use in portable equipment, the choppers can have noise level specifications of 1 mv into 100,000 ohms. In non-portable applications, the use of the dc drive permits ac drive wiring to be removed from the critical circuitry. Required power is 12 to 24 v dc.

Stevens-Arnold, Inc., Dept. ED, 7 Elkins St., S. Boston 27, Mass.
Booth 2934.

FAIRCHILD
SEMICONDUCTOR CORPORATION

The following Fairchild transistors are available from stock for same day shipment in quantities up to

1000

pieces per type.

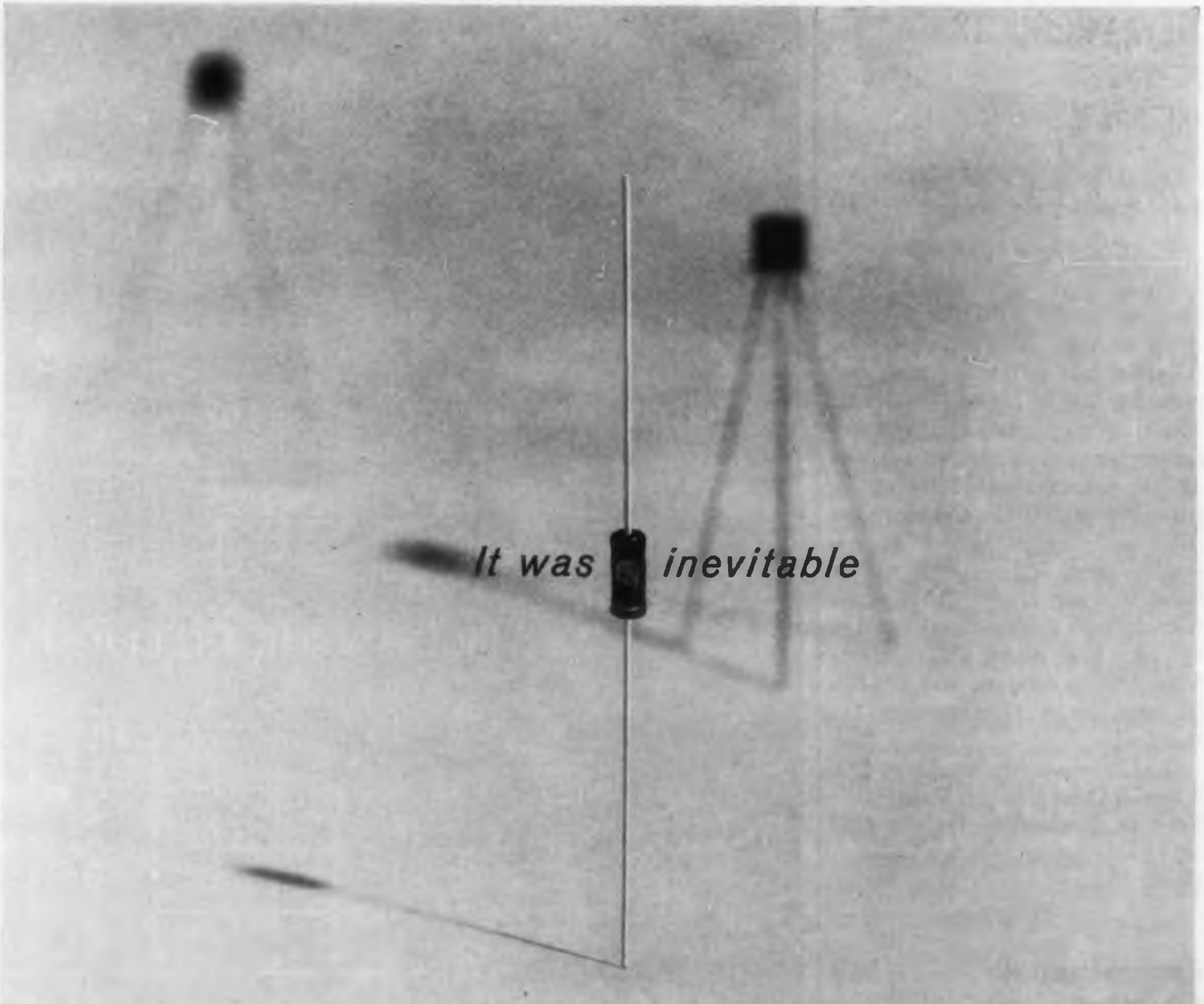
Standard NPN: 2N696, 2N697. High Voltage NPN: 2N699. High Beta NPN: 2N1420. Low Storage NPN: 2N1252, 2N1253. Standard PNP: 2N1131, 2N1132. Mesa: 2N706.

Schweber
ELECTRONICS

60 HERRICKS ROAD, MINEOLA, L. I., N. Y.
TWX G-CY-NY-580U PIONEER 6-6520

At factory prices of course!

CIRCLE 128 ON READER-SERVICE CARD



DIFFUSED SILICON DIODES FROM FAIRCHILD

THE FIRST—An ultra-fast computer diode: Four millimicrosecond maximum reverse recovery time of this new FD 100 overcomes the diode-caused speed limitations in computer circuits. Capacitance is only 2μμf at zero volts bias.

THE REASON—A need and the technology to serve it: Fairchild's diffused silicon transistors have achieved heretofore unattainable performance. Application of these transistors has in turn created the need for silicon diodes of similarly outstanding performance.

THE FOLLOW UP—A broad line of high reliability diodes: This Fairchild FD 100 diode is being followed by others providing industry-leading standards in reliability and uniformity—backed by a continuing accumulation of statistical data on a large scale.

TENTATIVE SPECIFICATIONS – FAIRCHILD FD 100
25°C Except As Noted

Symbol	Characteristic	Min.	Max.	Conditions
BV	Breakdown Voltage	40 volts		@ I_R =100 μA
I_R	Reverse Current		.100 μA	@ V_R =30v, 25°C
V_F	Forward Voltage Drop		1 v	@ I_F =10 mA
C	Capacitance		2 μμf	@ V_R =0v
t_{rr}	Reverse Recovery Time To Ir=1 ma		4 mμs	@ $I_f=-I_r=10$ ma
	Maximum Power Dissipation		200 mw.	
	Temp. Range Operating	–65°C to 175°C		
	Storage	–65°C to 200°C		

For full specifications, write Dept. B-3
See us at Booth #2701-3-5-7 on the second floor at I.R.E.

FAIRCHILD
SEMICONDUCTOR CORPORATION

4300 REDWOOD HIGHWAY • SAN RAFAEL, CALIFORNIA • GLENWOOD 6-1130 • TWX SRF 26

New York Area: Pioneer 1-4770 • Syracuse: GRanite 2-3391 • Philadelphia Area: TUrner 6-6623
Washington, D.C.: NAtional 8-7770 • Chicago: BRowning 9-5680 • Los Angeles: OLeander 5-6058

CIRCLE 129 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE
IRE SHOW

Microwave Hybrid 570

Coupling is 3 ±0.5 db

These octave band, hybrid couplers provide 3 ±0.5 db. Isolation is 20 db min, vswr is 1.25:1 max, insertion loss is 0.1 db max, and power is 100 w avg or 5 kw peak. Model 749 operates over the frequency range of 125 to 250 mc and is 11-3/4 in. long. Model 750 operates from 250 to 500 mc and measures 5-3/4 in. in length. Model 751, operating from 500 to 1000 mc, is 3-1/2 in. long. Model 752 operates from 1000 to 2000 mc and is 1-1/8 in. long and model 753 operates from 2000 to 4000 mc and is 1-5/8 in. long. Type N connectors are standard.

Sage Laboratories, Inc., Dept. ED, 3 Huron Drive, Natick, Mass.

***Price & Availability:** Price is $255 ea. Delivery time is up to 45 days.*

Booth 1910.

Environmental Chamber 569

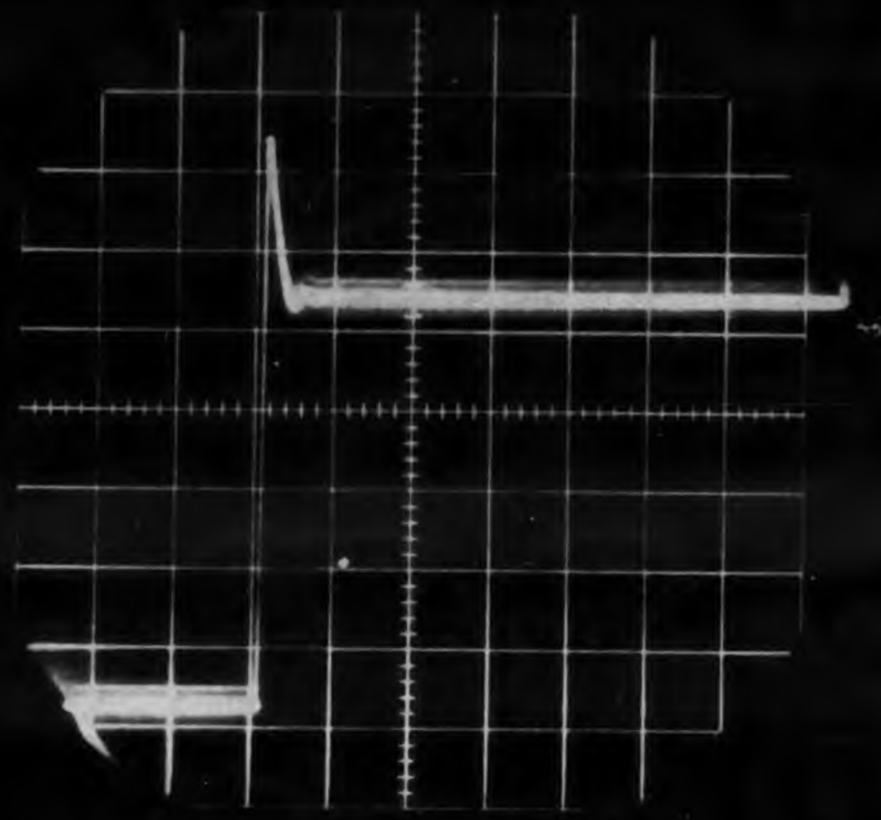
Simulates high altitudes and extreme heat

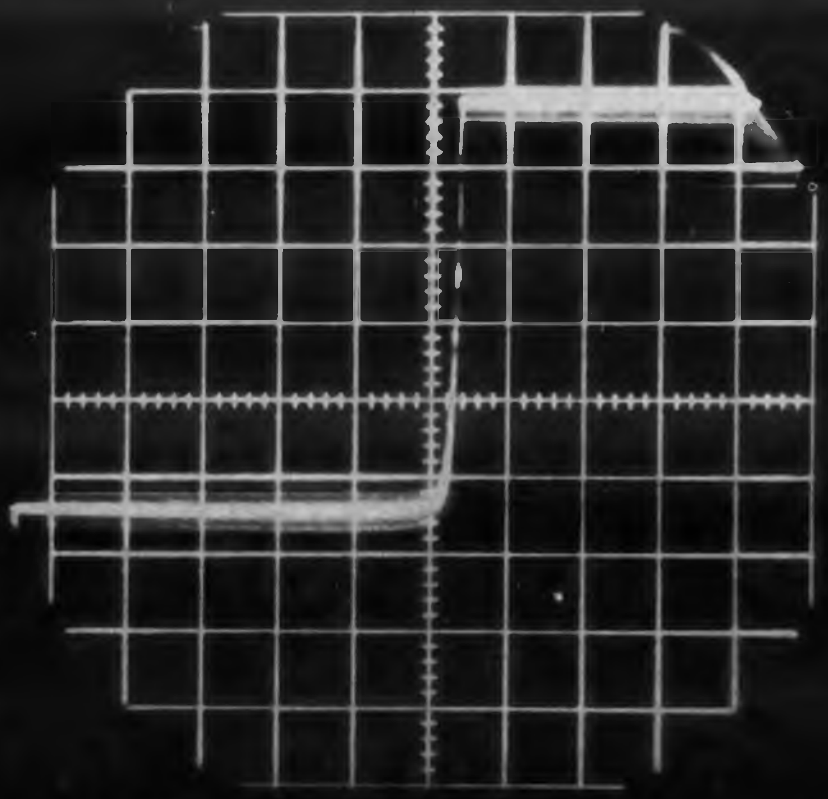
This environmental chamber is able to produce 1200 F of radiant heat under altitude conditions of 500,000 ft or 1 x 10^{-6} mm Hg absolute. A vapor trap insures efficient operation of the vacuum pump and an automatic, hot-gas defrost takes care of frost on the coils. Exterior dimensions, including machinery and instrumentation, are about 4 x 8 x 7 ft. Inside work space is a cylinder measuring 30 in. in diameter and 30 in. in depth. The chamber has applications in the testing of components and assemblies for space programs.

Tenney Engineering, Inc., Dept. ED, Union, N.J.

***Availability:** The unit can be delivered 8 to 10 weeks after receipt of order.*

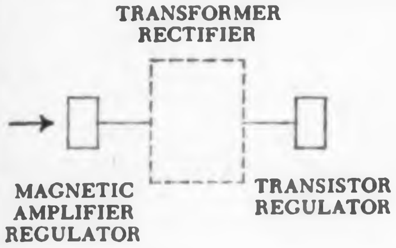
Booth 3226-3228.





PERKIN


MODEL NO. MTR.-636-15



NEW SOLID STATE REGULATION PRINCIPLE:

magnetic amplifiers for efficiency and reliability, transistors for fast response

Rugged magnetic amplifiers provide steady-state regulation of line and load. Fast-acting transistors suppress ripple and transients. Because the transistors function only during instantaneous line and load changes, their actual use is held to a minimum. MTR units thus have far better dynamic regulation than magnetic amplifier-regulated power supplies and much higher reliability than fully transistorized supplies.

PERKIN / MTR REGULATED LOW-VOLTAGE DC POWER SUPPLIES *prompt delivery*

Model No.	D.C. Output		Static Regulation		Dynamic Regulation		A.C. Input 60 CPS		Ripple
	Volts	Amps	Line	Load	Line†	Load††	Volts	Phase	RMS
MTR060-1 A	0-60	1	±10MV	±25MV	±10MV	± .2V	95-135	1	2MV
MTR060-5 A	0-60	5	±10MV	±25MV	±10MV	± .3V	95-135	1	2MV
MTR036-5	0-36	5	±10MV	±10MV	±10MV	± .2V	105-125	1	1MV
MTR036-15	0-36	15	±10MV	±10MV	±10MV	± .2V	105-125	1	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125	1	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125	1	5MV
MTR615-5	6-15	5	±10MV	±50MV	±0.1%	± .2V	105-125	1	3MV
MTR28-2	24-32	2	±0.1%	±0.1%	±0.1%	± .2V	105-125	1	5MV
MTR28-3	24-32	3	±0.1%	±0.1%	±0.1%	± .3V	105-125	1	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	± .3V	105-125	1	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	± .4V	105-125	1	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	± .5V	105-125	1	5MV
MTR28-100	24-32	100	±0.1%	±0.1%	±0.5%	±2.0V	208/230/ 460 ±10%	3	20MV

†For 10V step change on 115V nominal input units; 10% step change on Model MTR 28-100

††For changes no load to full load or full load to no load. On fractional load changes, specifications are improved.

All models have Automatic Current Limiting protective circuitry which eliminates fusing. Voltage and current are automatically reduced to a safe level on overloads of 125% rated output and above, including dead short circuits. Overloads and shorts can be sustained indefinitely without damage to the power supply. All units available standard 19" rack or cabinet mount. Dynamic impedance down to 25 milliohms.

WRITE FOR COMPLETE PERKIN CATALOG on tubeless power supplies and new technical article on dc power sources for transistorized circuits.

PERKIN
ENGINEERING CORPORATION
345 Kansas Street, El Segundo, California • ORegon 8-7215
ew England Area Office: 46 Amesbury St. • Lawrence, Mass. • MUrdock 3-3252

ALES REPRESENTATIVES
lbuquerque, N.M.—AMherst 8-1724
ngola, Ind.—217 & 8101-R
tlanta, Ga.—BLackburn 5-6660
hicago, Ill.—JUniper 8-0905
leveland, O.—REdwood 2-7444
allas, Tex.—FLeetwood 7-7080
Dayton, O.—CHapel 4-5551
Denver, Colo.—SUnset 1-7375
Detroit, Mich.—HOward 8-2461
Indianapolis, Ind.—STate 7-0009
Kansas City, Mo.—HEdrick 2-2528
Los Angeles, Calif.—HOllywood 9-7294
Minneapolis, Minn.—MIdway 6-2621
New York City, N.Y.—DIgby 4-2997
Orlando, Fla.—CHerry 1-2128
Philadelphia, Pa.—WAlnut 7-1820
Phoenix, Ariz.—WHitney 6-2111
St. Louis, Mo.—PArkview 1-6403
San Diego, Calif.—ATwater 3-2081
San Francisco, Calif.—EMerson 9-3354
Seattle, Wash.—PArkway 3-9000
Syracuse, N.Y.—GIbson 6-0220
Washington, D.C.—JUniper 5-7550
Agincourt, Canada—AXminster 3-7011

Variable Toroidal Inductors 694

Microminiature

Slotted for screw-driven adjustment, type ATE 34 microminiature, variable toroidal inductors have a maximum inductance of 500 mh with a Q-factor greater than 55 at 25 kc. The frequency range is 3 to 30 kc. The units measure 27/64 in. in diameter and 21/32 in. in height. They weigh 0.1 oz. The terminal spacing is in modules of 0.3 in. Completely encapsulated, the units meet MIL-E-15305 A and MIL-T specs 27, grade 4, class R. Designed for use in printed circuitry, they have applications in phase networks, variable transformers, oscillators, discriminators, and variable tuned circuits.

Burnell & Co., Dept. ED, 10 Pelham Parkway, Pelham, N.Y.
Booth 2909-2910.

Semiconductor Elements 705

Purities are 99.9% to 99.999%

Having purities of 99.9% to 99.999%, these semiconductor elements are available in the form of spheres, washers, dots, rings, or specially shaped tabs. Materials include: indium, aluminum, gallium, lead, tin, gold, silver, arsenic and composites of several materials.

Anchor Alloys, Inc., Dept. ED, 968 Meeker Ave., Brooklyn 22, N.Y.
Booth 4042.

Is your company announcing a new product?

Tell ELECTRONIC DESIGN about it at Booth 4404-4406.

◄ CIRCLE 130 ON READER-SERVICE CARD

tan-TI-cap †

CAPACITOR
STABILITY
ASSURED
BY 250-HOUR
PERFORMANCE
LOAD TEST

...expanded TI line of type SCM solid tantalum capacitors meets MIL specs

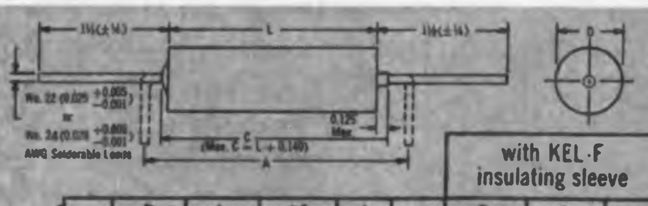
ACTUAL SIZE

Another assurance to you of Texas Instruments capacitor reliability — 250-hour performance load test on a sample basis of *all* lots of the Type SCM series.

Your margin of design safety is greater with *tan-TI-cap* capacitors. Type SCM capacitors are *100% tested* for capacity, dc leakage and dissipation factor, and are aged under load at elevated temperature. SCM units in all 203 standard ratings (6 - 35 volts, 1 - 330 μfd.) meet and exceed the electrical and mechanical requirements of MIL-C-55057 (Sig. C) and/or MIL-C-21720A (NAVY) specifications for solid tantalum capacitors.

Contact your nearest authorized TI distributor or TI sales office today for your immediate and future delivery requirements.

† trademark of Texas Instruments Incorporated



case size	D +0.010 −0.005	L ±0.031	*A ±0.031	wire size AWG	avg. wt. gms.	with KEL-F insulating sleeve D +0.020 −0.010	with KEL-F insulating sleeve L ±0.062	with KEL-F insulating sleeve avg. wt. gms.	with Mylar insulating sleeve** D ±0.010	with Mylar insulating sleeve** L ±0.031	with Mylar insulating sleeve** avg. wt. gms.
F	0.125	0.250	0.482	24	0.4	0.162	0.337	0.5	0.135	0.322	0.4
B	0.175	0.438	0.688	24	1.1	0.210	0.525	1.3	0.185	0.510	1.2
G	0.279	0.650	0.888	22	2.7	0.315	0.735	3.1	0.289	0.722	2.8
H	0.341	0.750	0.988	22	3.3	0.377	0.835	3.9	0.351	0.822	3.4

* Dimension "A" determined by suspending a one-pound weight from one lead and rotating the case from the vertical position to the horizontal position, and then repeating the procedure for the other lead.

** Meets all requirements of MIL-C-55057 and MIL-C-21720A, including dimensions.

All lots of Type SCM *tan*-**TI**-*cap* capacitors are tested for performance stability at rated temperature and voltage prior to release for shipment. Performed on a lot-sample basis, the test is run for 250 hours or until performance stability is established by successive time interval measurements of the principal parameters of each test capacitor.

Write to your nearest TI sales office on your company letterhead for Bulletin DL-C 1173 which gives detailed specifications on the complete SCM series.

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
POST OFFICE BOX 312 · DALLAS, TEXAS

NEW PRODUCTS

AT THE
IRE SHOW

AC Voltmeters 707

Gives true rms readings

Models 1761 and 2531 ac voltmeters provide true rms reading even when frequencies vary or are distorted. Both have an accuracy of ±0.5% of center-scale at 60 cps. They are temperature-compensated from —55 to +70 C. Each unit consists of a 0 to 1 ma indicator and a transducer designed around solid-state circuitry. The transducer, which measures about 3.65 in. in length and 2.55 in. in diameter, can easily be detached from the indicator and remotely located. Over-all depth of the instrument and the transducer is 5.65 in. The transducer converts the rms value of the input to a squared function of the average dc input. When designed as a suppressed zero ac voltmeter with a range of 105 to 125 v, the transducer suppresses the output until the rms value is 105 v.

Weston Instruments, Daystrom, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.
Booth 1708-1710-1809.

Environmental Chamber 572

For salt spray tests

Designed for determining the salt fog corrosion resistance of materials and components, model SS-2-5 Lucite environmental chamber meets the requirements of specs such as MIL-E-5272A, QQ-M-151A, and MIL-STD-202A. The chamber is equipped with temperature controls and indicators. Working dimensions are 20 x 20 x 20 in. Larger sizes can be furnished.

Associated Testing Laboratories, Inc., Dept. ED, 112 Clinton Road, Caldwell, N.J.
Price & Availability: *Price is $1705 fob Caldwell. Delivery is from stock to four weeks.*
Booth 3830-3832.

◄ CIRCLE 131 ON READER-SERVICE CARD

Vacuum Tube Voltmeter 700

Frequency range is 3 to 600 kc

Model 125A frequency-selective voltmeter covers the range of 3 to 600 kc. It has both narrow and wide selectivity settings plus a flat voltmeter position. Having a tunable mode of —90 to +32 dbm and a flat mode of —30 to +32 dbm, the instrument is suitable for carrier measurements, wave analysis, and general laboratory use.

Sierra Electronic Corp., Dept. ED, 3885 Bohannon Drive, Menlo Park, Calif.
Booth 3031-3032.

Epoxy Resin 704

Cures at room temperature

Type 202 medium viscosity epoxy resin is capable of curing at room temperatures with hardener type 202/9816. This material can be used as a casting resin, an electrical insulating resin for encapsulating, potting, or impregnating, and as a laminating resin for fiber glass products.

Furane Plastics, Inc., Dept. ED, 4516 Brazil St., Los Angeles, Calif.
Price & Availability: Price is $1.95 per lb for orders of less than 8 lb. Delivery is 48 hr after receipt of order.
Booth 4050.

Metal Cabinets 696

Have durable construction

These metal consoles, cabinets, and electronic housings are made using the Stress skin method which makes traditional joining methods unnecessary and provides greater durability. This method also helps eliminate accumulation of dust particles. Units are light weight.

Falstrom Co., Dept. ED, 304 Falstrom Court, Passaic, N.J.
Booth 4315-4317.

Do you have an "Idea for Design"?

Come to ELECTRONIC DESIGN Booth 4404-4406.

CIRCLE 132 ON READER-SERVICE CARD ➤

DISPLACEMENT
Models 580 (top)
and 581 (bottom)

VELOCITY
LVsyn

DISPLACEMENT
Linearsyn

Precision Transducers

FROM

SANBORN

Linear motion transducers available from Sanborn Company now include the compact, ready-to-use flange-mounted *Model 580* and threaded *581* "probe-styles" for displacements as small as 0.00002" . . . thirty models (shielded and unshielded) of the rugged *Linearsyn* differential transformer for strokes from ±0.005" to ±1.0", displacements as small as 0.000001" . . . and twelve models of the *LVsyn* for producing a DC voltage proportional to a linear velocity. Features of the *580—581* probe-style units include 0.5% linearity; basic sensitivity at 2400 cps of 2.4 volts output/inch displacement/volt excitation; built-in output level adjustment, phase shift and temperature change compensation; carbide-tipped stainless steel contact rod riding in jeweled bearings. Both the *LVsyn* and *Linearsyn* transducers are extremely durable units, immersible in working fluids, introduce little or no friction, and have infinite resolution. Standard Linearsyn coil lengths range from 0.564" to 6.88", LVsyn coil lengths from 3.16" to 22.75".

For differential and single-ended pressure measurements, *Series 267 and 268* transducers for operation in a carrier system offer sensitivities of 40 uv/mm Hg/volt excitation and 40 uv/0.1 mm Hg/volt excitation. Compact, Monel cases have standard Luer connectors.

Contact your local Sanborn Sales-Engineering Representative for bulletins containing complete facts or write the Sanborn Industrial Division in Waltham. Sanborn Sales-Engineering Representatives are located in principal cities throughout the U. S., Canada and foreign countries.

for long stroke, high pressure, high temperature requirements . . .

. . . special-order LVsyn and Linearsyn displacement transducers can be supplied. Strokes up to 20" are possible . . . pressure ratings up to 5000 psi, when transducer is submerged in a high pressure medium . . . operating temperature ranges as wide as −65°F to +450°F. Consult factory, stating your requirements.

PRESSURE
Series 267, 268

SANBORN COMPANY
INDUSTRIAL DIVISION
175 Wyman St., Waltham 54, Mass.
At I.R.E. Show Booths 3601-03-05

Miniature Pentodes 686

Voltage range is 300 v to 10 kv

Designed for use in high-voltage regulator circuits and as high-voltage amplifiers, types 7234, 6842, and 7683 cover a voltage range of 300 v to 10 kv and have transconductances as high as 5000 μmhos. The units are suitable for critical applications.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.
Booth 2234.

Standardized Circuit Tester 566

Include a variety of instruments

These standardized, pocket-sized, circuit testers include: volt-ohmmeters, volt-ohm-milliammeters, insulation testers, and foot-candle meters. These instruments handle any current to 20 amp and any voltage from 30 mv to 750 v. Each unit is fitted with five-way binding posts for connections by wire, plug, pin, or jack.

Weston Instruments, Daystrom, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.
Booth 1708-1710-1809.

Planning to write an article?
Stop by ELECTRONIC DESIGN Booth 4404-4406.

Good electronic design

you limit compromise by

PROOF:

G-E 7077

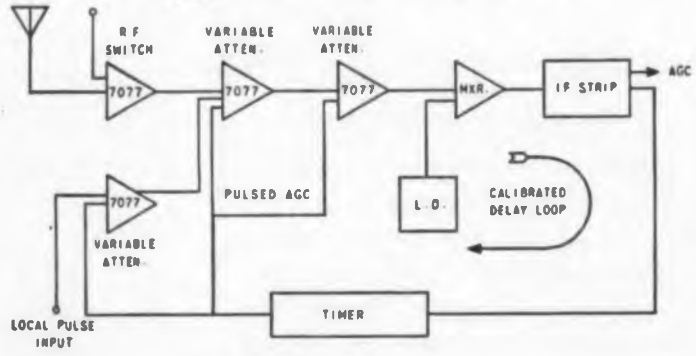
over a wide spectrum of

LOCKHEED

WIDE-BAND TAPE RECORDER.

For Lockheed, California Division, 28 General Electric 7077's serve as pre-amplifiers in a 14-channel 500-kc 60″-per-second tape recorder that stores wide-band information from an air defense exercise five times as rapidly as before. Extreme requirements of frequency, timing accuracy, and reproducibility are met by the 7077's low noise, high impedance, and high G_m. Also, the tube's small size matches the miniaturization needs of the Lockheed tape-recorder equipment.

MOTOROLA



GROUND-SURVEYING RADAR.

Motorola's Western Military Electronics Center in Phoenix uses four General Electric ceramic 7077's for high-speed RF switching and pulse attenuation in a 440-mc distance measuring circuit where timing to *one billionth of a second* is needed for pulse delay measurement. Minimum plate-to-cathode capacitance, high gain, low noise, and a configuration that makes the tube ideal for grounded-grid service, were reasons back of Motorola's choice of the G-E 7077.

Modulating Anode Pulser 702

For use with anode klystrons

Designed for use with modulating anode klystrons, model 278M anode pulser provides swings from —65 to +32.5 kv at a pulse repetition rate of 385 pulses per sec. Pulse width is selected from a range of 4 to 54 μsec. Pulse rise and fall times are less than 1.2 μsec and pulse tops are flat within 2%. Made in tank form, the unit contains the klystron socket, klystron filament transformer, isolating transformers, and other facilities of a complete self-contained modular unit.

Levinthal Electronic Products, Inc., Dept. ED, Stanford Industrial Park, Palo Alto, Calif.
Booth 3003.

Beam-Power Pentodes 571

Deliver up to 45 w

Type 7591 beam-power pentodes deliver up to 45 w with less than 1.5% distortion. Designed for use in audio amplifiers, the tubes operate at a rated screen dissipation of 3.3 w; screen dissipation of 6 w is permissible during periods of maximum input. A highly conductive copper-core material eliminates hot spots on the plate. The tubes use a T-9 glass bulb and an octal base; they can be mounted in any position.

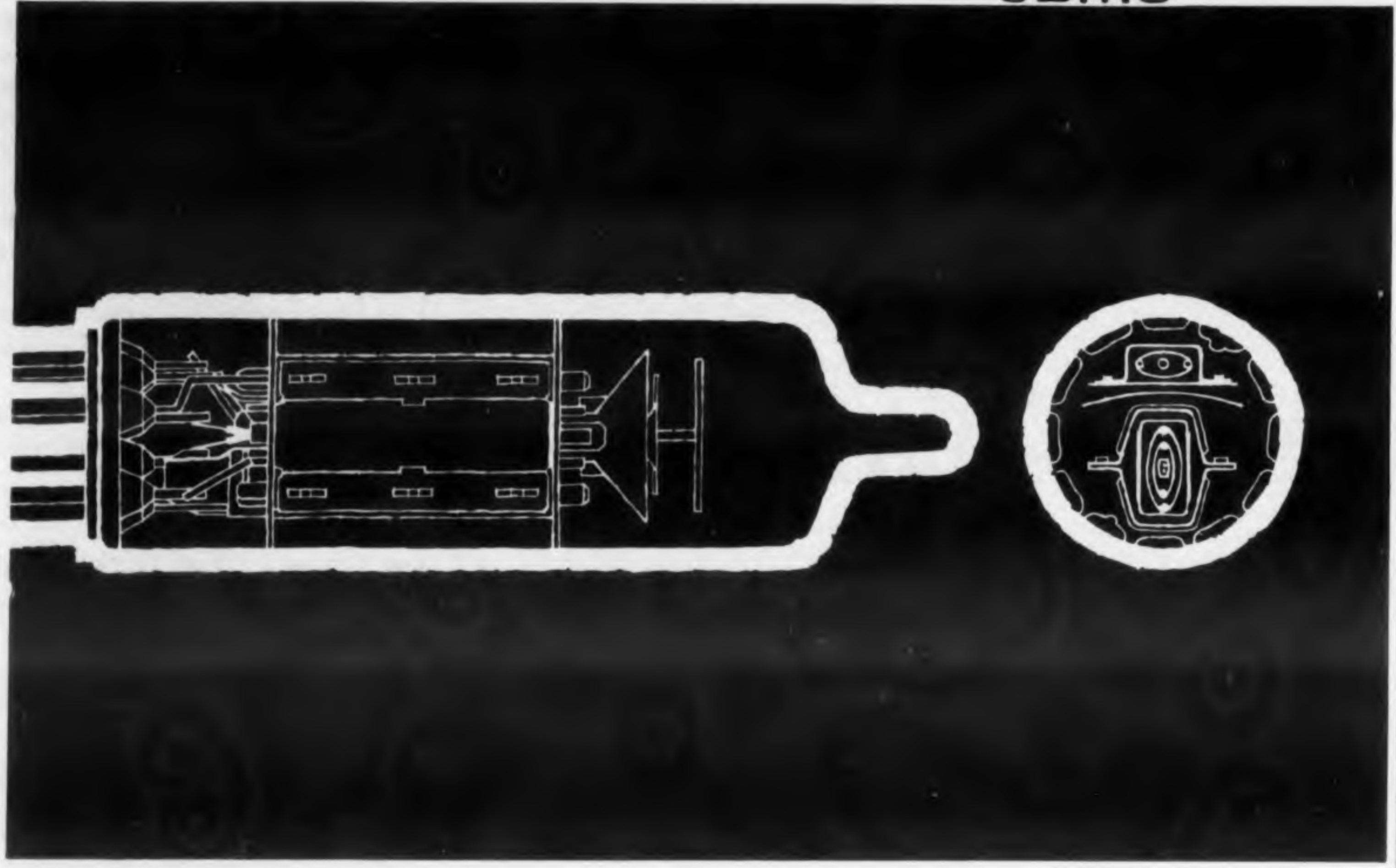
Westinghouse Electric Corp., Electron Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.
Booth 1402-1607.

Acoustic-Noise Test System 699

Produces 150-db intensity

Model AN-RV-15 acoustic-noise test system, designed to duplicate sounds present near jet and missile engines, produces sound pressure levels up to 150-db over-all intensity within eight octave bands. These bands cover a frequency range of 37.5 to 9,600 cps. The system has 15 cu ft of test space and accommodates specimens up to 44 in. long.

Associated Testing Laboratories, Inc., Dept. ED, Caldwell, N.J.
Booth 3830-3832.



NEW PRODUCTS AT THE IRE SHOW

Transducers 683

For underwater applications

The Dual-D underwater transducer provides orthogonal beams for supersonic sensing of sea-bottom depth simultaneously with forward obstacle detection. One transducer element, operating at 200 kc, provides a sensing beam for depth of water measurements. Another, operating at 300 kc, provides a horizontal forward beam of about 8 deg, angular spread. Both elements are encapsulated in a common epoxy housing. The elements are mounted to eliminate interference. The housing and mounting stud are nonmetallic.

Advanced Acoustics Corp., Dept. ED, 67 E. Centre St., Nutley, N.J.
Booth 2818-2820.

Cathode Ray Tube 692

Accelerating voltage is 500 v

Type K1951 3-in. cathode ray tube, designed for oscilloscopes and other instruments, has an accelerator voltage of 500 v, a post accelerator voltage of 1500 v, and a focusing voltage of 25 to 125 v. The tube has a flat face and is electrostatically focused and deflected. Deflection voltages are less than 15 v in either direction. Line width is 0.03 in. max. The tube has a linear-post accelerator for maximum deflection uniformity and minimum pattern distortion.

Allen B. DuMont Labs., Inc., Electron Tube Sales Dept., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.
Booth 3901-3905.

Thinking about an editorial career?

Visit ELECTRONIC DESIGN at Booth 4404-4406.

PSI AUTHORIZED DISTRIBUTORS

Contact one of these PSI Distributors for fast delivery at factory prices!

ACK SEMICONDUCTORS, INC.
Birmingham, Alabama
ACK RADIO SUPPLY OF GEORGIA, INC.
Atlanta, Georgia
ALLIED RADIO CORPORATION
Chicago 80, Illinois
ALMO RADIO CORPORATION
Philadelphia 7, Pennsylvania
CRAMER ELECTRONICS, INC.
Boston 16, Massachusetts
DENVER ELECTRONIC SUPPLY CO.
Denver 4, Colorado
ELECTRO SONIC SUPPLY CO., LTD.
Toronto 5, Ontario, Canada
ELECTRONIC SUPPLY
Melbourne, Florida
ELECTRONIC SUPPLY CORP.
Pasadena, California
ELECTRONIC WHOLESALERS, INC.
Washington 1, D.C.
ELMAR ELECTRONICS, INC.
Oakland, California
FERGUSON ELECTRONIC SUPPLY CO.
Detroit 38, Michigan
GENESEE RADIO & PARTS CO., INC.
Buffalo 16, New York
GRAHAM ELECTRONIC SUPPLY, INC.
Indianapolis 25, Indiana
KIERULFF ELECTRONICS, INC.
Los Angeles, California
LEW BONN COMPANY
Minneapolis, Minn.
OIL CAPITOL ELECTRONICS
Tulsa 16, Oklahoma
PEERLESS RADIO DISTRIBUTORS, INC.
Jamaica 33, New York
PIONEER ELECTRONIC SUPPLY CO.
Cleveland 15, Ohio
RADIO SPECIALTIES COMPANY, INC.
Alamogordo, New Mexico
RADIO SPECIALTIES CORP.
Phoenix, Arizona
RADIO SPECIALTIES, INC.
Albuquerque, New Mexico
ROCHESTER RADIO SUPPLY CO., INC.
Rochester 5, N.Y.
SEATTLE RADIO SUPPLY, INC.
Seattle, Washington
SREPCO, INC.
Dayton 4, Ohio
STANDARD RADIO PARTS, INC.
Tucson, Arizona
STANDARD SUPPLY COMPANY
Salt Lake City 10, Utah
STERLING RADIO PRODUCT, INC.
Houston 1, Texas
SYRACUSE RADIO SUPPLY CO.
Syracuse, New York
TERMINAL ELECTRONICS INC.
New York 11, N.Y.
WHOLESALE ELECTRONIC SUPPLY
Dallas, Texas
WHOLESALE RADIO PARTS COMPANY
Baltimore, Maryland

from PSI...Very High Voltage Cartridge Rectifiers

NO VOLTAGE DERATING

over entire TEMPERATURE RANGE

−55°C to 150°C!

EXTREMELY RUGGED • NON-METALLIC "COLD" CASE • WIRE-IN LEADS • EASY-TO-MOUNT • USE IN PRINTED CIRCUITS

No need to "over specify" for voltage derating considerations! These PSI 1N1730 and 1N2382 silicon rectifier series provide the lowest voltage drop, the highest current ratings and best reverse leakage characteristics of any available types.

The component diode strings are welded and packaged in non-metallic cases. The units are compact, light weight and easy to mount. With no heat sink requirements they are particularly suited to printed circuit board applications.

Electrical Specifications

	MAXIMUM RATINGS				ELECTRICAL CHARACTERISTICS		
EIA TYPE NUMBER	Peak Inverse Voltage (v)	Maximum RMS Input Voltage* (v)	Maximum Average Rect. Current* (mA) @ 25°C	Maximum Average Rect. Current* (mA) @ 100°C	Max. DC Fwd. Voltage Drop @ 100mA DC @ 25°C	Max. DC Rev. Current @ Rated PIV (μa) @ 25°C	Max. DC Rev. Current @ Rated PIV (μa) @ 100°C
1N1730	1000	700	200	100	5	10	100
1N1731	1500	1050	200	100	5	10	100
1N1732	2000	1400	200	100	9	10	100
1N1733	3000	2100	150	75	12	10	100
1N1734	5000	3500	100	50	18	10	100
1N2382	4000	2800	150	75	18	10	100
1N2383	6000	4200	100	50	27	10	100
1N2384	8000	5600	70	35	27	10	100
1N2385	10000	7000	70	35	30	10	100

* Resistive or inductive load.
OTHER SPECIFICATIONS:
Continuous DC voltage same as PIV.
Maximum surge current (8msec.) at 100°C: 2.5 amperes.
Operating temperature range: −55°C to 150°C.

Nine types...1,000 to 10,000 VOLTS!

FAST DELIVERY... IN PRODUCTION QUANTITIES!

Phone, wire or write for detailed specifications, curves, prices and delivery schedules.

Also ask about the extensive line of PSI Standard and Special Encapsulations . . . Ring Modulators, Bridge Rectifiers, Matched Pairs and Quads.

IRE BOOTHS 2742-2744

SALES OFFICES

NEW YORK—2079 Wantagh Ave., Wantagh, L. I., SUnset 1-7470
TWX: WANTAGH NY 2320

BOSTON — 471 Washington Street, Wellesley 81 • CEdar 5-0171

PHILADELPHIA — 320 Huntingdon Pike, Rockledge • PIlgrim 2-8089
TWX: ROCKLEDGE PA 1064

BALTIMORE — 1811 North Rolling Road, Windsor Building • WIndsor 4-3622

MADEIRA BEACH, FLA.—P.O. Box 8215 • WAverly 1-9735

OTTAWA—227 Lauier Ave., West • CE 2-8504

CHICAGO—6957 W. North Avenue, Oak Park, Illinois • VIllage 8-0750
TWX: OPK 1547

DALLAS—2681 Freewood Dr. P.O. Box 6067 • RIverside 7-1258

DETROIT—1204 No. Woodward, Royal Oak • LIncoln 8-4722

LOS ANGELES—8271 Melrose Ave. OLive 3-7850

PALO ALTO—701 Welch Road, Suite 305 • DAvenport 1-2240

PSI Authorized Distributors from coast-to-coast can supply up to 999 units at factory prices. See Distributor List in adjacent column.

Pacific Semiconductors, Inc.
A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.
12955 Chadron Avenue, Hawthorne, California

CIRCLE 135 ON READER-SERVICE CARD

A complete, flexible product line of reliable, precision subminiature potentiometers from DAYSTROM

More than 32 basic models . . . many exclusive and unique features . . . over 252 variations for military and industrial use.

Series 300 Series 301 Series 315

FULL SIZE—U.S. PATENT 2,880,293

SQUARETRIM POTENTIOMETERS

"the world's smallest trimmers"

for high resolution, minimum space requirements in airborne, missile, and ground instruments and systems applications where stability is a vital requirement.

These tiny SQUARETRIM models have an exclusive square shape for optimum packaging that allows stacking as many as twenty units into one cubic inch. Other features: more accurate trimming—almost one-third more turns per sweep than conventional models . . . greater stability through an exclusive worm gear adjusting device and the unique circular design of the mandrel.

Series 304

Series 319 (2 gang)

FULL SIZE—PATENTS PENDING

SINGLE-TURN POTENTIOMETERS

highest quality potentiometers, designed for exceptional linearity and maximum reliability and accuracy in applications where space is at a premium.

These series are small, compact, highly precise potentiometers. Typical examples: Series 304 utilize precision winding techniques that give linearity from 0.3% to 3%; a design that provides at least a 500,000 cycle service life. High temperature Series 314 (−55°C to +250°C) meets or exceeds latest environmental military specifications. Series 319 can be ganged without the use of bulky clamp rings . . . with each wiper positioned independently to meet any phasing need.

Series 341
(3 turn)
(10 turn)

FULL SIZE—U.S. PATENT 2,866,493

MULTI-TURN HIGH PRECISION POTENTIOMETERS

for rigorous temperature, altitude and vibration requirements in aircraft and missile applications.

Smallest package of its type, the Series 341 meets the most exacting performance requirements and is built to withstand severe vibrations or shock, eliminate backlash and reduce phase shift to negligibility. Standard models are ten-turn; models also available in 3 and 5 turns.

Series 410 Series 450

HALF SIZE—U.S. PATENT 2,900,614

MULTIPOT® POTENTIOMETERS

for low-cost requirements in general test equipment and computer applications.

All the MULTIPOT potentiometers provide a high degree of reliability and accuracy without the penalty of premium price. Precision winding techniques ensure exceptional resolution and desirable performance characteristics in a small, efficient package.

For complete specifications write for Data File ED-880-1.

IRE Show: Booth 1704-1706

DAYSTROM, INCORPORATED
PACIFIC DIVISION
9320 Lincoln Boulevard, Los Angeles 45, Calif.

CIRCLE 136 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Switching Galvanometer 689

Sensitivity is 1 μa

Designed to function in control systems where the energizing signal is too slight to operate conventional relays, this switching galvanometer has a sensitivity as low as 1 μa full scale. It energizes a 50-w relay and can directly control a magnetic switch. The instrument is suitable for applications requiring close control of temperature. The movement of the indicator pointer is controlled by magnets in the permanent contact, making possible slow contact closing.

The Hickok Electrical Instrument Co., Dept. ED, 10617 Dupont Ave., Cleveland 8, Ohio.
Booth 3616-3618.

Pulse Generator 687

Repetition rates are 1 cps to 10 mc

Model B-5A pulse generator has continuously variable pulse repetition rates from 1 cps to 10 mc in seven ranges. Rise and fall time is less than 8 mμsec. The unit has an electronic pulse delay that can be set to zero or is continuously variable from 0.03 to 500 μsec in five ranges. The pulse width is continuously variable from 0.02 to 12.5 μsec in four ranges.

Rutherford Electronics Co., Dept. ED, 8944 Lindblade St., Culver City, Calif.
Booth 3834.

Do you have a handy nomograph? Bring it to ELECTRONIC DESIGN, Booth 4404-4406.

Recording System 554

Has 8 channels

Model BSA-850 direct-writing, rectilinear recording system has 8 channels. The recording elements consist of seven of the firm's OS-600 oscillograph units and one OS-610 oscillograph unit; signals of 0 to 100 cps are recorded on true rectangular coordinates. The transistorized driver amplifiers may be used differentially or single-ended. Interchangeable plug-in preamplifiers include dc, ac carrier and chopper. Chart speeds can be selected from 0.5 cm per hr to 200 mm per hr. The unit measures 23.5 x 22 x 62 and weighs 350 lb without preamplifiers.

Cohu Electronics, Inc., Massa Div., Dept. ED, 5 Fottler Road, Hingham, Mass.

Price & Availability: *Price is from $4750 to $5050. The unit can be delivered in 30 days.*

Booth 3609-3611.

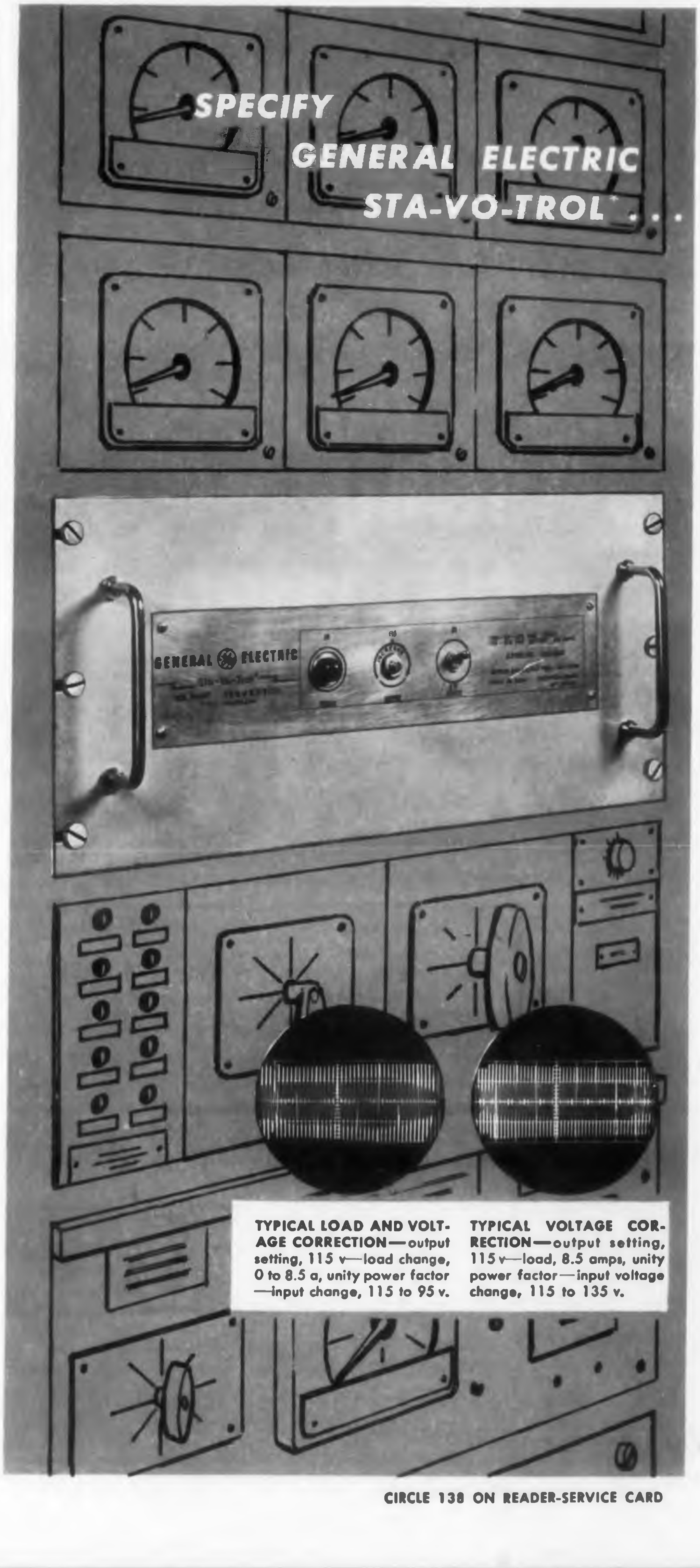
Microwave Amplifier Tube 621

For airborne use

Type VA-824B microwave amplifier tube is made for use in airborne systems. Mid-band saturated output is 5 w; power gains are up to 10 db. The basic operating range is 9.78 to 9.82 kmc. Convection cooling is employed. The tube can be used in continuous or pulse-modulated amplification or for synchrodyne or serrodyne frequency shifting. It weighs 9 oz and measures 1-1/2 x 2-1/4 x 3-3/8 in.

Varian Assoc., Dept. ED, 611 Hansen Way, Palo Alto, Calif.

Booth 2710-2720.



TYPICAL LOAD AND VOLTAGE CORRECTION—output setting, 115 v—load change, 0 to 8.5 a, unity power factor—input change, 115 to 95 v.

TYPICAL VOLTAGE CORRECTION—output setting, 115 v—load, 8.5 amps, unity power factor—input voltage change, 115 to 135 v.

CIRCLE 138 ON READER-SERVICE CARD

New Static Voltage Control

AT IRE BOOTH 2924

New General Electric Sta-Vo-Trol regulator gives you maintenance-free, automatic, *static* voltage control using unique rate feedback and industry-proven zener diode sensing.

Static components eliminate tubes, brushes, and other moving parts.

Sta-Vo-Trol regulators assure you reliable, constant voltage—regardless of line or load fluctuation—giving optimum performance of critical military and commercial electronic equipment.

Sta-Vo-Trol REGULATOR SPECIFICATIONS:

- Rating: 1 Kva output, 0 to 8.5 amperes, single phase, 60 cycles ±5%
- Input range: 95 to 135 volts
- Output range: 115 volts normal, 110 to 120 adjustable
- Accuracy: ±0.25% bandwidth†
- Response time: 6 to 12 cycles‡
- Load power factor range: 0.5 lagging to unity
- Wave-form distortion: 3%

† ±0.25% bandwidth for any line and load changes at constant power factor; ±0.5% bandwidth for changing load power factor.

‡ 6 to 12 cycles for 63% correction after ordinary line and/or load changes; up to 30 cycles for complete correction.

NET PRICE—$475

(type SLR-1000)

World-wide General Electric application and service facilities are available to you. For more information about the benefits of specifying G-E Sta-Vo-Trol voltage regulators for your application, write to Section 425-25, General Electric Co., Schenectady, N. Y.

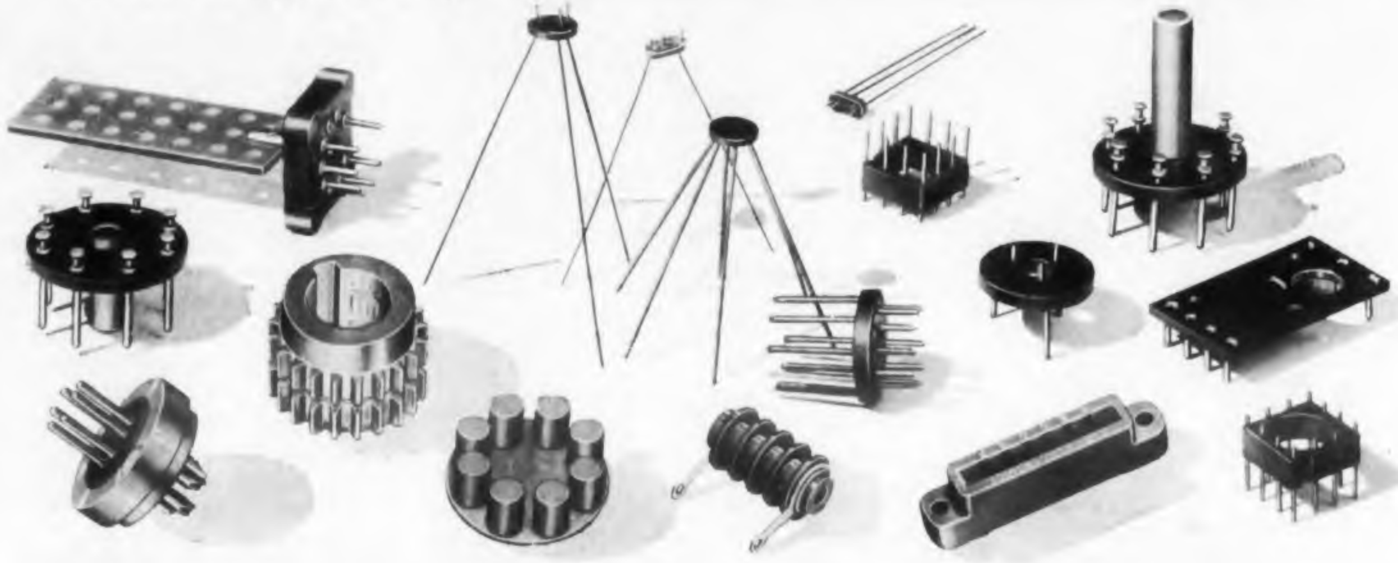
* Trademark of General Electric Company for static voltage regulators.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CUSTOM MOLDING OF
EPOXY SUB-COMPONENTS

...terminal boards, connectors, pin blocks,
shift registers, headers, with or without inserts!



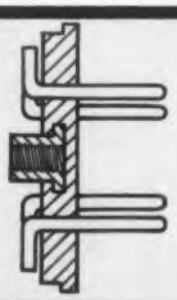
Epoxy Products, originator of the famous all-epoxy E-Pak encapsulation system, now offers its wide experience and equipment for the custom-molding of specialized epoxy sub-components. These sub-components can be molded with a wide variety of inserts (produced in our own precision metal working facilities) to fit your particular requirements. Every unit is delivered in finished form, tested and ready for reliable use with your component.

Let us design to meet your special requirements, in all materials including fire resistant and colored epoxy compounds. Write today for further information.

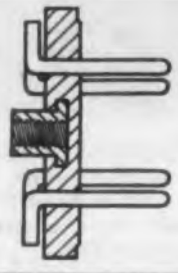
Here are 4 versions of custom-molded, all-epoxy sub-components

In addition to conventional "straight through" leads, headers can be designed where the leads take a bend through the body of the header.

Headers have been made with shoulder ridge that is molded to fit into and support the case. A threaded brass insert may also be molded into the header to fit the female end of the component.



Dissimilar leads may be welded together so that the bond between them can be molded into the header for additional strength.



Header leads are embedded to fit a standard seven-pin miniature socket. A wide choice of epoxy formulations, for use with copper, brass, silver, gold-plated metals, etc., is available.

EPOXY PRODUCTS
A DIVISION OF JOSEPH WALDMAN & SONS
137 Coit St., Irvington, N. J. • ESsex 5-6000

CIRCLE 139 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Recording System 553

For rectilinear reproduction

Model BSA-250 two-channel, portable recording system is for the rectilinear reproduction of electrical and physical phenomena. Speeds are: 0.5, 2, 5, 20, 50, and 200 mm per sec. Interchangeable plug-in preamplifiers are employed. Built-in, equalized driver-amplifiers are used. The power required is 105 to 125 v at 60 cps, 60 w. The unit weighs 45 lb.

Cohu Electronics Inc., Massa Div., Dept. ED, 5 Fottler Road, Hingham, Mass.

Price & Availability: *Price is $1050. Delivery is in three weeks.*

Booth 3609-3611.

Laboratory Oscilloscope 666

Sweep range is 2 sec to 0.1 µsec per cm

This 5-in. dc laboratory oscilloscope has a sweep range of 2 sec to 0.1 µsec per cm. Response is to 10 mc and sweep-timing accuracy is adjustable to 1%. The unit has plug-in interchangeable vertical amplifiers. The timing markers are crystal-controlled. Operation is from 110 to 120 v ac, dimensions are 16 x 12-3/8 x 19-1/2 in., and weight is 50 lb.

Allied Radio Corp., Dept. ED, 100 N. Weston Ave., Chicago 80, Ill.

Price & Availability: *Supplied in kit form, the unit is priced at $285 and is available from stock.*

Booth 3915-3917.

for immediate delivery of

GENERAL INSTRUMENT

semiconductors

at factory prices

call your authorized stocking distributor

CALIFORNIA
Electronic Supply Corp.
Pasadena
Newark Electric Company
Inglewood
Pacific Wholesale Co.
San Francisco
San Delco
San Diego
Shanks & Wright, Inc.
San Diego
Valley Electronic Supply Co.
Burbank

CONNECTICUT
Sun Radio & Electronics Co., Inc.
Stamford
The Bond Radio Supply, Inc.
Waterbury

FLORIDA
Electronic Supply
Melbourne; branches in
Miami, Orlando, St. Petersburg

ILLINOIS
Merquip Company
Chicago
Newark Electric Co.
Chicago

INDIANA
Brown Electronics, Inc.
Fort Wayne
Graham Electronics Supply, Inc.
Indianapolis

IOWA
Deeco, Inc.
Cedar Rapids

MARYLAND
Radio Electric Service Co.
Baltimore

MASSACHUSETTS
The Greene-Shaw Co., Inc.
Newton

NEW YORK
Delburn Electronics, Inc.
New York City
Hudson Radio & Television Corp.
New York City
Sun Radio & Electronics Co., Inc.
New York City

OHIO
Buckeye Electronics Distributors
Columbus
The Mytronic Co.
Cincinnati
Pioneer Electronic Supply Co.
Cleveland

OKLAHOMA
Oil Capitol Electronics
Tulsa

PENNSYLVANIA
D & H Distributing Co.
Harrisburg
Herbach & Rademan, Inc.
Philadelphia

TEXAS
Scooter's Radio & Supply Co.
Fort Worth

WASHINGTON
Seattle Radio Supply Co.
Seattle

WISCONSIN
Radio Parts Co., Inc.
Milwaukee

Distributor Division
GENERAL INSTRUMENT
CORPORATION
240 Wythe Avenue
Brooklyn 11, N.Y.

CIRCLE 140 ON READER-SERVICE CARD

GENERAL INSTRUMENT CORPORATION

AUTOMATIC

SUBMINIATURE

silicon power diode/rectifiers

PIV up to
600 V.

high
conductivity

150 ma
@ 150 C.

low
leakage

400 ma
25 C.

designed to meet USAF MIL-E-1/1143 specs

These fine silicon diode/rectifiers meet and exceed the USAF specs . . . and retain their outstanding characteristics and reliability at temperatures of 150° C. and more! Complete technical information on these and other General Instrument semiconductors is available upon request.

JEDEC TYPE NO.	MAXIMUM RATINGS			ELECTRICAL CHARACTERISTICS			
	PEAK INV. VOLT-AGE (V)	MAX. AVG. RECTIFIED CURRENT (mA)*		MINIMUM SATURA-TION VOLTAGE @ 100° C. (VOLTS)	MAXIMUM REVERSE CURRENT @ PIV (uA)		MAXIMUM VOLTAGE DROP @ 400 ma DC @ 25° C. VOLTS DC
		@ 25° C.	@ 150° C.		@ 25° C.	@ 100° C.	
1N645	225	400	150	275	0.2	15	1.0
1N646	300	400	150	360	0.2	15	1.0
1N647	400	400	150	480	0.2	20	1.0
1N648	500	400	150	600	0.2	20	1.0
1N649	600	400	150	720	0.2	25	1.0

*Resistive or inductive load

Semiconductor Division
GENERAL INSTRUMENT CORPORATION
65 Gouverneur Street, Newark 4, N. J.
Midwest office 5249 West Diversey Ave. Chicago 39
Western office 11982 Wilshire Blvd. Los Angeles 25

[illegible]

Visit us at the IRE Show, Booth 1218-24
CIRCLE 141 ON READER-SERVICE CARD

Three voltage ranges:
0-200, 125-325, 325-525 VDC

1.5 AMPERE MODELS **NEED ONLY 8¾" OF PANEL HEIGHT!**

(metered)		(unmetered)	
MODEL C-1580M:	0-200 VDC, 0-1500 MA.580.00	**MODEL C-1580:**	0-200 VDC, 0-1500 MA.550.00
MODEL C-1581M:	125-325 VDC, 0-1500 MA.605.00	**MODEL C-1581:**	125-325 VDC, 0-1500 MA.575.00
MODEL C-1582M:	325-525 VDC, 0-1500 MA.680.00	**MODEL C-1582:**	325-525 VDC, 0-1500 MA.650.00

800 MA MODELS **NEED ONLY 7" OF PANEL HEIGHT!**

(metered)		(unmetered)	
MODEL C-880M:	0-200 VDC, 0-800 MA.370.00	**MODEL C-880:**	0-200 VDC, 0-800 MA..340.00
MODEL C-881M:	125-325 VDC, 0-800 MA.345.00	**MODEL C-881:**	125-325 VDC, 0-800 MA..315.00
MODEL C-882M:	325-525 VDC, 0-800 MA.390.00	**MODEL C-882:**	325-525 VDC, 0-800 MA..360.00

400 MA MODELS **NEED ONLY 5¼" OF PANEL HEIGHT!**

(metered)		(unmetered)	
MODEL C-480M:	0-200 VDC, 0-400 MA.289.50	**MODEL C-480:**	0-200 VDC, 0-400 MA..259.50
MODEL C-481M:	125-325 VDC, 0-400 MA.274.50	**MODEL C-481:**	125-325 VDC, 0-400 MA..244.50
MODEL C-482M:	325-525 VDC, 0-400 MA.289.50	**MODEL C-482:**	325-525 VDC, 0-400 MA..259.50

200 MA MODELS **NEED ONLY 5¼" OF PANEL HEIGHT!**

(metered)		(unmetered)	
MODEL C-280M:	0-200 VDC. 0-200 MA.214.50	**MODEL C-280:**	0-200 VDC, 0-200 MA..184.50
MODEL C-281M:	125-325 VDC, 0-200 MA.189.50	**MODEL C-281:**	125-325 VDC, 0-200 MA..159.50
MODEL C-282M:	325-525 VDC, 0-200 MA.199.50	**MODEL C-282:**	325-525 VDC, 0-200 MA..169.50

For all power supply needs through 1.5 amperes:

LAMBDA
COM-PAK®
POWER SUPPLIES

Less space! Improved performance!
Long, trouble-free service!
Transient free output!

Fills the need for compact, regulated DC power supplies. Economy of panel space, functional simplicity, new quick-service features.

Wiring, tubes and other components readily accessible. You can reach them easily, service them fast.

400 MA, 800 MA, and 1.5 ampere models include new, high-efficiency, long-life, hermetically-sealed semi-conductor rectifiers. All Com-Pak models are constructed with hermetically-sealed magnetic components and capacitors for long trouble-free service.

Condensed Data

LINE REGULATION	Better than 0.15% or 0.3 Volt, whichever is greater.
LOAD REGULATION	Better than 0.25% or 0.5 Volt, whichever is greater.
INTERNAL IMPEDANCE	
C- 200 Series	Less than 6 ohms.
C- 400 Series	Less than 3 ohms.
C- 800 Series	Less than 1.5 ohms.
C-1500 Series	Less than 0.75 ohms.
RIPPLE AND NOISE	Less than 3 millivolts rms.
POLARITY	Either positive or negative may be grounded.
AMBIENT TEMPERATURE	Continuous duty at full load up to 50°C (122°F) ambient.
AC OUTPUT (unregulated)	6.5 VAC (at 115 VAC Input).
C- 200 Series	10 AMP
C- 400 Series	15 AMP
C- 800 Series	20 AMP
C-1500 Series	30 AMP
AC INPUT	105-125 VAC, 50-400 CPS
OVERLOAD PROTECTION	AC and DC fuses; built-in blown-fuse indicators.

SEND FOR COMPLETE 32-PAGE CATALOG

Contains full information and specifications on Lambda's full line of transistor-regulated and tube-regulated power supplies.

ALL LAMBDA POWER SUPPLIES ARE GUARANTEED FOR FIVE YEARS.

LAMBDA ELECTRONICS CORP.
11-11 131 Street, College Point 56, N. Y.

◄ CIRCLE 142 ON READER-SERVICE CARD

NEW PRODUCTS
AT THE IRE SHOW

Transistor Test Set 51

For Go/No-Go testing

Model 1500 transistor test set, for Go/No-Go operation, can handle 500 transistors per hr, performing ten tests on each. It is accurate to 1%. Specimens can be either silicon or germanium, npn or pnp. Diodes can also be tested. Power rating is 0 to 100 v at 0 to 0.1 amp. Sequencing can be automatic or manual.

Optimized Devices, Inc., Dept. ED, 864 Franklin Ave., Thornwood, N.Y.

Price & Availability: *Availability is two to three months. Price ranges from $7000 to $10,000.*

Booth 3016.

Shift Register 658

Uses magnetic elements

This shift register, using magnetic elements, permits a nondestructive output, both dynamic and static, plus any serial-parallel, input-output combination. Temperature range of the unit is —40 to +75 C without compensatory equipment. Each minor aperture offers an output level up to 100 mv at several volts. Only copper and toroidal ferrite cores are used.

Amp, Inc., Dept. ED, Harrisburg, Pa.

Booth 2527-2531.

Cable Covering 657

For break-outs, branch-outs, and splices

The Protechtor covers offer protection for break-outs, branch-outs, and splices. They can be supplied with two or more legs and in conventional T, Y, and fork-designs. They come in a full range of sizes.

Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles 14, Calif.

Availability: The product is now in production.

Booth 4044.

Microwave Diodes 535

Have low-noise figure

These Ku-band silicon microwave diodes, for radar and missile systems, are furnished as a matched pair. Available in both forward and reverse polarities, they virtually eliminate local oscillator noise and provide a receiver system with an over-all noise figure of 7.5 db at 16,000 mc. Types 1N78D and 1N78DR isolate the antenna and local oscillator terminals. Maximum operating temperature is 150 C. The devices have hermetic seals for environmental protection.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.

Booth 2322-2332, 2415-2425.

Booth 1914.

Silicon Rectifiers 644

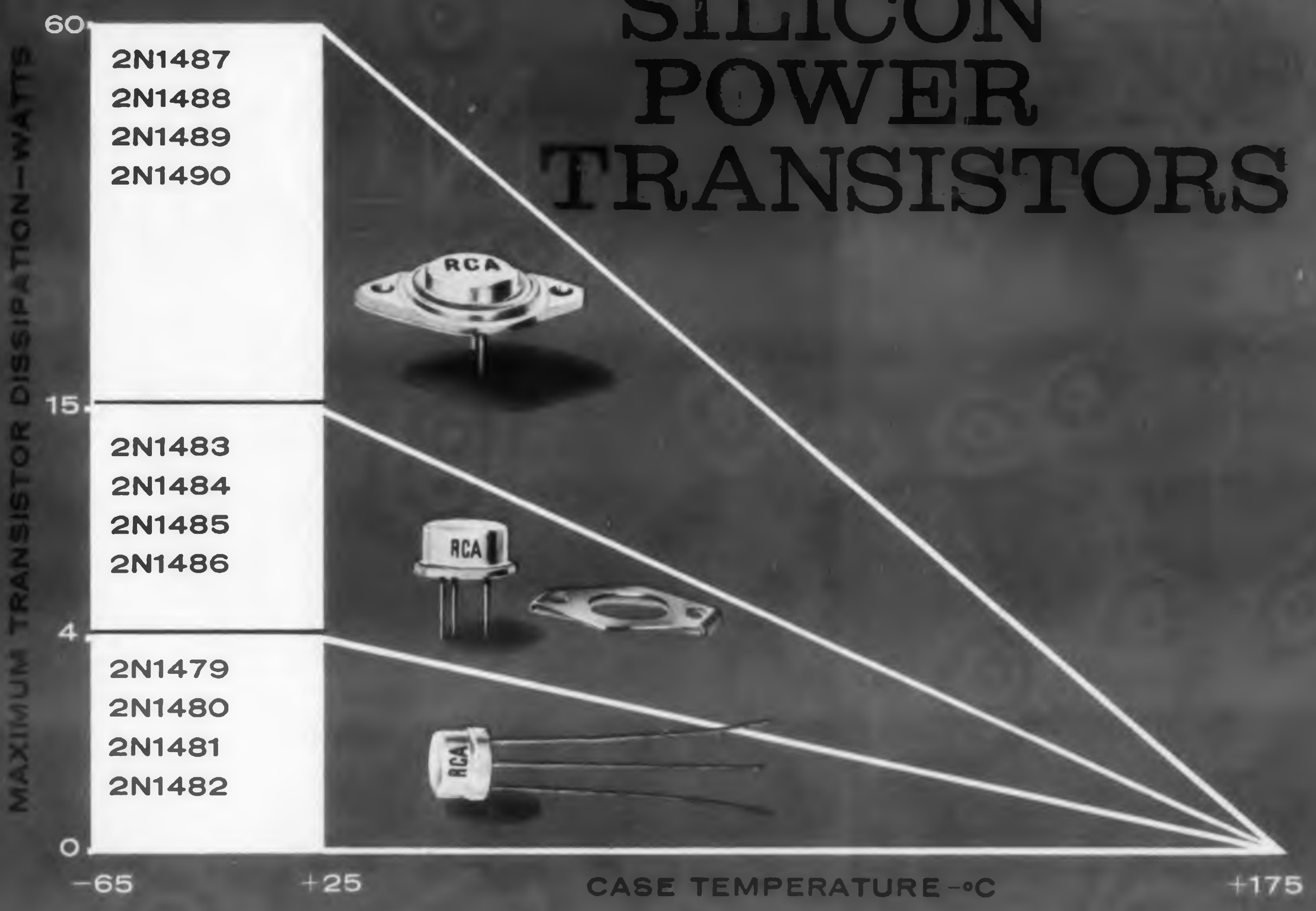
Are rated at 750 ma

Types 1N2611 through 1N2615 silicon, diffused-junction rectifiers are rated at 750 ma. Available in sizes from 200 to 600 v, they have high-surge handling capacity and very low back current. The units are suitable for use in communication equipment, computers, magnetic amplifiers and other applications which require reliable operation to 175 C.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Booth 1114-1115.

NEW RCA SILICON POWER TRANSISTORS



12 new N-P-N diffused-junction mesa transistors featuring low saturation resistance • high-temperature performance • high current beta • high power-handling capability

Out of RCA's broad experience in diffused silicon mesa techniques comes a comprehensive new line of medium, intermediate and high power silicon transistors, featuring low saturation resistance characteristics and high collector-current and voltage ratings.

For additional design flexibility these new RCA silicon transistors provide a choice of voltage ratings, beta and saturation resistance ranges.

The broad adaptability of these new RCA silicon types opens the way to a wide variety of high-temperature applications in industrial and military equipment. They are particularly useful in power switching circuits such as dc-to-dc converters, inverters, choppers, solenoid drivers and relay controls; oscillator, regulator, and pulse-amplifier circuits, and as class A and class B push-pull amplifiers for servo and other audio-frequency applications.

RCA Silicon Power Transistors were developed in cooperation with U. S. Army Signal Corps, on an Industrial Preparedness Measure for military devices.

All 12 new RCA Silicon Power Transistors are available in production quantities. Contact your RCA Field Representative today for complete sales information. For additional technical data, write RCA Commercial Engineering, Section C-18-NN-2, Somerville, N. J.

ELECTRICAL CHARACTERISTICS
Minimum and Maximum Values at Case Temperature = 25°C

RCA Type	Min. V_{CEX} (volts)	Min. V_{CEO}* (volts)	Max. I_C (amp)	Max. I_{CBO} (μa)	Max. Saturation Resistance (ohms)	h_{FE}
				V_{CB} = 30v	I_C = 0.2 amp	I_C = 0.2 amp
2N1479	60	40	1.5	10	7	15-75
2N1480	100	55	1.5	10	7	15-75
2N1481	60	40	1.5	10	7	35-100
2N1482	100	55	1.5	10	7	35-100
				V_{CB} = 30v	I_C = 0.75 amp	I_C = 0.75 amp
2N1483	60	40	3	15	2.67	15-75
2N1484	100	55	3	15	2.67	15-75
2N1485	60	40	3	15	1.00	35-100
2N1486	100	55	3	15	1.00	35-100
				V_{CB} = 30v	I_C = 1.5 amp	I_C = 1.5 amp
2N1487	60	40	6	25	2.00	10-50
2N1488	100	55	6	25	2.00	10-50
2N1489	60	40	6	25	0.67	25-75
2N1490	100	55	6	25	0.67	25-75

*sustaining volts

RADIO CORPORATION OF AMERICA

SEMICONDUCTOR AND MATERIALS DIVISION **SOMERVILLE, N. J.**

ANOTHER WAY RCA SERVES YOU THROUGH ELECTRONICS

East: 744 Broad St., Newark, N. J., HUmboldt 5-3900 • **Northeast:** 64 "A" St., Needham Heights 94, Mass., Hillcrest 4-7200 • **East Central:** 714 New Center Bldg., Detroit 2, Mich., TRinity 5-5600 • **Central:** Suite 1154, Merchandise Mart Plaza, Chicago, Ill., WHitehall 4-2900 • **West:** 6355 E. Washington Blvd., Los Angeles, Calif., RAymond 3-8361 • **Southwest:** 7905 Empire Freeway, Dallas 7, Texas, FLeetwood 2-8663 • **Gov't:** 224 N. Wilkinson Street, Dayton, Ohio, BAldwin 6-2366; 1625 "K" Street, N.W., Washington, D.C., District 7-1260

AVAILABLE, TOO, THROUGH YOUR AUTHORIZED RCA DISTRIBUTOR

Visit RCA at the New York IRE Show—Booth #s 1601-1608; 1701-1707

NEW PRODUCTS
AT THE IRE SHOW

Power Klystron 622

Gain is 50 db

Tunable over 1000 mc, type VA-823 cw power klystron has a gain of 50 db and a low noise figure. A series of these units can be used to cover the range of 8 to 10 kmc. Power output is 5 kw. Other specifications include: integral cavity construction, liquid cooling, and automatic focusing. The unit measures 3.5 x 6 x 14 in.

Varian Assoc., Dept. ED, 611 Hansen Way, Palo Alto, Calif.

Availability: Delivery time is 90 to 120 days.

Booth 2710-2720.

Tube and Transistor Socket 641

Has Teflon insulating body

This subminiature tube and transistor socket has an all Teflon insulating body. Compression mounting and spring tension are employed. The contact material is brass, silver-plated and gold-flashed. Over-all length is 7/16 in., body length is 0.268 in. and contact diameter is 0.018 in.

Garlock Electronic Products, The Garlock Packing Co., Dept. ED, Camden 1, N.J.

Booth 2814-2816.

Switch capsule of the new Clareed Sealed Contact Reed Relay consists of a pair of magnetically operated contacts, hermetically sealed in a glass capsule, in an atmosphere of inert gas.

SPECIFICATIONS

Contact Arrangement: Normally form A, form B, in combination form C

Overall length: 3-¼ in. max.

Outside diameter: 0.215 in. max.

Contact material: Gold

Contact rating: 15 volt-amperes max., non-inductive: 1 amp. max.; 250 volts max.

Contact resistance: 25-40 milliohms.

Life expectancy: At 14 volt-amperes (½ ampere, 28 volts dc), 20,000,000 operations.
At 7 volt-amperes (¼ ampere, 28 volts dc), 100,000,000 operations.

Minimum breakdown voltage: (60 cps) 500 volts rms.

Insulation resistance: 500 k megohms min.

Low level load test: 8 microamps, 800 ohms, 250 millivolts, open circuit operated at 3 ips, 100 million operations with no failures.

		Milliseconds (including bounce)		
	Watts to Just	Operate		
Switches per Coil	Operate Typical Coils	Excess NI over P.U. 100	200	Release
1	0.25	1	0.8	0.25
2	0.30	1.5	0.9	0.25
3	0.35	2.2	1.5	0.25
4	0.42	3.2	2.2	0.25
5	0.52	3.5	2.5	0.25
6	0.8	5	3.5	0.50
12	1.5	6	5	0.50
20	3.5	8	6	0.50

CONTACT BOUNCE	At "just operate"	0.3 ms max.
	At 200 excess NI	0.5 ms max.
	At 400 excess NI	0.8 ms max.
	No bounce on release.	

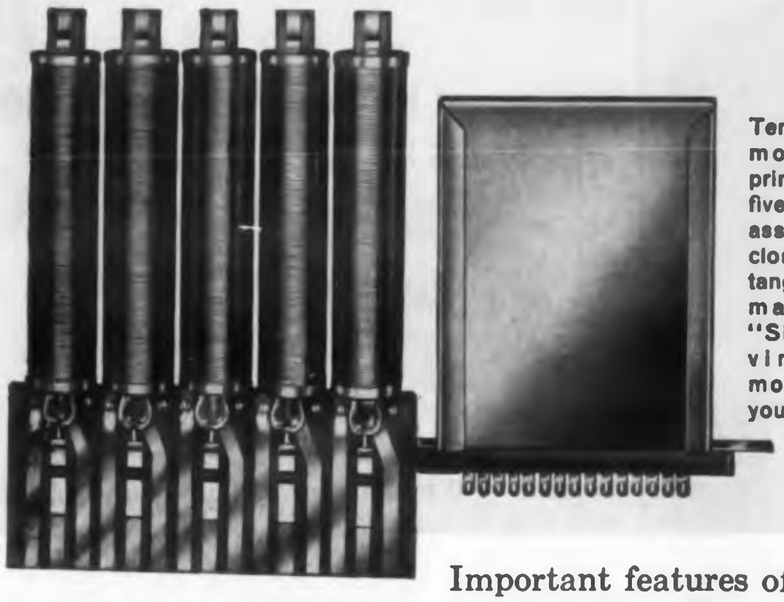
CLAREED®

a New Concept in Relay Design

The new CLAREED Sealed Contact Reed Relay effectively eliminates contact contamination. With its contacts hermetically sealed in contaminant-free inert gas, this new design assures millions of perfect operations. Hundreds of millions are possible when operated at up to ½ rated contact load.

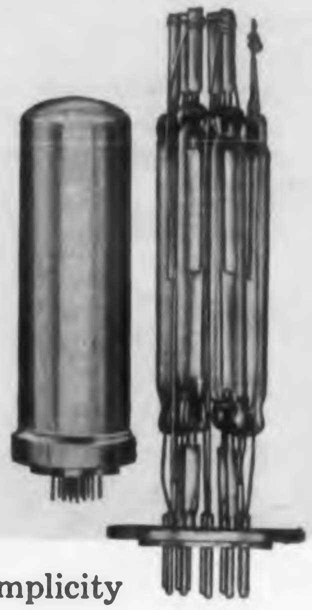
CLAREED relays are ideal components for transistor drive applications and for use in computers and data processing equipment. Their low inductance and the low inductance change in the operating coil at each operation limits the transients produced. Submit your packaging problem for recommendations.

• PACKAGED TO MEET *your* REQUIREMENTS



Ten CLAREED switches, mounted in line on a printed circuit board with five magnetic coils. This assembly can then be enclosed in the flat, rectangular container or it may be coated with "Skin-Pack," a tough vinyl plastic, and mounted directly into your equipment.

Six CLAREED switches clustered for mounting in a single tube container.



Important features of CLAREED relays are their simplicity and flexibility. They may be mounted to meet the requirements of almost any application and environmental condition, even on your own printed circuit board—to comply with your mechanical design configurations.

CLAREED relays are as flexible as your application requires. Consultation with your nearby CLARE sales engineer is invited. Additional information may be obtained from C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Limited, Box 134, Downsview, Ontario. Cable Address: CLARELAY. *Send for Bulletin CPC 5.*

SEE IT
AT THE
IRE SHOW
New York Coliseum
March 21-24
BOOTH NOS.
2218 &
2220

CLARE FIRST in the industrial field

Toroidal Cores 640

Made of silicon-steel tapes

These toroidal cores are made of 0.001, 0.002, and 0.004-in. oriented silicon-steel tapes. They are annealed for high squareness ratio. The saturation flux density is in the range of 16,500 to 17,500 gauss. Typical bias, or H_1, is 0.5 oersteds; typical gain, or delta H, is 0.1 oersteds.

G-L Electronics Co., Inc., Dept. ED, 2921 Admiral Wilson Blvd., Camden 5, N.J.

***Price & Availability:** Price is from $1 to $10 ea, for quantities of 1 to 1000. Production quantities can be delivered in two weeks.*

Booth 2015.

Power Supplies 643

Outputs are 6 to 36 v dc

Models PS4305, PS4315, and PS4330 power supplies, having current ranges of 0 to 5, 0 to 15, and 0 to 30 amp, respectively, have outputs of 6 to 36 v dc. Ripple and noise level at the output are less than 1 mv. Regulation is provided to maintain the output voltage within 0.025% for line and load changes of 10% from zero to full load. The output voltage is selected by front panel controls. Designed for critical industrial applications as well as military use, the units are compact.

Power Sources, Inc., Dept. ED, Burlington, Mass.

Booth 1914.

Potentiometers 520

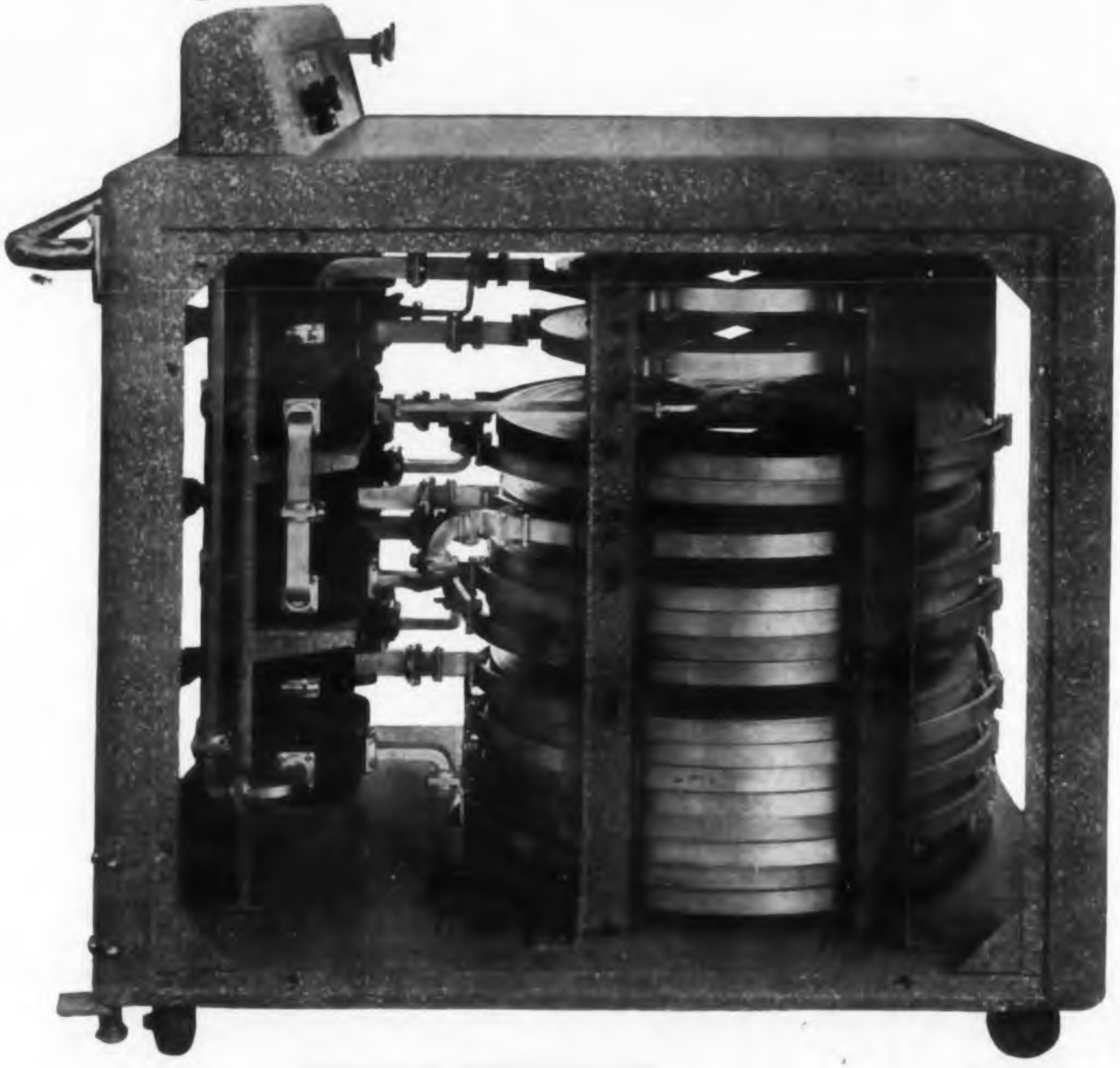
Precision type

Included in this line of precision potentiometers are the following types: model 7216, a 7/8-in. in diameter, 10-turn unit; model 70, a 1/2 in. sq trimmer; model 71, a 1/2-in. sq pin type for use in printed circuitry; and single and multi-turn potentiometers.

Beckman Instruments, Helipot Div., Dept. ED, 2500 Fullerton Rd., Fullerton, Calif.

Booth 1201-1203.

◄ CIRCLE 143 ON READER-SERVICE CARD



Gearless Drill-Head 66

For printed circuits

This gearless drill-head is designed for drilling printed circuits. The hole pattern to be drilled can be easily changed. Phenolic laminate is used for the guide and drive plates. The hole pattern is drilled simultaneously in three phenolic plates; the plates can be removed and stored for future use. Holes as close as 0.125 in. between spindles can be drilled. A rectangular pattern up to 14 x 17 in. is the capacity range.

Zagar, Inc., Dept. ED, 24000 Lakeland Blvd., Cleveland 23, Ohio.

Availability: *Made on order, the unit can be supplied in three to four months.*

Booth 4241.

Hi-Pot and Insulation Tester 509

Range is to 3500 v dc and 2500 v dc

Model AI-5E hi-pot and insulation tester has a dc range of 0 to 3500 v and an ac range of 0 to 2500 v at 60 cps. The insulation resistance range at 500 v dc is 3.5 to 50,000 meg. Applications of the instrument include cable checking, incoming inspection tests and checking and grading of long production runs. The circuit automatically removes the test voltage when the predetermined leakage current level is exceeded. The rack-mounted unit weighs 22 lb and measures 7 x 19 x 7 in. A portable unit can also be furnished.

Arizona Instrument Corp., Dept. ED, 3839 N. 39th Ave., Phoenix, Ariz.

Price: *$553 fob Phoenix.*

Booth 1230-1232.

Have you sent us your subscription renewal form?

BOURNS
TRIMPOT®

Schweber

FOR
IMMEDIATE
LARGE
QUANTITY
DELIVERY
AT
FACTORY
PRICES

2000

Yes! Schweber can sell
to 2000 pieces of any model
of BOURNS TRIMPOT®
at factory prices.
Sizeable quantities are
available for immediate
shipment from stock from
Schweber's warehouse.

Schweber
ELECTRONICS

60 HERRICKS ROAD. MINEOLA. L. I., N.Y.
PIONEER 6-6520. TWX G-CY-NY-580U
CIRCLE 145 ON READER-SERVICE CARD

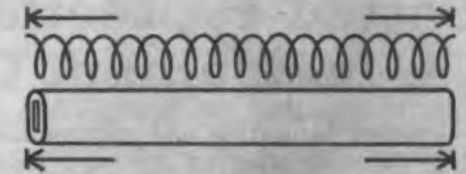
See us March 21-24 at the I.R.E. Show/Booths 1619-1621

BOURNS
TRIMPOT®
WITH
BUILT-IN
TEMPERATURE
STABILITY

Stable settings under extreme temperature conditions is an outstanding feature of the Trimpot® potentiometer. This thermal stability is built-in through all phases of design and production—

MATCHED COEFFICIENTS OF THERMAL EXPANSION

Resistance wire and mandrels have matched coefficients of thermal expansion to reduce the "strain gage effect." Linear expansion rates for the mandrel and wire match so closely that the temperature coefficient value for the entire wirewound element approximates that of the wire itself.

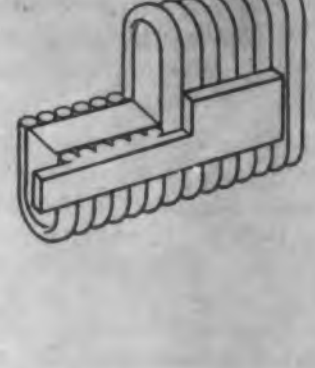


THERMALLY STABLE CERAMIC MANDRELS

Bourns takes advantage of high thermal stability of ceramic materials for element mandrels. Today, all Bourns Trimpot potentiometers provide the improved performance and reliability afforded by ceramic materials.

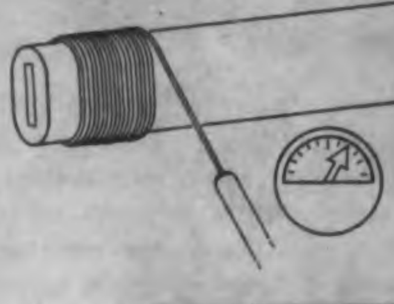
EXCLUSIVE SILVERWELD® TERMINATION

Silverweld is an actual metal-to-metal fusion of element wire and external terminal. In doing away with mechanical or soft-solder joints, Bourns eliminates potential hot spots thus extending the potentiometer's temperature range. The fusion of the Silverweld terminal to many turns of wire on the resistance element avoids the problem of single wire termination. Silverweld is virtually indestructible under thermal stresses.



EXCLUSIVE TENSION CONTROL EQUIPMENT

Bourns has developed specialized winding equipment that provides constant and precise control of wire tension during winding operations. "Necking" of the wire or resistance-altering stresses never occur. Instead the wire remains uniform—well able to withstand temperature variations with no appreciable change in resistance.



Specify Trimpot – the original leadscrew-actuated potentiometer with reliability on which you can depend. 20 basic models – 4 terminal types – 3 mounting styles.

BOURNS

BOURNS, INC., TRIMPOT DIVISION
6135 MAGNOLIA AVE., RIVERSIDE, CALIF.
PLANTS: RIVERSIDE, CALIF. AND AMES, IOWA

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.

CIRCLE 146 ON READER-SERVICE CARD

Automatic Analyzer 551

Range is 10 cps to 19 kc

Model D-940 analyzer covers the frequency range of 10 cps to 19 kc in four bands. Any one or a series of these can be selected for automatic scanning. The unit performs amplitude-frequency analyses of steady signals and amplitude-frequency-time analyses of nonsteady signals. Analysis of all types of complex waveforms is possible. Results can be plotted on the firm's recorder as X-Y or X-time data. Operation of the unit is automatic.

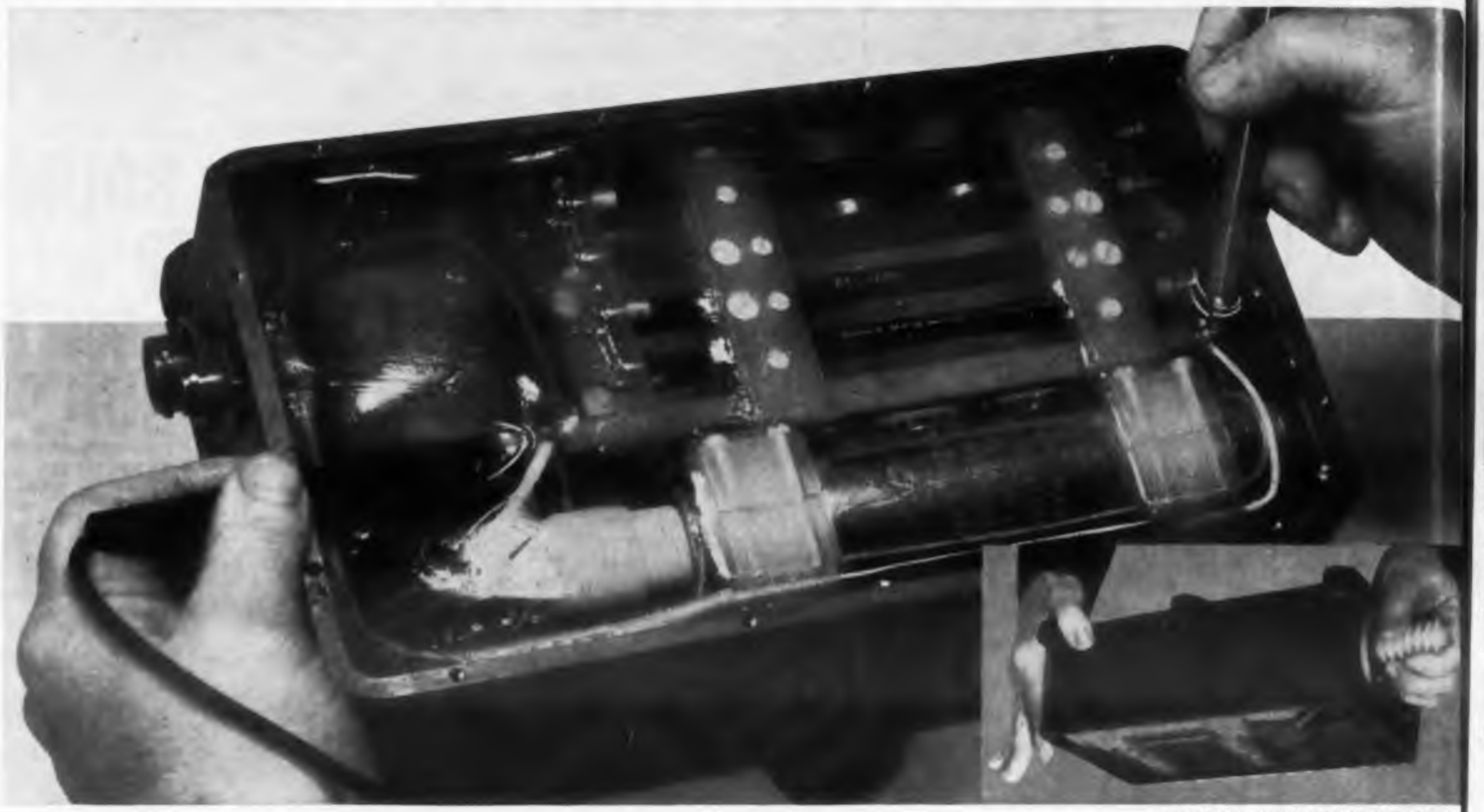
Muirhead Instruments, Inc., Dept. ED, 441 Lexington Ave., New York 17, N.Y.
***Price:** $11,250 fob New York.*
Booth 3230.

Power Supply 545

For reflex klystron tubes

Model V-7405 power supply, designed for operating reflex klystron tubes in laboratory and test applications, has a regulated beam voltage of 150 to 850 v. A coarse beam voltage-control provides for selection of the necessary operating range in 100-v steps, and a fine-control adjusts the voltage within the selected operating range. The reflector supply voltage is 20 to 800 v. The regulation and filter circuits of the reflector supply reduce the ripple to less than 20 μv rms. The reflector supply may be internally modulated with square-wave, saw-tooth, or sine-wave modulation.

Varian Assoc., Dept. ED, 611 Hansen Way, Palo Alto, Calif.
***Availability:** The unit can be delivered in 90 days.*
Booth 2714-2720.



SILICONE NEWS from Dow Corning

NEW: "Solid-State" Fluid

PHOTO COURTESY CBS LABORATORIE

Now: Potted Protection Plus Visual & Instrument Checking

The newest development in potting and encapsulating materials is Dow Corning Dielectric Gel. Supplied as a crystal clear fluid plus catalyst, it pours easily into assemblies and sub-assemblies, fills every void, sets up to a firm, pliable, transparent gel. The gelled mass exerts virtually no stress on components; has excellent adhesion; will not displace if vibrated or inverted. Potted components and connections are visible, probes can be inserted through it for instrument checking. When probes are removed, the gel heals itself, leaving no voids.

Here's how Dielectric Gel aids miniaturization: When designing the high voltage power supply for their new Photoscan airborne reconnaissance system, CBS Laboratories Division of Columbia Broadcasting System Inc., had to meet stringent reliability requirements despite elevated temperatures, high vibration levels, severe size and weight limitations. Their new design and miniaturization techniques were made possible by Dielectric Gel.

Requiring only 0.09 cubic feet complete, with components spaced less than 1/4" apart without danger of arcing, the new power supply provides output voltages that can be regulated from 1,000 to 25,000 volts. Current capacity at 25 kv is well over 100 microamperes. This power supply is an integral part of Photoscan, a universal visual intelligence-gathering, processing and transmitting system which can readily be installed in virtually any missile or air-borne vehicle. The units are small, light in weight, simple to install and service.

PROPERTIES OF CURED DIELECTRIC GEL

Color		Water White
Specific Gravity at 25 C		0.970
Coefficient of Thermal Conductivity:		
(cal per cm °C sec) 150 C		0.00070
200 C		0.00078
Electric Strength*, volts per mil		800
Dielectric Constant†	23 C	150 C
100 cps - 0.1 Mcs	3.0	2.6
Dissipation Factor†		
100 cps	0.0005	0.002
1.0 kc	0.0005	0.0005
0.1 Mcs	0.0001	0.0001
Volume Resistivity†, ohm-cm	1×10^{15}	1×10^{14}

* 60 cycles, rapid rise, 0.020 inch-spacing of 0.5 inch-diameter spherical electrodes.

† Using 54 mmfd fixed air capacitor, Cardwell type, ER-50-FS as electrodes, ASTM D150-54T and D1169-52T.

Dielectric Gel, plus CBS Laboratories packaging techniques simplify volume production problems . . . assure high voltag power supplies that are compact, reliab and easy to service.

Write for more information on Dow Cor ing Dielectric Gel, the new potting materi that permits visual and instrument chec ing of potted electronic circuitry a simplifies production problems.

CIRCLE 800 ON READER-SERVICE CARD

Your nearest Dow Corning office is the number one source for information and technical service on silicones.

first in silicones

Dow Corning

...other silicones aid miniaturization

Light Silicone-Glass Parts Resist Heat

Where space is small, silicone-glass laminates make ideal parts. Reasons: they resist heat and humidity; are easy to fabricate into miniature components; resist creep and delamination. Silicone-glass laminates are light weight, strong, have good dimensional stability, withstand operating temperatures to 250 C, have low loss factor; permit adjacent soldering and have high resistance to moisture, ozone, arcing and corona.

In the geophysical well-logging instrument shown, Schlumberger Well Surveying Corporation specified terminal boards of silicone-glass laminate. The silicone laminate proved more reliable under operating conditions and easier to fabricate than other materials.

CIRCLE 801 ON READER-SERVICE CARD

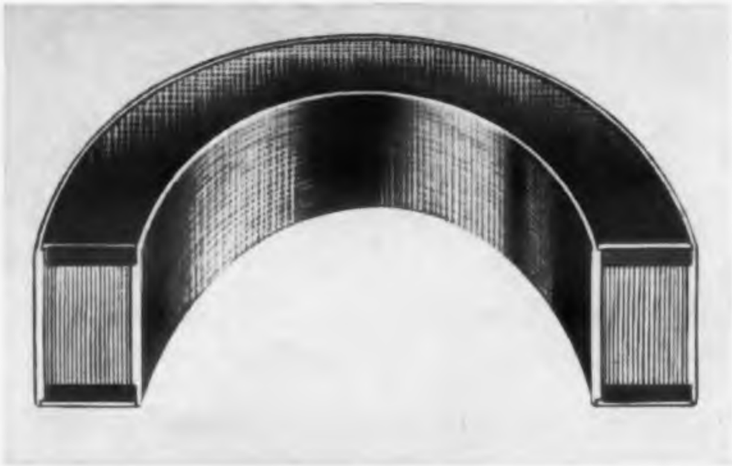
Silastic Assures Reliability Of Miniature Tube

Here's a good example of how miniaturization is aided by Silastic®, the Dow Corning silicone rubber.

A single tube from the line of Beam Switching Tubes developed by the Electronic Tube Division of Burroughs Corporation can replace as many as 90 transistors, diodes and resistors in electronic distributing, switching, and counting circuits. But proper operation and continued reliability depend upon the relationship of crossed magnetic and electrical fields . . . determined by the relative position of the glass envelope and the magnet which surrounds it. This positioning is very critical.

A cushion of Silastic assures proper alignment, bonds the glass envelope and magnet, provides greater shock resistance than any other material tested . . . contributes to the ease with which the tube meets military shock, vibration and other environmental requirements. Easily applied by simple injection techniques, Silastic is also used between magnet and tube shield.

CIRCLE 802 ON READER-SERVICE CARD

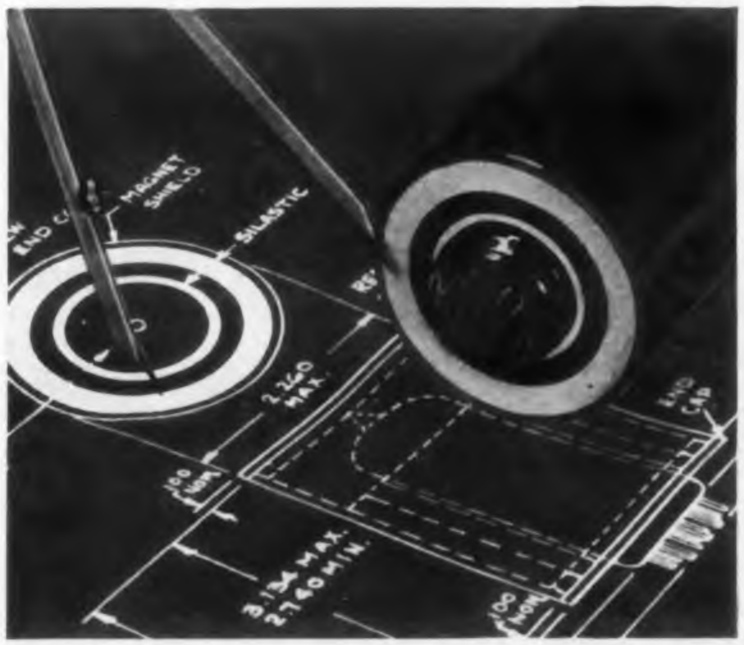


Silicone Compounds Cushion Small Cores

Tape wound toroidal cores, in both miniature and large sizes, are cushioned with silicone compounds between core and outer box by Magnetics Inc. Through the damping effects of the grease-like Dow Corning compounds, their phenolic-boxed cores are protected against vibration, shock effects and strain due to temperature change. They're "performance-guaranteed" up to 177°C.

Dow Corning silicone compounds were selected because they're inert, have high heat resistance and are easily applied. The compounds are nongumming, nonmelting, maintain a stable viscosity from —75 to 200 C. They have excellent dielectric, damping and heat-dissipation qualities, and are superior barriers to moisture. Other firms use silicone compounds for heat-sinks, sealants and similar applications, both mechanical and electrical.

CIRCLE 803 ON READER-SERVICE CARD



VISIT BOOTHS 4501-4503 AT IRE SHOW

CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

CIRCLE 800 TO 803 ON READER-SERVICE CARD

Analyzer-Oscillator 550

Frequency range is 200 cps to 650 kc

Model D-888-A analyzer-oscillator, having a frequency range of 200 cps to 650 kc, can be used as a frequency analyzer or as an oscillator. Made for laboratory use, the instrument has an accuracy of 2%. A three-stage amplifier, using amplified, negative feedback, provides for frequency selection. When the instrument operates as an analyzer, the selectivity corresponds to a Q-factor of 70 or more and an octave discrimination of 40 db. An input of 1 mv gives an output of 10 v into 1000 ohms. As an oscillator, the instrument has the output connected back to the input stage. The output is variable and has a maximum value of 2.5 v into 600 ohms. The unit comes in a portable bench mounting cabinet with over-all dimensions of 17.5 x 10.5 x 13 in.

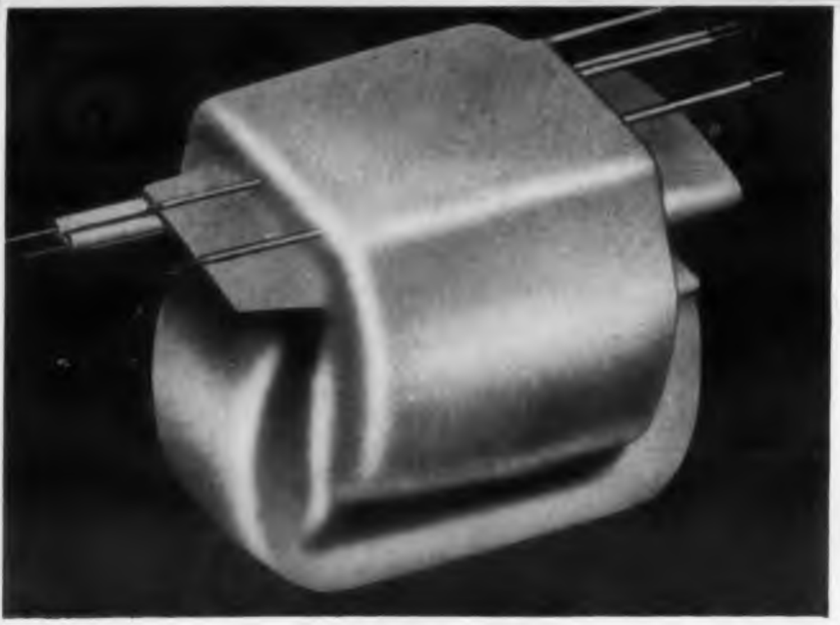
Muirhead Instruments, Inc., Dept. ED, 441 Lexington Ave., New York 17, N.Y.
Price: $1220 fob New York.
Booth 3230.

Magnetic Latching Relay 559

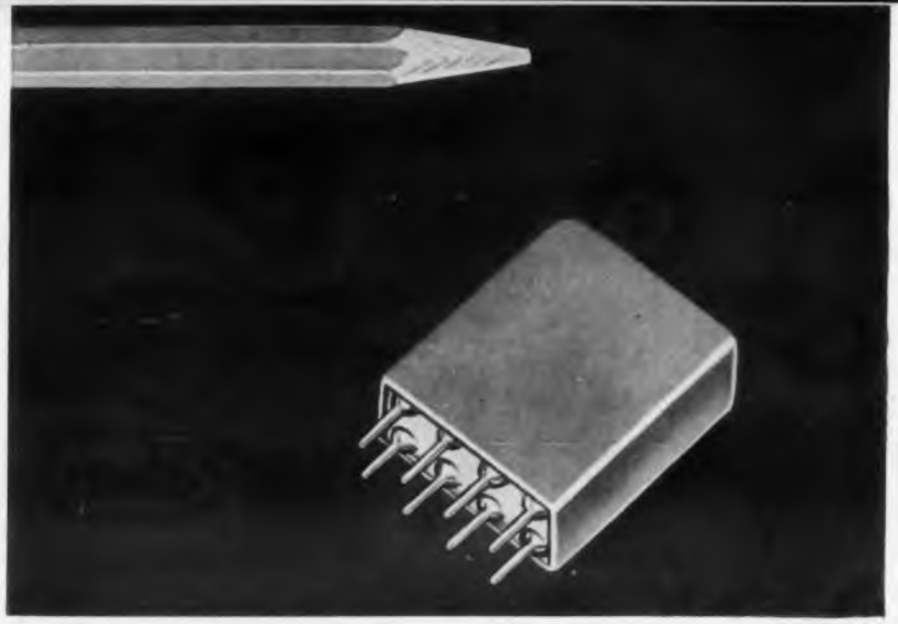
Is rated at 10 amp

Type BR-9 magnetic latching relay is rated at 10 amp. Able to operate on 100 mw, this dpdt relay weighs about 1 oz and has a life expectancy of 100,000 cycles at 125 C. It stands 50 g shock for 11 msec and 30 g vibration from 10 to 2000 cps. Maximum coil dissipation is 3 w. The requirements of MIL-R-5757C and 25018 are met.

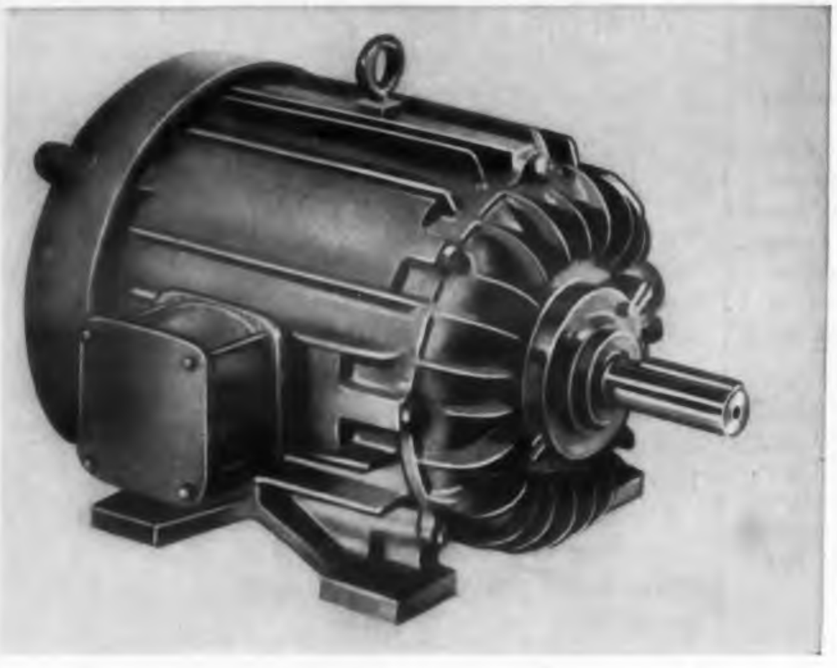
Babcock Relays, Inc., Dept. ED, 1640 Monrovia Ave., Costa Mesa, Calif.
Booth M-15.



Epoxy magnet wire is ideal for encapsulated systems.



Epoxy magnet wire has high dielectric strength.



Epoxy magnet wire has high resistance to heat shock and overloads.

Epoxy magnet wire is unaffected by transformer oils.

EPOXY MAGNET WIRE

Its outstanding acceptance stems from compatibility —plus heat-shock resistance, thermal stability, high dielectric strength

Not since Anaconda first offered Formvar many years ago has a magnet wire gained such rapid acceptance—and solved so many serious application problems—as has Anaconda Epoxy.

The biggest reason—the unusual compatibility of Epoxy with virtually every insulation system in use today. No deterioration of the Epoxy film is experienced due to chemical reaction with insulating varnishes tested to date, for example . . . no problems from film deterioration in encapsulated systems.

But Epoxy offers much more than compatibility. High heat resistance (Class B; 130°C) . . . unusual resistance to heat shock . . . high dielectric strength, even under conditions of extreme humidity . . . excellent flexibility and winding properties . . . outstanding adherence of insulation. Epoxy magnet wire is now available in a complete range of sizes—rounds, squares, and rectangulars.

Epoxy magnet wire is an Anaconda development—now in its fourth year of production, preceded by seven years of research in the Anaconda magnet wire laboratories. Why not obtain samples and data for your next exacting requirement. Ask your Anaconda man . . . or write for Epoxy Catalog No. C-101 and samples to: Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York. 59240

SEE THE MAN FROM

ANACONDA®

FOR EPOXY MAGNET WIRE

NEW PRODUCTS

AT THE IRE SHOW

Silicon Rectifiers 503

Are rated at 6 and 12 amp

These silicon diffused-junction rectifiers are offered in two series: types 1N1341 through 1N1347 are rated at 6 amp, and types 1N1199 through 1N1205 are rated at 12 amp. Both series have piv ranges of 50 to 500 v. All units have low forward-voltage drop, low leakage, and high uniformity of characteristics. Each diode is nickel-plated. A flattened-pierced end on the anode lead permits fast, easy wiring.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El-Segundo, Calif.

Price & Availability: *The 6-amp units are priced at $3.95 to $16.95 ea in quantities of 1 to 99; the 12-amp units are priced at $4 to $17.60 in quantities of 1 to 99. Delivery is from stock.*

Booth 2901-2903.

Wire and Cable Tubing 532

Made of irradiated polyethylene

This irradiated polyethylene Zippertubing is for jacketing wires and cables which are subjected to gamma and beta rays. The tubing has a life expectancy of 5 yr when used in the presence of nuclear reactors. It also withstands both high and low temperature extremes and offers protection against chemicals.

Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles, Calif.

Availability: *The product is available from stock.*

Booth 4044.

◄ CIRCLE 148 ON READER-SERVICE CARD

Meter Calibrator 538

Accuracy is 0.5%

This meter calibrator, for checking ohmmeters, dc microammeters, dc milliammeters, dc ammeters, and ac and dc voltmeters, has a full-scale accuracy of 0.5%. Ranges are between 0 to 2.5 and 0 to 500 v ac and dc, between 0 to 100 μa and 0 to 1 amp, and from 1 ohm to 1000 meg. The calibrator is suitable for production uses and can be used in military applications. The unit is completely solid state. It measures 10.5 x 19 x 15 in.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Price: *$995 ea.*

Booth 3009.

Insulation Cutter 536

Handles tubing from 3/8 to 1-1/4-in. long

This insulation cutter handles tubing from 3/8 to 1-1/4 in. long. Operating automatically with two machine heads, it cuts the tubing from reels and simultaneously places it on one or both leads of such components as resistors, and capacitors. Line voltage required for the machine is 110 v at 60 cps.

Design Tool Corp Electro Machinery Div., Dept. ED, 772 Bergen St., Brooklyn 38, N.Y.

Price & Availability: *The unit is made on order, can be delivered in 8 weeks, and is priced at $2500.*

Booth 4122.

Electrical Tester 533

For axial-lead components

This orienting and testing machine electrically tests diodes, capacitors and resistors at an average rate of 3500 pieces per hr. It mechanically rejects substandard parts and orients each component in the direction of its polarity.

Universal Instruments Corp., Dept. ED, 139 E. Frederick St., Binghamton, N.Y.

Price & Availability: *Price is $4650. Delivery time is 30 days.*

Booth 4019.

NEW PRODUCTS AT THE IRE SHOW

Pulse Generator 665

Four-channel type

Model 3010A four-channel mμsec current pulse generator operates at frequencies to 3 mc and higher. Rise time is 0.04 μsec at 1 amp. The unit provides four variable-width and amplitude pulses, two positive and two negative. It has applications in testing magnetic and other current-driven devices.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

Price & Availability: *Price is $4760. Delivery time is eight weeks.*

Booth 3810-3812.

Microwave Mixer 546

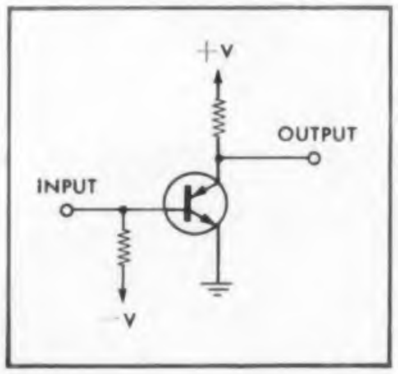
Range is 8.5 to 9.6 kmc

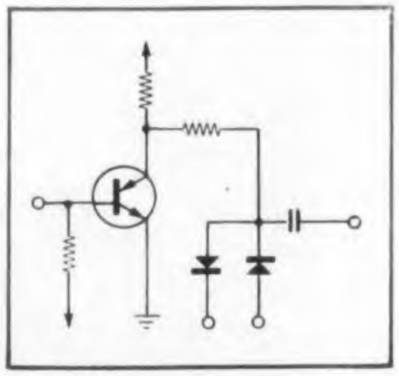
Type V-8302 hybrid microwave mixer, designed for the range of 8.5 to 9.6 kmc, is for general X-band receiver use and is suitable for missile and airborne applications. The noise figure at 9.2 kmc is 9 db typical, including 3 db if noise. The signal input vswr is less than 2 v. The if output impedance is about 200 ohms shunted by about 10 μμf. The unit measures 3/4 x 1-5/8 x 1-5/8 in.

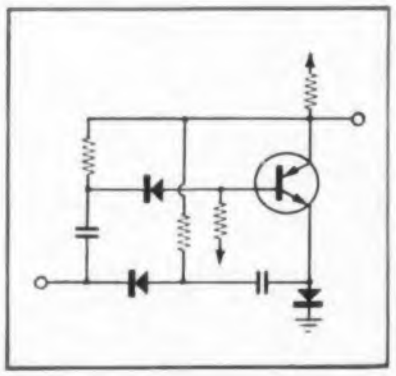
Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

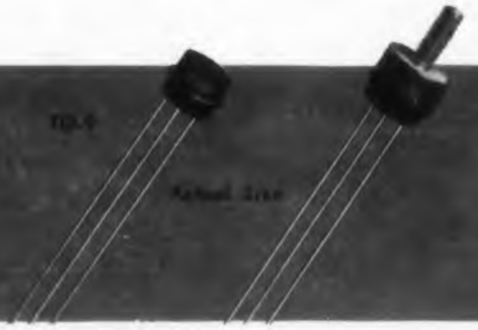
Availability: *Delivery time is 30 days.*

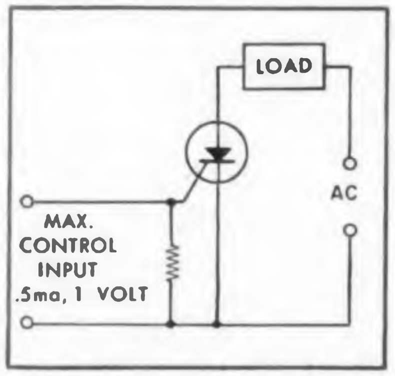
Booth 2714-2720.

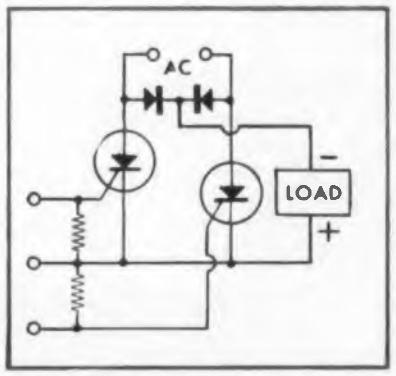


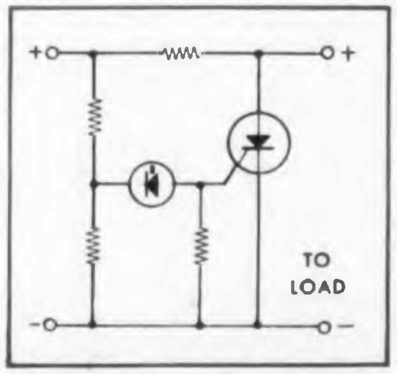






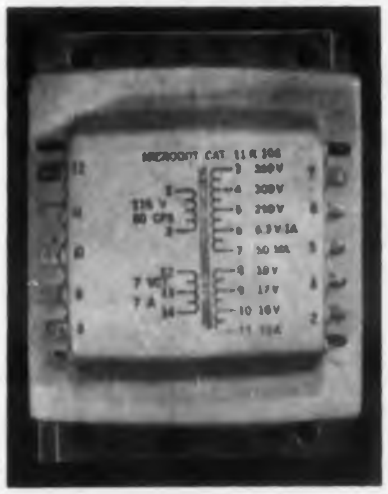






Specialty Transformers 461

Come in wide range of sizes



These specialty transformers range from miniature to standard sizes. The unit shown has a special encapsulation which provides uniform dimensional stability and permits other characteristics to exceed Mil specs.

Microdot Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

Booth 2101-2103.

Diversity Combiners 560

For rf receivers

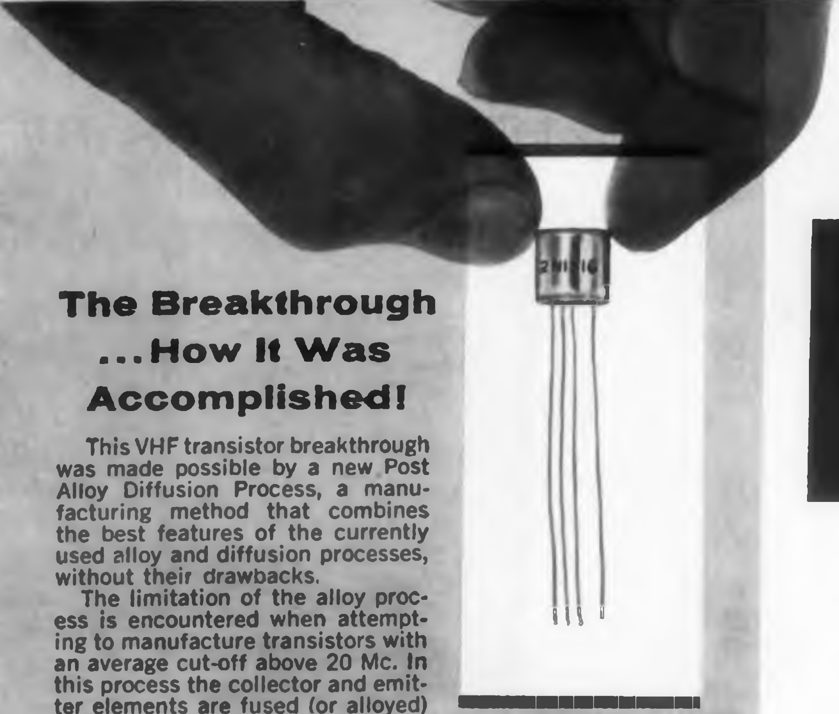
Types DCA-500 and DCA-1000 diversity combiners are designed for use with rf receivers. The DCA-500 handles the output of two receivers and the DCA-1000 handles the output of four receivers. These output signals are mixed into a single output in the combiner. Signal-to-noise ratio is kept low. Response time is 2 msec. Distortion is less than 1%. Required input is 120 v at 50 to 400 cps, 150 w. The unit weighs 45 lb and measures 19 x 7 x 15 in.

Nems-Clark Co., Dept. ED, 919 Jesup Blair Drive, Silver Springs, Md.

***Price & Availability:** DCA-500, $2700; DCA-1000, $3500. Delivery is from stock.*

Booth 3826-3828.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN



The Breakthrough ...How It Was Accomplished!

This VHF transistor breakthrough was made possible by a new Post Alloy Diffusion Process, a manufacturing method that combines the best features of the currently used alloy and diffusion processes, without their drawbacks.

The limitation of the alloy process is encountered when attempting to manufacture transistors with an average cut-off above 20 Mc. In this process the collector and emitter elements are fused (or alloyed) to the base. For this to be successfully accomplished the base must be relatively thick and the thickness very accurately controlled in order that during the fusion process the collector and emitter elements do not flow through the base and short the transistor. This relatively thick base increases the transit time, precluding any usable response above 20 Mc.

In the diffusion process the base is formed on the collector by gaseous diffusion in a high temperature oven. Very thin bases can be manufactured by this method with low transit time and very high cut-off frequencies. In this process the problem lies in attaching the emitter junction and base lead.

In the AMPEREX Post Alloy Diffusion Process, alloying and diffusion take place simultaneously. The transistor is built up on a piece of P-type germanium. Two small pellets are placed on the germanium. Pellet B, the base pellet, contains only an N-type impurity. Pellet E, the emitter pellet, contains a P-type and an N-type impurity.

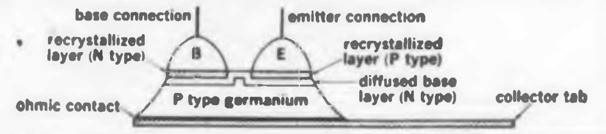
When this assembly is heated at a certain temperature, the germanium dissolves into the metal pellets until saturation is reached, and the pellet impurities diffuse into the solid germanium.

However, the P-type impurity in pellet E has such a low diffusion constant, that for practical purposes it does not penetrate into the germanium. The N-type impurity in pellets E and B has a much greater diffusion constant and readily penetrates into the solid germanium to form a diffused N-type layer underneath the pellets.

When the assembly is cooled down, a layer of germanium recrystallizes from the pellets as in the normal alloy technique. The recrystallized layer of pellet E contains many atoms of the P-type impurity and is, therefore, a P-type germanium layer. The germanium layer recrystallized from pellet B is, of course, the N-type because there are no other impurities in the pellet.

Connections are made to the germanium and the metal pellets and a "mesa-like" P-N-P transistor is obtained. The original P-type germanium is the collector, pellet B the base, and pellet E the emitter.

This process makes it possible to mass produce transistors with a base layer of a few ten-thousandths of an inch for very short transit time and high cut-off frequencies. The yield is also very high which enables AMPEREX to supply these transistors at low prices.



MAXIMUM RATINGS	2N1515	2N1516	2N1517
$-V_{CB}$	20 V	20 V	20 V
$-I_C$	10 mA	10 mA	10 mA
P_C at $T_{amb} \leq 25°C$	83 mW	83 mW	83 mW
TYPICAL CHARACTERISTICS			
Gain-Bandwidth Product (f_t, $I_E = 1$ mA)	70 Mc	70 Mc	70 Mc
Gain-Bandwidth Product (f_t, $I_E = 4$ mA)	—	180 Mc	180 Mc
Power Gain			
G at 0.45 Mc ($I_E = 1$ mA)	35 db	35 db	—
G at 10.7 Mc ($I_E = 1$ mA)	22 db	24 db	—
G at 100 Mc ($I_E = 1$ mA)	—	—	12 db
Conversion Gain G_C at 26 Mc	—	18 db	—
Noise Figure NF at 0.45 Mc	3 db	3 db	—
NF at 10.7 Mc	5 db	4 db	—
NF at 100 Mc	—	—	9 db

If You Will Remember
ONE New Name—

P·A·D·T*

You Can Forget
FIVE Old Transistor Problems

Amperex®

High Gain VHF Transistors

manufactured by the

Post Alloy Diffusion Technique

are unrivalled for:

1. **RELIABILITY**
2. **OPERATING STABILITY**
3. **UNIFORMITY**
4. **PRICE**
5. **AVAILABILITY**

At last, you can realistically use high frequency transistors for RF and IF amplifiers in production FM receivers; as mixers, oscillators and RF and IF amplifiers in mobile radio equipment, car radios and short wave receivers; and as broadband amplifiers in instrumentation and industrial applications.

Implemented and fully proven by Amperex, a unique manufacturing technique originating with Philips of the Netherlands now enables Amperex to provide you with production VHF Post Alloy Diffused Transistors* of unparalleled laboratory quality at truly reasonable prices.

The new Amperex "Post-Alloy-Diffusion" P-N-P Transistors combine the best qualities of both the alloy and the diffusion approaches to transistor construction. As a result of the special "self-jigging" techniques, a maximum degree of uniformity is achieved. Thus the necessity for "selection" is completely eliminated.

The 2N1516 is designed for use as a mixer oscillator in short wave receivers, as an IF amplifier in FM receivers, and as a broadband linear amplifier for instrumentation and industrial applications. The 2N1516 features a high cut-off frequency of 70 Mc and a low collector-to-base capacitance of 1.8 $\mu\mu f$.

The 2N1515 is designed for high gain IF amplifier service in medium and short wave receivers.

The 2N1517 is designed for use as a local oscillator and preamplifier in FM receivers and has a power gain of 12 db at 100 Mc.

This is, of course, only the beginning of the Amperex **PADT** *story. Availability is further assured by a new Amperex* **PADT** *plant in Slatersville, Rhode Island. A range of new* **PADT** *transistors, now in the final stages of development will provide UHF performance at VHF prices and give every promise of providing increased reliability and uniformity.*

ask Amperex

the industry's reliable source of quality transistors and diodes for industrial and entertainment applications.

Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, Long Island, New York
In Canada: Rogers Electronic Tubes & Components, 116 Vanderhoof Avenue, Toronto 17, Ontario

---

NEW PRODUCTS
AT THE IRE SHOW

Oscilloscope 50

Generates from 5 to 50,000 sweeps per sec

Model S-16-B digital data display unit, which can also be used as a general purpose oscilloscope, generates horizontal sweeps at rates from 5 to 50,000 sweeps per sec. The unit provides 6 x 10 cm raster presentation on a 5-in. flat face cathode ray tube screen. Step voltages with amplitudes of 600 mv to 30 v and rise times up to 0.07 μsec produce the full scale vertical raster. Positive going pulses of 2 v or greater intensify the trace; negative going slopes of 2 v extinguish the trace. The unit measures 11.25 x 7 x 13.5 in. and weighs 19 lb.

Waterman Products Co., Inc., Dept. ED, 2445 Emerald St., Philadelphia 25, Pa.
Booth 3105-3106.

Diodes 645

Two types available

One type is a glass-package, 1/4-w, silicon Zener diode offered in sizes from 6.8 to 200 v and in tolerances of 20%, 10%, and 5%. Also offered is a 1/2-w, temperature-compensated, glass-package Zener reference diode. It provides a reference source of 9 v over the temperature range of −55 to +150 C with temperature coefficients of 0.01, 0.005, 0.002, 0.001, and 0.005% per deg C.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.
Booth 1114-1115.

◀ CIRCLE 151 ON READER-SERVICE CARD

Cutting Machine 653

For germanium and silicon

The Roton table drive is designed r cutting germanium, silicon, and her materials. By providing a rollg rather than a sliding fit between e screw and the nut, the machine s a drive that is virtually frictionss. The unit can be adapted for e with the firm's model WMA afering machine.

Micromesh Manufacturing Corp., ept. ED, 1020 Commerce Ave., nion, N.J.

ooth 4038.

roadband Amplifier 656

For TV systems

Model MLA-B vhf, broadband plifier offers sharp reception for ge or small TV systems. It has w-noise inputs, frame-grid, and axial fittings. It produces more an 40-db cascode amplification on l vhf channels.

Blonder - Tongue Laboratories, c., Dept. ED, 9 Alling St., Newark N.J.

ooth 3225.

ower Supplies 629

For traveling wave-tubes

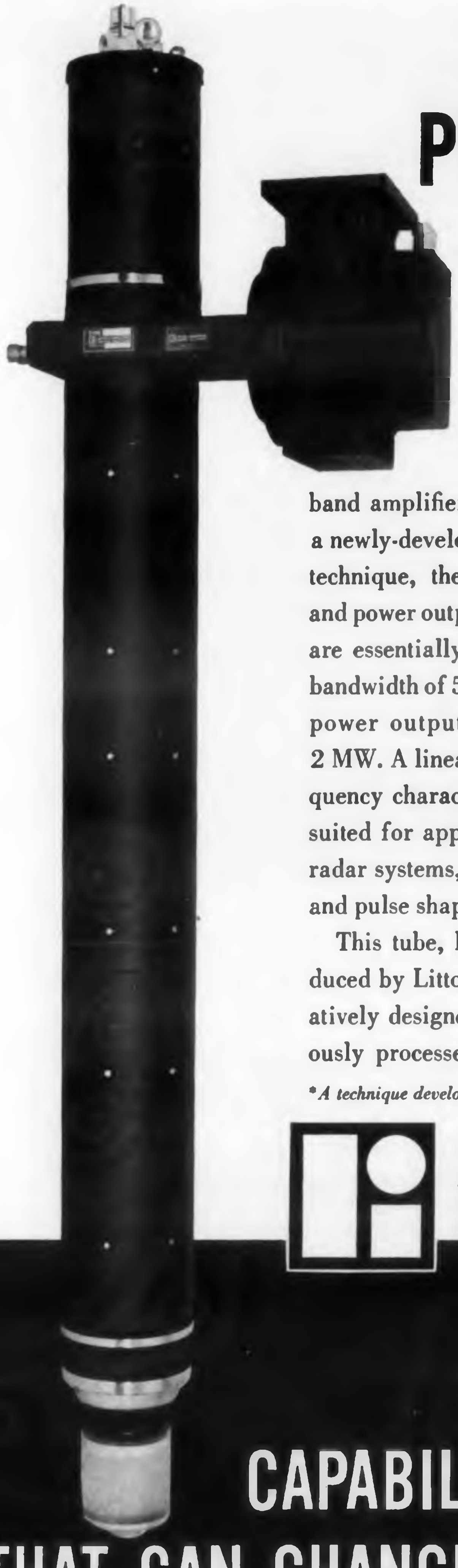
Models 252 and 253 power supes are designed to operate any v or medium-noise figure travelg wave tubes. The input ranges m 50 to 450 cps which permits eration at remote locations, with scellaneous power sources or in borne applications. Extra solenoid d heater power are provided. The ater supply is dc. Either am or ase modulation is available ough a BNC front panel connec-

Alfred Electronics, Dept. ED, Commercial St., Palo Alto, lif

ce & Availability: Model 253 is ce l at $1090; model 252, $890. it will be available the first week April.

ot 1633.

IR LE 152 ON READER-SERVICE CARD ➤



L-BAND KLYSTRON PROVIDES BROADBAND PERFORMANCE

This addition to Litton Industries' Klystron family introduces a new concept in broadband amplifier tubes. Through use of a newly-developed Skirtron* bunching technique, the L-3283 achieves gain and power output characteristics, which are essentially flat over the minimum bandwidth of 50 Mc. Its minimum peak power output at the band edges is 2 MW. A linear phase shift versus frequency characteristic makes it ideally suited for application in sophisticated radar systems, where electronic tuning and pulse shaping are required.

This tube, like all other tubes produced by Litton Industries, is conservatively designed and rated; and rigorously processed to provide thousands of hours of reliable operation. Typical of the performance obtained from applying this design philosophy is that of the L-3035, a 2.2 MW L-band Klystron, whose *average* operating life in field service is approaching 3,000 hours. Some of these tubes are continuing to provide top performance after operating for more than 10,000 hours.

The Skirtron technique is being applied to other tubes now being developed to obtain even broader-band performance at higher power levels and in other frequency ranges. Should you require high power broadband performance for your current (L-3283 is available now) or future system planning, write to Litton Industries, Electron Tube Division, Office E 33, 960 Industrial Road, San Carlos, California.

***A technique developed by Litton Industries which provides improved broadband performance.**

LITTON INDUSTRIES Electron Tube Division

BARRATRON TRANSMITTING TUBES • MAGNETRONS • KLYSTRONS • TRAVELING WAVE TUBES • BACKWARD WAVE OSCILLATORS • CARCINOTRONS • GAS DISCHARGE TUBES NOISE SOURCES • CROSSED-FIELD AMPLIFIERS • HIGH DEFINITION CRT • DIRECT-WRITING CRT • COLOR CRT • STORAGE TUBES • MICROWAVE FILTERS • DUPLEXERS • TR TUBES

CAPABILITY
THAT CAN CHANGE
YOUR PLANNING

pace setting NEW

SUPER-TANTUMCAP

TANTALUM
SOLID ELECTROLYTE
CAPACITOR

Micamold

EXCEEDS PROPOSED MIL SPECS IN THESE CRITICAL AREAS . . .

Super-Tantumcap for special applications—Standard Tantumcap for general use. *Both* meet all proposed MIL specs (the Super *exceeds* them), have the same long life, miniature size and "Built-in Reliability." For complete information write today for Bulletin No. 115W.

TYPICAL APPLICATIONS	CHARACTERISTICS	SUPER-TANTUMCAP	MIL-C-26655 (USAF) PROPOSED
Coupling, Energy storing, Pulse energy	Leakage current	.015 μa/V/μf	.05 μa/V/μf
Pulse networks, Bypassing, Filtering	Dissipation factor	.03	.06

BUILT-IN RELIABILITY Micamold's manufacturing concept wherein rigid controls during production insure the quality and stability proved by "after the fact" testing. Results are much more conclusive!

Micamold

MICAMOLD ELECTRONICS MANUFACTURING CORPORATION
SUBSIDIARY OF GENERAL INSTRUMENT CORPORATION
65 Gouverneur Street, Newark 4, N. J., HUmboldt 5-2100

GENERAL INSTRUMENT CORPORATION [illegible] AUTOMATIC MANUFACTURING DIVISION, SEMICONDUCTOR DIVISION, RADIO RECEPTOR COMPANY [illegible] TRANSDUCER CORPORATION, MICAMOLD ELECTRONICS MANUFACTURING CORPORATION AND GENERAL INSTRUMENT [illegible] OF CANADA LTD. (SUBSIDIARIES)

CIRCLE 153 ON READER-SERVICE CARD

Digital Display 660

Measures 1 x 1 in.

Type LD-11 incandescent digital readout displays zero through 9 on an area measuring 1 x 1 in. A lenticular optic technique is used, eliminating the need for projection lenses. Numerals are high density white on black or black on white. Long-life bulbs operate on 2.5, 6, 12, and 28 v. Of modular construction, the unit is designed for direct panel-mounting.

Burroughs Corp., Electron Tube Div., Dept. ED, P.O. Box 1226, Plainfield, N.J.

Price & Availability: *Complete with 2.5-v bulb, the unit is priced at $24 ea in quantities up to 99. It is immediately available from stock.*

Booth 1211-1213-1215.

Voltmeter 663

Measures from 1 mv to 10 v

Model 411A voltmeter measures from 1 mv to 10 v and has a sensitivity of 10 mv full scale. Frequency range is 5 kc to 1 kmc. Accuracy is ±3% full scale from 10 kc to 50 mc, ±6% from 50 mc to 150 kmc, and ±1 db from 5 kc to 1 kmc. The instrument has a large, linear meter scale.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palo Alto, Calif.

Booth 3302-3304-3306, 3401-3403-3405.

Don't miss an issue of ELECTRONIC DESIGN; return your renewal card today.

announcing the availability on the American market of

HIRSCHMANN

plugs • sockets

terminals


multiple connectors


small, multi-pole connectors


small shielded, multi-pole connectors


pick-up plugs and sockets


pick-up sockets


phono plugs and sockets


banana plugs


miniature plugs, couplers and sockets


terminals


sockets


terminal strips

HIRSCHMANN precision made components, a standard of excellence in Europe for more than 30 years, are now available to meet your design, production and replacement needs from the Rye Sound Corp., its 20 sales offices and its national distributor organization. Hirschmann products are standard equipment on such well-known European brands as Norelco, Grundig, Nordmende, Blaupunkt, Lowe, Telefunken, Siemens, Braun, Uher and many others.

Hirschmann plugs, sockets and terminals offer two distinct advantages—American designed equipment for American consumption can use these products, and American designed equipment for European consumption can also use these products because they are designed to satisfy both American and European standards.

The Hirschmann line consists of miniature type plugs, connectors, and couplings for transistor and other small size applications, as well as standard sizes. The line includes multiple connectors from 2 to 36 poles, round types, flat types, wire mounts, panel mounts, wall mounts, etc. Depending upon the type of plug, they generally feature strain relief, axial and transverse wire connection, flexible sleeves, cord grips, unbreakable construction and shockproofing.

Included also are spring-loaded and insulated test prods, plus flexible and rigid types, alligator clips, banana plugs, continental type electrical plugs, universal multi-function panel terminals, spade terminals. A complete 52-page catalog with detailed specifications dimensions and applications is available by writing to S. M. Scher

Exclusive U. S. sales agent

RYE SOUND CORP., 145 Elm Street, Mamaroneck, N. Y.
West Coast warehouse: 1113 El Centro, Hollywood 38, Calif.

***Other precision Rye Sound products include:* earphones, headsets, miniature microphones, sub-miniature components**

CIRCLE 156 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Display Scanner 632

Model 166C, used with type 160B oscilloscope, provides outputs to duplicate crt traces with an X-Y recorder. It provides uniform, detailed plots over the entire waveform.

Hewlett-Packard Co., Dept. ED, 275 page Mill Road, Palo Alto, Calif.

Booth 3302-3304-3306, 3401-3403-3405.

Wirewound Resistors 491

Bobbin types WW and HW have resistances of 0.1 ohms to 6 meg. Made to surpass MIL-R-93B, the units have tolerances of 0.02% to 1%.

Dale Products, Inc., Dept. ED, Columbus, Nebr.

Booth 2627-2629.

IF and RF Amplifiers 490

These units cover a band from 40 to 80 mc, have a 30-db gain, and a matched input with a vswr of less than 1.5 v. Power supplies are included.

LEL, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

Price & Availability: Price is $1795 ea. Delivery time is 30 days.

Booth 2102.

Waveguide Switches 681

This complete line of manual and electrically-operated four-post rotary switches includes a variety of waveguide sizes.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Booth 3713-3717.

AC Voltage Standard 422

Output is from mv to 1000 v over the range of 50 to 4000 cps. Accuracy is better than 0.1% and harmonic distortion is less than 0.07%.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

Price & Availability: The product will be available by October, 1960. Price has not been determined.

Booth 3701-3703.

Lumped Constant Delay Networks 423

Offering a wide range of specifications, these precision units, which were formerly custom designed only, are now standard cataloged items.

Polyphase Instrument Co., Dept. ED, E. Fourth St., Bridgeport, Pa.

Booth 2839.

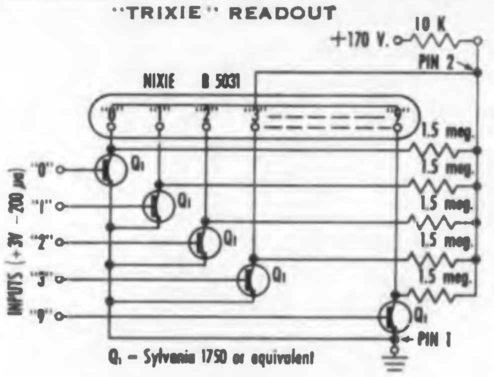
Fastening Devices 540

These miniature locknuts, clinch nuts, and lock collars are for shafts as small as 1/16-in. in diam.

Standard Pressed Steel Co., Dept. ED, Jenkintown, Pa.

Booth 4127.

"TRIXIE" READOUT



Q₁ – Sylvania 1750 or equivalent

A REVOLUTIONARY CIRCUIT DESIGN MAKES THE NIXIE® INDICATOR TUBES DIRECTLY COMPATIBLE WITH TRANSISTOR CIRCUITS

New "junction protection" technique permits the use of medium voltage NPN transistors to operate the **Nixie** indicator tubes.

The result is the lowest power, all-electronic visual readout.

"Trixie" readouts are immediately available from stock.

For complete information write today for Technical Bulletin #TR 56.

ELECTRONIC CONTRIBUTIONS BY

Burroughs Corporation

ELECTRONIC TUBE DIVISION
Plainfield, New Jersey

*Trademark of Burroughs Corporation

See us at IRE — Booths #1211-1213-1215

CIRCLE 157 ON READER-SERVICE CARD

Band-Pass Filter 512

Tuning range is 145 to 175 mc

Model L-150-1S7 band-pass filter has a tunable range of 150 to 175 mc. The unit is temperature-compensated by means of an invar drive. The unloaded Q-factor is 7200, impedance is 52 ohms, and the insertion loss may be varied in steps from 0.5 to 3 db. The temperature range is 10 to 150 F. The unit measures 37 x 8 x 8 in. and weighs 8.5 lb. It is manufactured in Canada.

Sinclair Radio Laboratories, Inc., Dept. ED, 412 Chamber of Commerce Bldg., Buffalo, N.Y.

***Price & Availability:** Price is $230; Delivery is in two weeks or less.*

Booth 1630.

1-Mc Limit Bridge 521

For Go/No-Go Testing

Designed for testing capacitors on a Go/No-Go basis, model AB-5-1 limit bridge has a range of 0 to 1000 μμf in two ranges. Accuracy up to 50 μμf is ±0.2 μμf; accuracy between 50 and 1000 μμf is ±1%. Speed of response is less than 0.1 sec. This unit meets government and commercial specifications. It is housed in an enclosure measuring 23.5 x 13.5 x 19 in. and can be supplied for rack mounting.

Industrial Instruments Automation Corp., Dept. ED, 89 Commerce Road, Cedar Grove, Essex County, N.J.

Booth 3513.

CIRCLE 158 ON READER-SERVICE CARD ➤

make your connections with

DAGE

Booth No. 2433
IRE Show

complete line of triaxial connectors for

- isolated ground systems
- high impedance probe assemblies
- two separate grounds
- remote switch-to-ground situations
- two signals in same cable

DAGE delivers...

The emphasis DAGE places on engineering services is unique even in the electronics field.

DAGE engineers and representatives are specialists in engineering to specifications. "On call" at all times, they will work with you at your plant or in the field to help solve problems involving connector design and application.

DAGE offers facilities for the design, production and testing of coaxial and triaxial connectors and precision hermetic seals. The new DAGE Facilities Brochure gives full details . . .

DAGE *write or phone* ELECTRIC CO., INC.
Beech Grove, Indiana

CIRCLE 159 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Video Signal Generator 664

Range is 20 kc to 20 mc

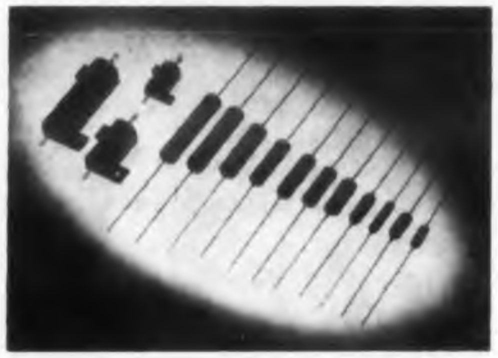
Model V-333A video signal generator provides point-to-point test signals continuously from 20 kc to 20 mc. A rotary switch selects one of these three bands: 20 to 200 kc, 0.2 to 2 mc, and 2 to 20 mc. Response is flat for the full-range and is continuously monitored. Accuracy of the lower bands is ±3% or less; accuracy from 2 to 20 mc is ±40 kc or ±1%. This generator system includes a radar trigger pulse adapter.

Foto-Video Laboratories, Inc., Dept. ED, 36 Commerce Road, Cedar Grove, N.J.

Booth 3013.

Wirewound Resistors 514

Have ratings of 2 to 50 w



Types NS and MS wirewound resistors are available as silicone-coated units with ratings of 2, 3, 5, 7, and 10 w and as metal clad units with ratings of 10, 25, and 50 w. They are non-inductively wound, miniature units. A heat and moisture-resistant coating is used.

Sage Electronics Corp., Dept. ED, Box 3926, Brighton Sta., Rochester 10, N.Y.

Availability: Units are made to customer specifications and can be delivered in 14 to 28 days after ordering.

Booth 2236.

Have you sent us your subscription renewal form?

Amazing, New, High Inductance

WEE-DUCTOR

The R.F. Choke that's so small you can pack 200,000 to a cubic foot

Tiny, new, WEE-DUCTOR covers a full range of inductances from 0.10 μH to 56,000 μH yet it measures only 0.157" x 0.375".
Unique ferrite sleeve and core construction provides 560,000 to 1 inductance range in a tiny package . . . and yet when assembled side-by-side, exhibit less than 2% coupling.
Essex WEE-DUCTORS are available immediately from stock. WEE-DUCTORS are the latest addition to Essex's broad line of Standard R.F. Choke Coils.

Essex Electronics Standard Line of R.F. Chokes

ESSEX PART NO.	WEE-DUCTOR	RFC—S	RFC—M	RFC—L
L μH	.1-56,000	.1-100	1.0-1,000	1.0-10,000
Max. Res. Ω	.035-499	.02-6.0	.04-21	.03-80
I Max. mA	3000-26	4000-220	2700-125	4000-80
Dia.	.157	.188	.250	.310
Length	.375	.440	.600	.900

WRITE TODAY
Free Descriptive Literature
Available

ESSEX ELECTRONICS
DIVISION OF
NYTRONICS, INC.
550 Springfield Ave., Berkeley Heights, N. J.
CRestview 3-9300

CIRCLE 160 ON READER-SERVICE CARD

Directional Table 539

Model 90A is a voltage-to-angular position platform for subjecting directional gyros to angular positions about a vertical axis. Operation of the table displaces it 180 deg in either direction.

Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., Culver City, Calif.

***Price & Availability:** Price is $2800; delivery time is 30 days.*

Booth 3846.

Line-Type Modulators 682

Standardization of basic circuitry permits adaptation to precise requirements. Ample protection of equipment is incorporated; operator safety is provided for. Protective oscillator tube circuitry can be included.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Booth 3713-3717.

Noise Figure Meter 636

Model 344A makes automatic measurements on operating radar sets. The unit's high senstivity permits decoupling the noise source up to 20 db from the main transmitter line to minimize system degradation.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palo Alto, Calif.

Booth 3302-3304-3306, 3401-3403-3405.

Socket Screw 541

Type pHd socket screw provides good holding power by using a strong head which does not cause indentation in soft materials. Improvement over previous models in fatigue life is by means of a new thread form.

Standard Pressed Steel Co., Dept. ED, Jenkintown, Pa.

Booth 4127.

Teflon Coaxial Cables 542

Made to meet MIL-C-17, these miniature cables are designated types RG-187/U, RG-188/U, RG-195/U, and RG-196/U.

Inso Electronic Products, Inc., Wire and Cable Div., Dept. ED, Union, N.J.

Booth 4054.

Miniature Soldering Irons 543

Model 115-10W heats to 672 F in 70 sec and model 115-15W heats to 717 F in 50 sec. Both use 3/32 and 5/32-in. tips and are made for immediate plug-in.

Oryx Co., Dept. ED, 13804 Ventura Blvd., Sherman Oaks, Calif.

***Price & Availability:** Price is $6.95. They are available through distributors.*

Booth 4111.

NEW PRODUCTS

Relay 463

General purpose type

Originally designed for antenna switching in the 200 mc range, this unit can be used as a general purpose relay. It comes with silver contacts rated at 5 amp, or palladium contacts rated at 3 amp. Contact arrangements are: single-pole, normally opened, normally closed, or double-throw; and double pole, normally closed. Operating temperature range is from —30 to +100 C. Relay contacts are designed not to open under vibration of 0.015 in. total excursion.

F. A. Scherma Manufacturing Co., Inc., Dept. ED, 424 Broome St., New York 13, N.Y.

Price & Availability: Available from stock. Prices range from $1.45 to $2.85.

PAM-PDM Multicoders 414

For airborne and missile use

For airborne and missile use, the SL series of solid state low level multicoders provides up to 88 channels. Available are both single and multiple speed models capable of providing standard IRIG signals PAM, PDM, and record in 30 to 90 channel formats. Speeds are 112.5 to 900 samples per sec. Separate outputs are provided. Accuracy is 0.5% for signals of 10-mv amplitude, full scale. The 88-channel model shown measures 4 x 4 x 7 in. and weighs about 6 lb. It requires less than 5 w from a 28-v dc source. No vacuum tubes or germanium devices are used.

General Devices, Inc., Dept. ED, Box 253, Princeton, N.J.

CIRCLE 163 ON READER-SERVICE CARD ➤

Converter Amplifier 433

For use with ac electro-mechanical transducers

Model PE-2 converter amplifier provides a carrier voltage and converts the ac output of a transducer into a proportional dc signal for the readout of physical data on indicators, recorders, or servo control devices. The unit is for laboratories, missile ground support, and general industrial uses. Output impedance is 1000 ohms, output voltage is ±10 v dc max, and system gain is 100 nominal. The full-scale meter sensitivity range is ±10 to ±0.05 v. The unit consists of a regulated power supply, oscillator, amplifier, gain control, demodulator, and output meter. It is fully transistorized and operates on 115 v ac 60 cps.

Pacific Electro-Kinetics, Dept. ED, 329 S. Vermont Ave., Glendora, Calif.

Price & Availability: *Price is $620 per unit. Delivery is from stock to 30 days.*

Waveguide Adapter 464

Covers the 8000 to 10,000 mc range

Model 105 waveguide adapter covers the 8000 to 10,000 mc range; it bends 30 deg and twists 45 deg. It compresses 1/8 in. and expands 1/8 in. for each 3 in. of length, and is available in lengths of 3-1/2, 8, and 12 in. For all units, the maximum vswr is 1.08 to 1 or better throughout the band. The 8 and 12 in. units will permit increased twist and bend while maintaining the same electrical characteristics.

Douglas Microwave Co., Inc., Dept. ED, 252 E. Third St., Mount Vernon, N.Y.

Price & Availability: *Available from stock. Prices start at $85, depending on size.*

CIRCLE 163 ON READER-SERVICE CARD

TYPE		SIZE	RESISTANCE (ohms)	WATTAGE	TC
NF **Fusion sealed.** Glass encapsulation is fusion sealed to leads and has zero moisture absorption. Exceeds requirements of MIL-R-10509C, Char. B.		NF60 NF65	100 to 100 K 100 to 360 K	⅛ @ 70°C. ¼ @ 70°C.	±.03%/°C. from −55°C. to +150°C., ref. to 25°C.
N **Fixed film.** Extremely low noise level. 0.1 microvolt/volt. Derating to 140°C. Average resistance change after 5000 hrs. is less than 1%. Exceeds MIL-R-10509B, Char. X specs.		N20 N25 N30	10 to 500 K 10 to 1.5 meg. 30 to 4.2 meg.	½ @ 40°C. 1 @ 40°C. 2 @ 40°C.	±.03%/°C. from −55°C. to +105°C., ref. to 25°C.
S **Fixed film: high temperature.** Less than 0.35% resistance change after 1000 hrs. of load-life tests at max. dissipation. Exceeds MIL-R-11804C, Char. P.		S20 S25 S30	10 to 500 K 10 to 1.5 meg. 30 to 4.2 meg.	**120°C. 40°C.** ½ 1 1 2 2 4	±.03%/°C. from −55°C. to +235°C., ref. to 25°C.
R **Power.** Essentially non-inductive in high-frequency operations. Inherent noise level less than 0.1 microvolt per volt. Exceptional moisture resistance and overload capacity. Exceeds MIL-R-11804C.		R31 R33 R35 R37 R39	10 to 70 K 30 to 150 K 20 to 300 K 20 to 500 K 40 to 1 meg.	7 @ 40°C. 13 @ 40°C. 25 @ 40°C. 55 @ 40°C. 115 @ 40°C.	±.03%/°C. from −55°C. to +235°C., ref. to 25°C.

When ounces and inches are important, specify high-reliability Corning MIL resistors

Fuse a tin oxide coating to a piece of special glass. Spiral a helix in it. Attach leads. You have a unique resistor.

Why unique? Because the coating is an integral part of the glass base. It cannot come off or change its position unless the unit itself is destroyed.

Because our tin oxide film cannot suffer change through oxidation, its physical and electrical characteristics remain constant in use.

The end result is a simple, rugged, extremely reliable line of resistors with exceptional low-noise and stable-temperature characteristics.

If you need resistors high in reliability, small in size, and light in weight, you should know more about this Corning design. The coupon will bring you complete technical data.

Address: Corning Glass Works, 540 High St., Bradford, Pa. For orders of 1000 or less, contact your distributor serviced by Erie Distributor Division.

CORNING ELECTRONIC COMPONENTS
CORNING GLASS WORKS, BRADFORD, PA.

Please send data sheets on ☐ NF ☐ N ☐ S ☐ R
Name ……
Company ……
Address ……
City …… Zone …… State ……

CIRCLE 164 ON READER-SERVICE CARD

One of the fastest computing systems ever developed, the UNIVAC Solid-State Computer performs at internal speeds commonly associated with large-scale equipment. Its remarkable speed and storage capacity enable the UNIVAC Solid-State Computer to eliminate much pre-sorting and pre-collating...and combine calculating, reproducing, gang-punching, data-collation, and tabulating in a single run. Each UNIVAC SSC contains over 1,400 printed circuits plated with AUTRONEX ACID GOLD.

REMINGTON RAND USES AUTRONEX* ACID GOLD PROCESS TO PLATE UNIVAC PRINTED CIRCUITS

Remington Rand, Division of Sperry Rand Corporation, Utica, New York, uses the AUTRONEX ACID GOLD PROCESS to plate printed circuit boards for their world-famous UNIVAC Solid-State Computer Systems and Equipment. Installation of the patented AUTRONEX ACID GOLD PLATING PROCESS for this work, "... totally eliminated resist failures and rejects in the electroplating phase," according to a report from Remington Rand's Supervisor of Chemical Engineering.

This report goes on to say that "AUTRONEX ACID GOLD in printed circuit production offers definite advantages and promotes the highest quality production." Here are some of these advantages proved in Remington Rand's own laboratories:

1. Harder and more wear-resistant surfaces.
2. Elimination of one step in plating cycle — no cyanide gold strike required.
3. Promotes higher bond strength of circuit to dielectric base material by minimizing danger of damaging the adhesive layer.
4. Solder flow through plated holes is definitely better, thereby improving over-all quality.
5. AUTRONEX ACID GOLD has totally eliminated circuit lifting and rejects on boards plated after etching. Formulations used previously attacked the adhesive and undermined the circuit paths.

The conclusion of the report we have been quoting needs no further comment: "We would like to commend the manner in which your company has serviced us in regards to materials, equipment and valuable advice. In many instances your promptness in making equipment and materials delivery has been instrumental in meeting vital production target dates."

The patented AUTRONEX ACID GOLD PLATING PROCESS has production-proved its unique advantages for over two years in the plants of leading manufacturers the world over. AUTRONEX can help *you* make a better, more reliable product—probably at far less cost than with any gold plating formulation you may be presently using. Evaluate AUTRONEX ACID GOLD ELECTROPLATE in your own plant, *on your own product*. We'd be happy to plate sample parts for you at no obligation. Write...wire...or 'phone. We'll make all the arrangements.

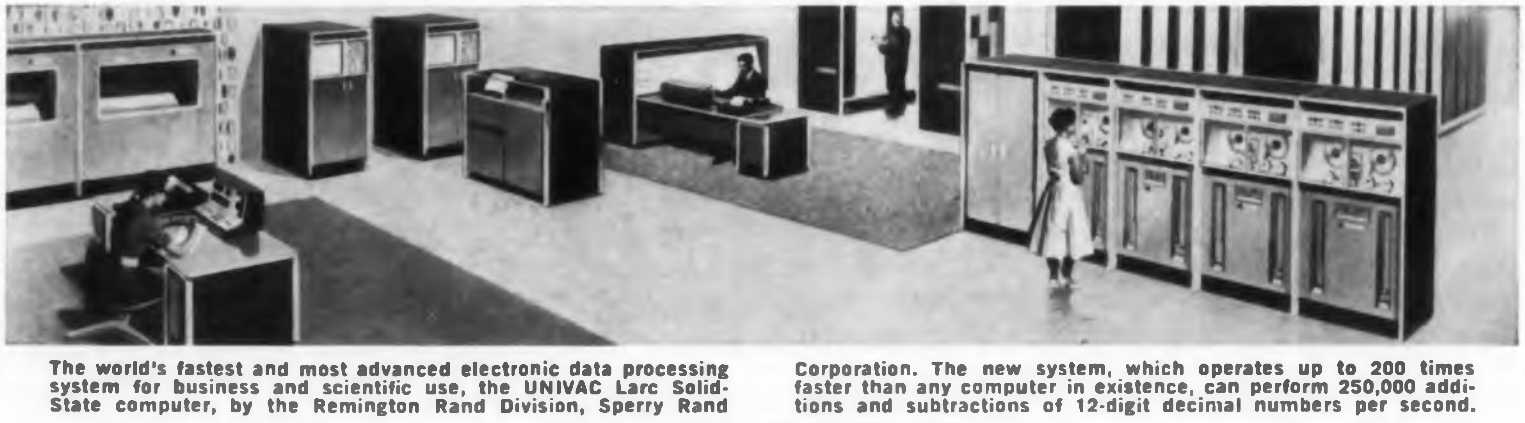
*Trademark for Sel-Rex patented Acid Gold Plating Process

Sel-Rex®

PRECIOUS METALS DIVISION

SEL-REX CORPORATION

NUTLEY 10, NEW JERSEY



The world's fastest and most advanced electronic data processing system for business and scientific use, the UNIVAC Larc Solid-State computer, by the Remington Rand Division, Sperry Rand Corporation. The new system, which operates up to 200 times faster than any computer in existence, can perform 250,000 additions and subtractions of 12-digit decimal numbers per second.

CIRCLE 165 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

AC Voltage Dividers 5 6

Accuracies are 1 to 10 ppm

Series RB-500 ac voltage dividers have accuracies of 1 to 10 ppm, depending on the model. They are available in a wide range of types for laboratory, production, and field service applications. Portable, bench, and rack models can be supplied in general purpose, deviation, sine-cosine, binary, and automatic-stepping types. All models have an adjustable ratio transformer. They have in-line readout and provide a range of ratios of +1.111111:1 to −0.111111:1.

North Atlantic Industries, Inc., Instrumentation Div., Dept. ED, Terminal Drive, Plainview, L.I., N.Y.

Booth 3012.

Power Supply 513

Occupies 16 sq. in. bench space

Model 101 power supply, designed for low power transistor applications, occupies 16 sq in. bench space. The supply voltage range is 4 to v dc, the trip current range is 12 to 500 ma, an the turn-off time is 250 μsec. A 1.5-v battery used.

Sinclair Radio Laboratories, Inc., Dept. ED 412 Chamber of Commerce Bldg., Buffalo, N.Y. ***Price & Availability:*** *Price is $35 fob Buffal Delivery is in two weeks or less.*

Booth 1630.

Don't forget to mail your renewal for

to continue receiving

ELECTRONIC DESIGN

CIRCLE 166 ON READER SERVICE CARD

Crystal Can Relay 458

Sensitivity is 250 mw

Type MV 7033 crystal can relay has a sensitivity of 250 mw. Designed to meet MS 24250-6, it operates over the temperature range of −65 to +125 C, under vibration of 20 g to 2000 cps, and under shock to 50 g. The nominal operating voltage is 26.5 v dc and the coil resistance is 600 ohms. Contact arrangement is dpdt with a rating of 2 amp at 115 v ac. It is hermetically sealed and is constructed with side-angle brackets and solder-hook terminals.

Elgin National Watch Co., Dept. ED, 2435 N. Naomi St., Burbank, Calif.

Price & Availability: *Units are available from stock at a price that is normal for crystal can relays.*

Booth 2232.

Digital Frequency Meter 459

Measures 10 cps to 110 mc

Model 7175 digital frequency meter measures from 10 cps to 110 mc with an accuracy of 0.00003% ±0.1 cps. The instrument has a sensitivity of 100 mv rms. The input impedance is 1 meg up to 10 mc and 100 ohms above 10 mc. The meter consists of a counter closely integrated with a heterodyne frequency converter. The reading appears in the form of a counter display of 0,000,000 to 9,999,999; the operator adds a reference indication of 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, or 100 mc.

Beckman Instruments, Inc., Berkeley Div., Dept. ED, 2200 Wright Ave., Richmond, Calif.

Price & Availability: *Available for 30 day delivery, the unit is priced at $1895.*

Booth 3416-3418.

◀ CIRCLE 166 ON READER-SERVICE CARD

Now

AMERICA'S LARGEST MANUFACTURER OF COMMERCIAL VIDEO TRANSFORMERS

In just two years the Electronic Components Division of ESC has become the nation's leading supplier of quality custom-built and stock Video Transformers.

ESC Video Transformers are designed and manufactured to meet the requirements of simultaneous transmission of both low and high frequencies commonly encountered in television, computers, scatter transmission, atomic instrumentations, etc.

Additional applications include interstage coupling, phase inversion, isolation and pulse applications requiring extremely wide range in pulse width of good wave form.—Bandwidths from audio to above 10 mc.—available cased and uncased, in stock designs or to your rigid specifications.

Write today for complete technical data.

electronic components division

ESC CORPORATION

and still AMERICA'S LARGEST PRODUCER OF CUSTOM-BUILT AND STOCK DELAY LINES

ESC was the first company devoted exclusively to the design and manufacture of custom-built and stock Delay Lines... for military and industrial applications. Whatever the requirement, ESC can design and build precisely the Delay Line you need—easily, efficiently and exactly as specified. Write today for complete technical data.

See You At The IRE Show—Booth #2915

exceptional employment opportunities for engineers experienced in computer components... excellent profit-sharing plan.

ESC CORPORATION 534 Bergen Boulevard, Palisades Park, New Jersey

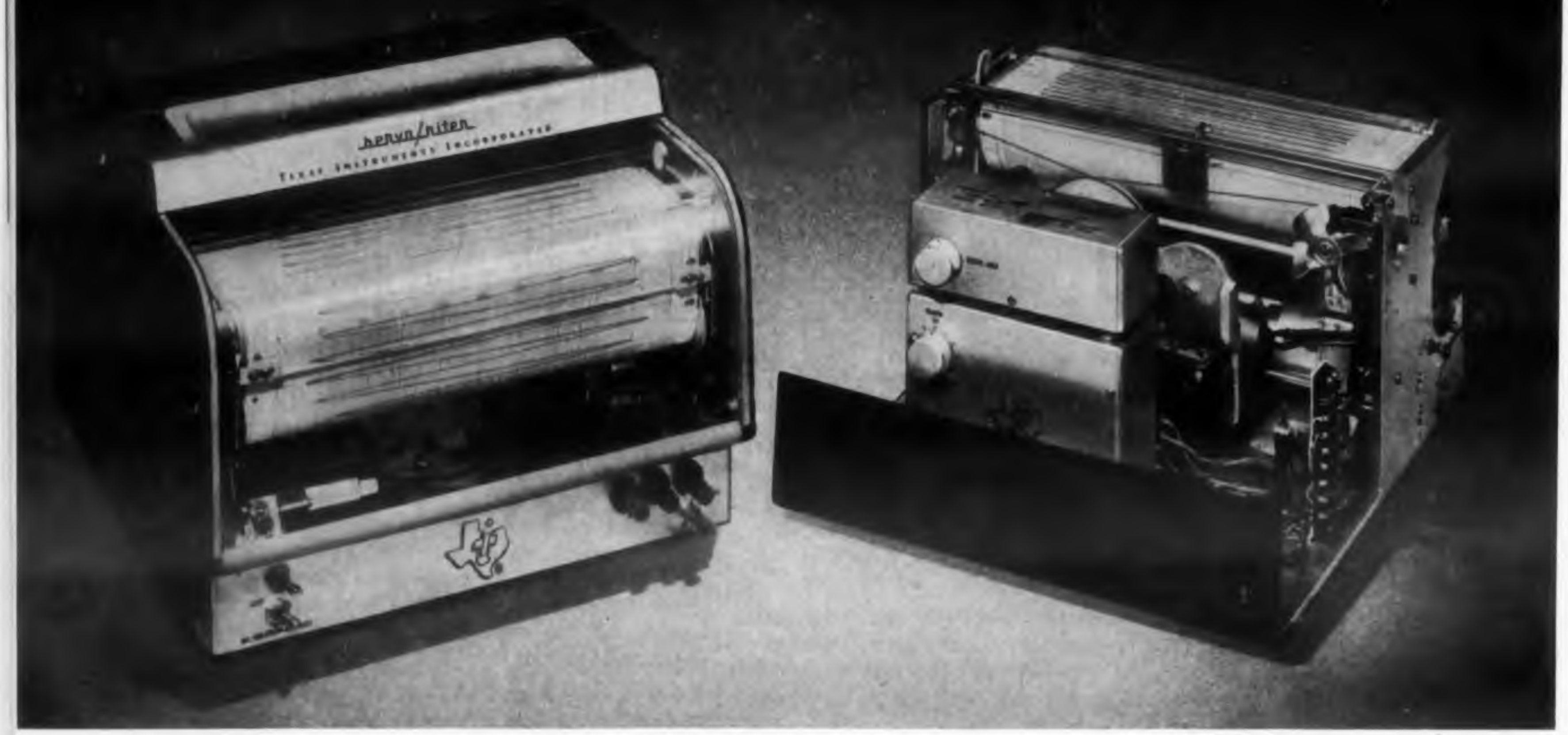
Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers • Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 167 ON READER-SERVICE CARD

NEWEST way to write performance . . .

servo/riter*

SELF-BALANCING POTENTIOMETRIC RECORDER



OFFERS YOU MORE HIGH PERFORMANCE FEATURES THAN ANY OTHER RECORDER . . . at any price!

The old cliché, "You can pay more but you can't buy better" was never more applicable than in the new "servo/riter" recorder. Texas Instruments has developed a self-balancing potentiometric recorder that incorporates *premium* engineering refinements, sensitivity, reliability and quality construction as *standard* equipment.

High-Sensitivity — Standard electrical span of 2.5 millivolt d-c with off-balance input resistance of 4 megohms gives a power sensitivity of better than 10^{-17} watts.

Fast Pen Speed — Span step response is less than 0.5 second.

High Interference Rejection — Good filtering provides high orders of rejection to common-mode d-c and all types of 60 cps interference. Guard shields permit making full-accuracy measurements at hundreds of volts above ground.

Long-Term Reliability — Tube life is prolonged by heat-dissipating shields. Amplifier gain is stabilized by partial negative feedback. Non-lash, non-wearing, toothed belt drive gives long consistent performance.

Superior Operating Conveniences — Recorder function is easily changed by plug-in input units. Presently standard are 2.5, 5, or 10 millivolt d-c electrical spans . . . special applications and ranges are easily accommodated. "Micrometer" control for zero adjustment and main amplifier gain control are readily accessible as are all other adjustments, connections, and controls. The popular 10-speed chart gears and the high-capacity, easy-prime ink handling system proved on the "recti/riter"® recorder are standard equipment on the "servo/riter" recorder.

There are four "servo/riter" recorder models to choose from . . . *Single Channel, Narrow Grid; Single Channel, Wide Grid; Dual Channel, Narrow Grids; and Dual Channel (overlapping pens), Wide Grid.* Write for technical literature and TI engineering assistance in your specific end or OEM use.

TEXAS INSTRUMENTS
INCORPORATED
GEOSCIENCES & INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS • CABLE: TEXINS

The new "servo/riter" recorder is a companion to the proved "recti/riter" recorder.

*"servo/riter" is a trademark of Texas Instruments

NEW PRODUCTS
AT THE IRE SHOW

Jacks 38

For communication equipment

The long-frame Twin-Jax are designed for communication equipment. Two styles are offered: MT-388, having a shorting feature that is broken when a two-conductor plug is inserted into either sleeve, and MT-389, with three interconnected conductor jacks. Type MT-388 is also known as military type JJ-088. Both models have double width frames with two mounting ears on 1-3/8-in. centers. Bushings are on 5/8-in. centers.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.
Booth 2827.

Power Resistor 475

Is rated at 5 w up to 100 C

Type RH-5 subminiature power resistor is rated at 5 w up to 100 C when mounted on a panel measuring 5 x 7 x 0.026 in. The unit has a free-air rating of 5 w at 25 C. Resistance range is 10 ohms to 20 K with tolerances of 0.05%, 0.1%, 0.25%, 0.5%, 1%, and 3%. The operating temperature range is from —55 to +275 C and the temperature coefficient is 0.00002 per deg C. The unit is sealed in silicone and enclosed in an aluminum radiator-finned housing for mounting to a chassis or heat sink. Welded construction is used from terminal to terminal. Impervious to salt spray and moisture, the unit meets MIL-R-18546B.

Dale Products, Inc., Dept. ED, Columbus, Nebr.
Booth 2627-2629.

◄ CIRCLE 168 ON READER-SERVICE CARD

Constant Voltage Relay 480

Operates from —65 to +85 C

The SV series constant-voltage relay, designed to operate over the temperature range of —65 to +85 C, maintains its pull-in voltage to within ±5% of nominal. Voltage range is 25 to 200 v dc. The contact rating is 4 amp at 115 v ac or 32 v dc. The unit stands vibration of 20 g to 2000 cps and shock of 50 g for 11 msec.

Hi-G, Inc., Dept. ED, Bradley Field, Windsor Locks, Conn.

Price & Availability: *The unit is made on order and can be delivered in 30 days.*

Booth 2227.

Trimmer Potentiometers 479

Rating is 1 w to 90 C

The 1200 series of trimmer potentiometers offers a rating of 1 w at up to 90 C. These 25-turn units have complete welded construction of all fixed connectors and are sealed for maximum protection against environmental conditions. Temperature range is —65 to +165 C, resistance range is 10 ohms to 50 K, and standard tolerance is 5%. Dimensions are 1.25 x 0.28 x 0.31 in. Three terminal configurations are offered.

Dale Products, Inc., Dept. ED, Columbus, Nebr.

Booth 2627-2629.

Sweep Generator 482

Is flat to ±0.05 db

Model 707-1 rf sweep generator provides an output flatness of ±0.05 db over the highest single octave, 50 to 100 mc. Variable sweep rates are from 60 per sec to one every two minutes. The unit is adaptable for use with an X-Y plotter.

Jerrold Electronics Corp., Industrial Electronics Corp., Dept. ED, 15th & Lehigh, Philadelphia 32, Pa.

Price & Availability: *Available from stock for 30-day delivery, the unit is priced at $795.*

Booth 3056.

CIRCLE 169 ON READER-SERVICE CARD ➤

A PARTIAL LISTING OF INDUSTRY'S WIDEST LINE!

GENERAL PURPOSE SILICON DIODES

Type Number	Peak Inverse Voltage, Volts	DC Output Current, Ma	Max. DC Reverse Current Ma
A — [illegible]			
1N1701	50	300	0.4
1N1702	100	300	0.4
1N1703	200	300	0.3
1N1704	300	300	0.3
1N1705	400	300	0.3
1N1706	500	300	0.3
[illegible]			
1N1707	50	500	0.4
1N1708	100	500	0.4
1N1709	200	500	0.3
1N1710	300	500	0.3
1N1711	400	500	0.3
1N1712	500	500	0.3
[illegible]			
SD-91	100	550	1.0
SD-92	200	550	1.0
SD-93	300	550	1.0
SD-94	400	550	0.80
SD-95	500	550	0.65
SD-91A	100	750	0.5
SD-92A	200	750	0.5
SD-93A	300	750	0.5
SD-94A	400	750	0.4
SD-95A	500	750	0.3
B — [illegible]			
1N536	50	250	0.4
1N537	100	250	0.4
1N539	300	250	0.3
1N1095	500	250	0.3
1N1096	600	250	0.3
B — [illegible]			
1N538	200	250	0.3
1N540	400	250	0.3
1N547	600	250	0.3
C — [illegible]			
1N253	95	1000	0.001
1N254	190	400	0.001
1N255	380	400	0.0015
C — [illegible]			
1N607	50	800	0.025
1N608	100	800	0.025
1N609	150	800	0.025
1N610	200	800	0.025
1N611	300	800	0.025
1N612	400	800	0.025
1N613	500	800	0.025
1N614	600	800	0.025
C — [illegible]			
1N607A	50	800	0.001
1N608A	100	800	0.001
1N609A	150	800	0.001
1N510A	200	800	0.001
1N611A	300	800	0.001
1N612A	400	800	0.0015
1N613A	500	800	0.002
1N614A	600	800	0.0025
D — [illegible]			
5E4 (Cap. Load)	400	350	0.5
(Res. Load)	400	500	0.5
2E4 (Cap. Load)	400	200	0.5
(Res. Load)	400	300	0.5

FOR DETAILED DATA, CIRCLE READER-SERVICE CARD NO. 811

INTERNATIONAL RECTIFIER

SPECIFY THE LEADING LINE . . .

Choose from the industry's widest line of axial lead and stud mounted silicon diodes. All units available "off-the-shelf" at your nearest Authorized Industrial Distributor or from Industrial Representatives throughout the world.

A WORLD OF DIFFERENCE THROUGH RESEARCH

SYMBOL OF QUALITY IN SEMICONDUCTORS

INTERNATIONAL RECTIFIER CORPORATION: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA

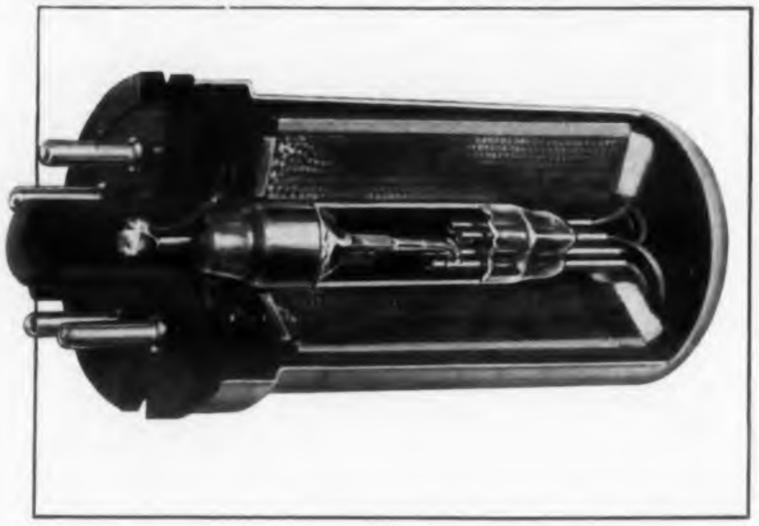
NEW YORK CITY: 1580 LEMOINE, FORT LEE, N. J., WINDSOR 7-3311 • SYRACUSE, NEW YORK: 2366 JAMES STREET, HEMPSTEAD 7-8495 • CHICAGO, ILLINOIS: 205 W. WACKER DRIVE, FRANKLIN 2-3888 • CAMBRIDGE, MASS., 17 DUNSTER ST., UNIVERSITY 4-6520 • ARDMORE, PENNSYLVANIA. SUBURBAN SQUARE BLDG., MIDWAY 9-1428 • BERKLEY, MICHIGAN: 1799 COOLIDGE HIGHWAY, LINCOLN 8-1144 • CANADA: 1581 BANK ST., OTTAWA, ONTARIO, REGENT 3-6880

BISHOP
Tubular Products NEWS

"METALS FOR PRECISION AND PERFORMANCE"

C. P. CLARE'S MERCURY-WETTED CONTACT RELAYS PERFECTLY SEALED WITH GLASS-TO-METAL SEALING ALLOY

C. P. Clare & Company, Chicago, Illinois, produces a complete line of mercury-wetted contact relays characterized by long life, high speed of operation and no contact bounce. To supply relays that have a conservative life expectancy of more than a *billion* operations requires absolute perfection in all phases of manufacturing. C. P. Clare uses BISHOP's #52 alloy tubing for the critical tubular stems of these relays. Mercury and hydrogen at 150 psig are introduced through this connecting stem—which is then sealed off by welding and forging. Can glass-to-metal sealing alloys solve any of your problems? BISHOP makes a complete line . . . use the coupon for details. (Circle 816 on inquiry card)



TUBING TAKES 5,400 PSI IN HONEYWELL'S MISSILE CHARGING SYSTEM

Super pressure stainless steel tubing connects many components of the cubicles illustrated. Minneapolis-Honeywell's Missile Equipment Division, Pottstown, Penna. builds these control cubicles that make up the gas charging system for the Bomarc missile. BISHOP supplies Honeywell with two sizes of 304 seamless super pressure tubing for this application. During charging of the missile, tubing handles pressures up to 5,400 psi. If you use small diameter tubing—super pressure, commercial quality or other—consider BISHOP. Use the coupon for a copy of BISHOP's Tubular Products Bulletin. (Circle 817 on inquiry card)

J. BISHOP & CO.
platinum works

FOR HELPFUL DATA USE THIS HANDY COUPON

☐ Glass-To-Metal Sealing Alloy Data
☐ Tubular Products Bulletin No. 12
☐ Special Tubing Data
☐ Platinum Products Catalog No. 4

Check information you'd like and mail to
J. BISHOP & CO.,
55 King St., Malvern, Penna.

Name
Position
Company
Address
City Zone State

Tubular Products Division
55 KING STREET, MALVERN, PENNA.
NIagara 4-3100

THIS IS THE BISHOP LINE:
Products of all the Platinum Metals... Small diameter Stainless Steel, nickel and special alloy tubing

CIRCLE 816, 817 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

L-Band Oscillator 456

Electronically tunable

Type Z-5405 L-Band oscillator is electronically tunable over the range of 1000 to 2300 mc with a minimum power output of 1 w. The average efficiency over this range is about 20% and power variation is less than 1.5:1. A microwave power source with a dc input-lead and an rf output-connector, the unit weighs 3 lb and does not require air or water cooling. Applications are in radar counter-measure, telemetry, fusing, and other communications systems.

General Electric Co., Dept. ED, Schenectady 5, N.Y.
Booth 2904-2932.

Ball-Bearing Potentiometer 508

Has 2-in. diam

Type BC-200 ball-bearing precision potentiometer is a single-turn unit measuring 2 in. in diameter. It has good linearity and low-starting and running torque. Ganging can be accomplished readily with a special drive pin and tension pickup combination. Precise 360-deg external phasing permits independent rotation of each ganged potentiometer for accurate individual or related adjustment. The unit has a one-piece molded housing and a phenolic envelope.

Dejur-Amsco Corp., Electronics Div., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.
Availability: Units can be delivered in 14 days.
Booth 2307-2309.

IMMEDIATE DELIVERY

OF

ELMENCO

capacitors

IN QUANTITIES UP TO

500 Per Item

CONTACT THESE AUTHORIZED
ELMENCO INDUSTRIAL DISTRIBUTORS

The authorized distributors listed below carry a full stock of all **Elmenco Capacitors** and can give you **Immediate Delivery** from stock.

ARIZONA: Radio Specialties & Appl. Corp., 917 N. 7th St., Phoenix; **Standard Radio Parts Inc.**, 218 N. First Ave., Tucson

CALIFORNIA: Brill Elect., 610 E. 10th St., Oakland; **Elect. Supply Corp.**, 2085 E. Foothill Blvd., Pasadena; **Federated Purchaser Inc.**, 11275 W. Olympic Blvd., L. A. 64; **Hollywood Radio Supply Inc.**, 5606 Hollywood Blvd., Hollywood 28; **Pacific Wholesale Co.**, 1850 Mission St., San Francisco 3; **Peninsula Elect.**, 656 S. 1st St., San Jose; **Shanks & Wright Inc.**, 2045 Kettner Blvd., San Diego; **Shelley Radio Co. Inc.**, 2008 Westwood Blvd., L. A. 25; **R. V. Weatherford Co.**, 6921 San Fernando Rd., Glendale 1; **Zack Electronics**, 654 High St., Palo Alto.

COLORADO: Denver Electronics Supply Co., 1254 Arapahoe St., Denver 4.

DISTRICT OF COLUMBIA: Capitol Radio Wholesalers Inc., 2120 14 St., N.W., Wash., D. C.

FLORIDA: Elect. Supply, 909 Morningside Dr., Melbourne; **Elect. Supply**, 61 N. E. 9th St., Miami.

ILLINOIS: Newark Electronics Corp., 223 W. Madison St., Chicago 6.

MARYLAND: Kann-Ellert Electronics Inc., Howard & Redwood Sts., Balt. 1; **Wholesale Radio Parts Co. Inc.**, 308 W. Redwood St., Baltimore 1.

MASSACHUSETTS: Cramer Electronics Inc., 811 Boylston St., Boston 16; **Radio Shack Corp.**, 730 Commonwealth Ave., Boston 17.

NEW JERSEY: Federated Purchaser Inc., 1021 U. S. Rte. 22, Mountainside; **Radio Elec. Service Co., Inc.**, 513 Cooper St., Camden 2.

NEW MEXICO: Midland Specialty Co., 1712 Lomas Bl. N.E., Albuquerque; **Radio Specialties Co., Inc.**, 209 Penn Ave., Alamagordo.

NEW YORK: Arrow Elect. Inc., 525 Jericho Turnpike, Mineola, L. I., **Elect. Center Inc.**, 211 W. 19th St., N.Y. 11; **Harvey Radio Co., Inc.**, 103 W. 43rd St., N.Y. 36; **Lafayette Radio**, 100 Sixth Ave., N.Y. 13; **Terminal Elect. Inc.**, 236 W. 17 St., N. Y. 17.

PENNSYLVANIA: Almo Radio Co., 412 N. 6th St., Phila. 23; **George D. Barbey Co. Inc.**, 622 Columbia Ave., Lancaster; **George D. Barbey Co. Inc.**, 2nd & Penn Sts., Reading; **D. & H. Distributing Co., Inc.**, 2535 N. 7th St., Harrisburg; **Phila. Elect. Inc.**, 1225 Vine St., Phila. 7; **Radio Elec. Service Co., Inc.**, 701 Arch St., Phila. 6; **A. Steinberg & Co.**, 2520 N. Broad St., Phila.; **Wholesale Radio Parts Co., Inc.**, 1650 Whiteford Rd., York.

TEXAS: All-State Dist. Co., 2411 Ross Ave., Dallas 1; **Busacker Elect. Equip. Co. Inc.**, 1216 W. Clay, Houston 19; **Engineering Supply Co.**, 6000 Denton Dr., Dallas 35; **Midland Specialty Co.**, 500 W. Paisano Dr., El Paso; **The Perry Shankle Co.**, 1801 S. Flores St., San Antonio.

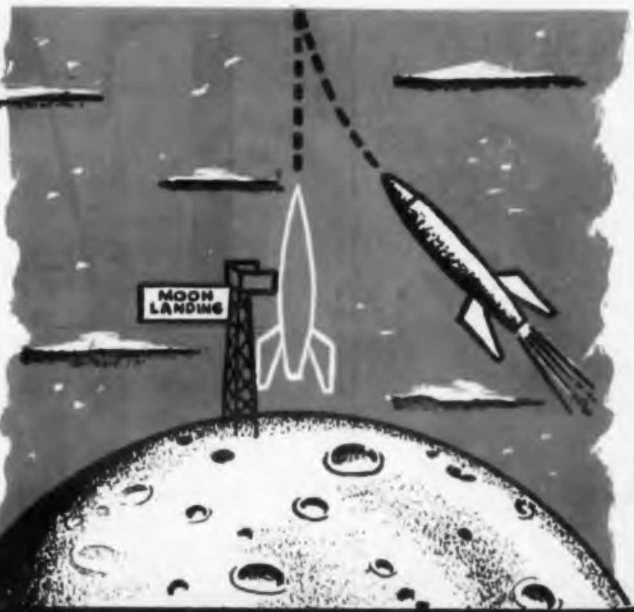
WASHINGTON: C & G Radio Supply Co., 2221 Third Ave., Seattle.

CANADA: Electro Sonic Supply Co., Ltd., 543 Yonge Street, Toronto 5, Ont.

ARCO ELECTRONICS, INC.
NEW YORK • DALLAS • LOS ANGELES
Exclusive Supplier of ELMENCO Capacitors to Distributors and Jobbers in U.S.A. and Canada

CIRCLE 171 ON READER-SERVICE CARD

It could happen... with El-Menco CAPACITORS!



NEW

*Mylar-Paper Dipped CAPACITORS

TYPE MPD

INSURE FAILURE-PROOF PERFORMANCE!

Only 1 Failure in 7,168,000 Unit-Hours for 0.1 MFD Capacitors

Setting a new standard of reliability!

*Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 100°C with rated voltage applied — have yielded a failure rate of only 1 per 716,800 unit-hours for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield ONLY 1 FAILURE IN 7,168,000 UNIT-HOURS.

SUPERIOR FEATURES!

- *Five case sizes in working voltages and ranges:*

200 WVDC —	.018 to .5 MFD
400 WVDC —	.0082 to .33 MFD
600 WVDC —	.0018 to .25 MFD
1000 WVDC —	.001 to .1 MMF
1600 WVDC —	.001 to .05 MFD

SPECIFICATIONS

- TOLERANCES: ±10% and ±20%. Closer tolerances available on request.
- INSULATION: Durez phenolic resin impregnated.
- LEADS: No. 20 B & S (.032") annealed copperweld crimped leads for printed circuit application.
- DIELECTRIC STRENGTH: 2 or 2½ times rated voltage, depending upon working voltage.
- INSULATION RESISTANCE AT 25°C: For .05MFD or less, 100,000 megohms minimum. Greater than .05 MFD, 5000 megohm-microfarads.
- INSULATION RESISTANCE AT 100°C: For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microfarads.
- POWER FACTOR AT 25°C: 1.0% maximum at 1 KC.

Write for Technical Brochure Giving Complete Information on the El-Menco Tubular Dur-Paper Line.

THESE CAPACITORS WILL EXCEED ALL THE ELECTRICAL REQUIREMENTS OF E.I.A. SPECIFICATION RS-164 AND MILITARY SPECIFICATIONS #MIL-C-91A AND MIL-C-25A.

FOR FAILURE-PROOF PERFORMANCE . . . COUNT ON EL-MENCO MYLAR-PAPER DIPPED CAPACITORS . . . FROM MISSILE GUIDANCE SYSTEMS TO DATA PROCESSING EQUIPMENT!

*Registered Trade Mark of DuPont Co.

El-Menco *Capacitors*

THE ELECTRO MOTIVE MFG. CO., INC.
WILLIMANTIC CONNECTICUT

Manufacturers of El-Menco Capacitors
- molded mica • dipped mica • mica trimmer • dipped paper
- tubular paper • ceramic • silvered mica films • ceramic discs

Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada
Arco Electronics, Inc., 64 White St., New York 13, N. Y.

CIRCLE 172 ON READER-SERVICE CARD

Hermaphroditic Connector 453

Rack and panel type

Series 8105 micro-miniature hermaphroditic connector is a rack and panel type with high-contact density. Both mating insulators are alike except for their contact numbering. The mating contact area extends 50% above the insulator surface and 50% below it, inside the insulator contact holes. The connector shown has four rows of 8 contacts; spacing between contacts is 0.1 in. and between rows, 0.125 in.

Elco Corp., Dept. ED, M St. Below Erie Ave., Philadelphia 24, Pa.
Booth 1515.

Mixer-Preamplifier Assembly 446

Range is 10.5 to 12.4 kmc

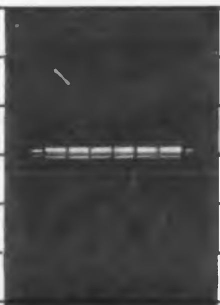
Operating over the range of 10.5 to 12.4 kmc, Model MMX-3 matched mixer-preamplifier assembly is gain-stabilized and has a 20-mc if bandpass centered at 60 mc. The over-all gain is 25 db min and the noise figure is 9 db max. Output impedance is 50 ohms. The unit is suitable for gain and noise figure measurements on masers and parametric up-converters in addition to use as a standard sub-assembly for radar or missile receiving systems.

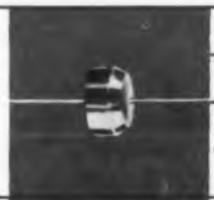
LEL, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.
Price & Availability: Price is $995 ea when one unit is ordered and $695 ea for quantities up to 50. It is available from stock for a three to four-week delivery.
Booth 2102.

TARZIAN

designer's line

silicon rectifiers include 84 high efficiency types

amps. DC (100° C)		peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	Tarzian Type	Jedec No.
0.325		2800	1960	3.25	19.5	280SM	1N1113
0.35		2400	1680	3.5	21	240SM	1N1112
0.375		2000	1400	3.75	22.5	200SM	1N1111
0.4		1600	1120	4	24	160SM	1N1110
0.425		1200	840	4.25	25.5	120SM	1N1109
0.45		800	560	4.5	27	80SM	1N1108
0.5		100	70	5	30	10M	1N1081
		200	140	5	30	20M	1N1082
		300	210	5	30	30M	1N1083
		400	280	5	30	40M	1N1084
		400	280	5	30	M-500	1N1084
		500	350	5	30	50M	–
		600	420	5	30	60M	–
		200	140	7.5	75	F-2	1N2482
		400	280	7.5	75	F-4	1N2483
		600	420	7.5	75	F-6	1N2484
0.75		100	70	7.5	75	10H	–
		200	140	7.5	75	20H	1N2485
		300	210	7.5	75	30H	1N2486
		400	280	7.5	75	40H	1N2487
		500	350	7.5	75	50H	1N2488
		600	420	7.5	75	60H	1N2489

amps. DC (100° C)		peak in-verse volt-age	max. RMS volts	max. amps. re-cur-rent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jede
1.5		100	70	10	100	–	–	10J1	1N1
		200	140	10	100	–	–	20J1	1N1
		300	210	10	100	–	–	30J1	1N1
		400	280	10	100	–	–	40J1	1N1
2		100	70	30	100	–	–	10LA	1N1
		200	140	30	100	–	–	20LA	1N1
		300	210	30	100	–	–	30LA	1N1
		400	280	30	100	–	–	40LA	1N1
10		100	70	50	150	–	–	10J2	1N1
		200	140	50	150	–	–	20J2	1N1
		300	210	50	150	–	–	30J2	1N1
		400	280	50	150	–	–	40J2	1N1
20		50	35	120	200	5RAN	1N1157	5RAP	1N1
		100	70	120	200	10RAN	1N1158	10RAP	1N1
		200	140	120	200	20RAN	1N1159	20RAP	1N1
		300	210	120	200	30RAN	1N1160	30RAP	1N1
		400	280	120	200	40RAN	–	40RAP	-
35		50	35	210	350	5SAN	1N1161	5SAP	1N1
		100	70	210	350	10SAN	1N1162	10SAP	1N1
		200	140	210	350	20SAN	1N1163	20SAP	1N1
		300	210	210	350	30SAN	1N1164	30SAP	1N1
		400	280	210	350	40SAN	–	40SAP	-

Rated at from 0.325 to 250 amps,
in complete variety of case designs and terminals

Proved performance, low cost,
prompt shipment from stock

Sarkes Tarzian's "Designers' Line" silicon rectifiers offer the small size, high efficiency, mounting versatility, and wide range of ratings that can help solve many of your power conversion circuitry problems. Tarzian's realistic prices make these high quality components practical for almost all commercial and military applications.

The 84 types of Tarzian "Designers' Line" rectifiers feature extremely low junction current density to provide maximum reliability and operating life.

Their −55°C to +125°C temperature range makes Tarzian silicon rectifiers ideal for circuits where ambient temperatures are high and small size is desired. Ratings range from 0.325 to 250 amperes.

Tarzian types are available for immediate delivery in production quantities from factory or warehouse stocks. Complete power conversion engineering service on your rectifier requirements is available at no charge or obligation.

For further information contact your nearest Tarzian sales representative or write to Section **4394B,** Semiconductor Division, Sarkes Tarzian, Inc., Bloomington, Indiana.

SARKES TARZIAN, INC.
SEMICONDUCTOR DIVISION
BLOOMINGTON, INDIANA
In Canada: 700 Weston Rd., Toronto 9, Ontario
Export: Ad Auriema, Inc., New York City

	peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jedec No.
	50	35	210	350	5S3N	–	5S3P	–
	100	70	210	350	10S3N	–	10S3P	–
	200	140	210	350	20S3N	–	20S3P	–
	300	210	210	350	30S3N	–	30S3P	–
	400	280	210	350	40S3N	–	40S3P	–
	50	35	600	1000	5VAN	1N1165	5VAP	1N1179
	100	70	600	1000	10VAN	1N1166	10VAP	1N1180
	200	140	600	1000	20VAN	1N1167	20VAP	1N1181
	300	210	600	1000	30VAN	1N1168	30VAP	1N1182
	400	280	600	1000	40VAN	–	40VAP	–
	50	35	600	1000	5V3N	–	₅V3P	–
	100	70	600	1000	10V3N	–	10V3P	–
	200	140	600	1000	20V3N	–	20V3P	–
	300	210	600	1000	30V3N	–	30V3P	–
	400	280	600	1000	40V3N	–	40V3P	–
	50	35	900	1500	5WAN	1N1263	5WAP	1N1267
	100	70	900	1500	10WAN	1N1264	10WAP	1N1268
	200	140	900	1500	20WAN	1N1265	20WAP	1N1269
	300	210	900	1500	30WAN	1N1266	30WAP	1N1270
	400	280	900	1500	40WAN	–	40WAP	–

amps. DC (100° C)		peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jedec No.
		50	35	900	1500	5W3N	–	5W3P	–
		100	70	900	1500	10W3N	–	10W3P	–
150		200	140	900	1500	20W3N	–	20W3P	–
		300	210	900	1500	30W3N	–	30W3P	–
		400	280	900	1500	40W3N	–	40W3P	–
		50	35	1200	2000	5XAN	1N1263A	5XAP	1N1267A
		100	70	1200	2000	10XAN	1N1264A	10XAP	1N1268A
		200	140	1200	2000	20XAN	1N1265A	20XAP	1N1269A
		300	210	1200	2000	30XAN	1N1266A	30XAP	1N1270A
200		400	280	1200	2000	40XAN	–	40XAP	–
		50	35	1200	2000	5X3N	–	5X3P	–
		100	70	1200	2000	10X3N	–	10X3P	–
		200	140	1200	2000	20X3N	–	20X3P	–
		300	210	1200	2000	30X3N	–	30X3P	–
		400	280	1200	2000	40X3N	–	40X3P	–
		50	35	1500	2500	5Y3N	–	5Y3P	–
		100	70	1500	2500	10Y3N	–	10Y3P	–
250		200	140	1500	2500	20Y3N	–	20Y3P	–
		300	210	1500	2500	30Y3N	–	30Y3P	–
		400	280	1500	2500	40Y3N	–	40Y3P	–

CIRCLE 173 ON READER-SERVICE CARD

Ohmmeter 397

Range extends as low as 10 μohms

The EMT model 325 ohmmeter has a range extending down to 10 μohms and an upper limit of 3000 milliohms. It reads directly the internal resistance of storage and primary batteries with and without load; it can also be used to measure switch contacts, breakers, and very low resistance busses. The range of the instrument is divided into nine sub-ranges. The test frequency is 50 to 60 cps. Connection of the test sample is performed by clips. The instrument is manufactured in Germany.

Electronic Applications, Inc., Dept. ED, 194 Richmond Hill Ave., Stamford, Conn.

Price & Availability: *Price is $399. Delivery is in 60 days.*

Booth 3929.

High Impedance Comparator 383

Frequency range is 400 cps to 10 kc

Model B-921 high impedance comparator has an adjustable voltage ratio of 0.333:1 to 3:1 and a frequency range of 400 cps to 10 kc. A three-terminal bridge, the instrument has an R-trim of −200 to +800 ohms. Accuracy is 0.001%. A battery-operated preamplifier is incorporated in the unit; a source and a selective amplifier-detector are also necessary for operation.

Wayne Kerr Corp., Dept. ED, 1633 Race St., Philadelphia 3, Pa.

Price & Availability: *Price is $1350 fob Philadelphia. Delivery is in four to six weeks.*

Booth 3827-3829.

"AND HAVING WRIT, MOVES ON*"

Who stands still, falls behind. Fairchild Semiconductor Corporation is devoting considerable effort to building the lead it has achieved in advanced silicon semiconductor devices. We are not unique in our technological abilities; we do have a head start. It is an opportunity and a challenge based in Time.

Other manufacturers will duplicate our currently unique transistors. By then, our projects now in Research & Development will have become the advanced products of their own time and the challenge continues. Success is followed by greater successes ...or obsolescence.

Our facilities and working atmosphere have attracted engineers and scientists of the highest caliber. Their work, combined with creatively oriented management policies and the abilities of the entire staff, has resulted in a whole series of product innovations.

We are still moving on in transistors, and have now branched into diodes of similarly advanced technologies. Current programs include integrated solid-state circuitry and investigations of semiconductor films and III-V compounds. If yours is a relevant background, and if you would like to move ahead with us, we would very much like to hear from you.

FAIRCHILD
SEMICONDUCTOR CORPORATION

545 WHISMAN RD. / MOUNTAIN VIEW, CALIF. / YORKSHIRE 8-8161

*The Rubáiyát of Omar Khayyám

◄ CIRCLE 900 ON CAREER FORM, P. 317

NEW PRODUCTS

AT THE IRE SHOW

Jacks 38

Made of nylon

These banana jacks are made o tough, low-loss nylon. Having a wid temperature and humidity rang they are made for mounting in 5/1 in. holes in panels up to 5/16 i thick. The contacts are cadmiu plated brass.

Herman H. Smith, Inc., Dep ED, 2326 Nostrand Ave., Brookly 10, N.Y.

Price & Availability: *They a available from stock at the price o $20 per 100.*

Booth 2325.

Laminates 37

Can be used at 500 F

Made for electronic application these laminates are specially de signed for high temperature us Type ARF-HT asbestos mat pla tic, having a flexural strength 35,000 psi lengthwise and 25,00 psi crosswise, retains 40% of orig nal flexural strength after a 100 hr exposure to 500 F. Type G3-H glass fabric plastic, having a fle ural strength of 60,000 psi lengt wise and 50,000 psi crosswise, al retains 40% of flexural strength aft 1000 hr at 500 F. Standard shee are 36 x 36 in. and 36 x 72 in. Typ ARF-HT is 0.031 to 2 in. thick an type G3-HT is 0.01 to 2 in. thick.

Synthane Corp., Dept. E Oaks, Pa.

Booth 4521-4523.

aper-Pin Connectors 370

Are zinc die cast

Th se zinc, die-cast taper-pin nn ctors are suitable for a variety ap lications such as in computers d pe recorders. Various designs lude: double receptacles which ow connections to be made from her end, parts cast with predemined breaking points to enable with any combination wiring heme, and parts cast with rivet gs.

Gries Reproducer Corp., Dept. D, 125 Beechwood Ave., New chelle, N.Y.

oth 4110.

otating-Coil 368 aussmeter

Accuracy is 0.1%

This rotating-coil gaussmeter asures dc magnetic fields to an uracy of 0.1%. It reads 0 to 10,- gausses with a resolution of ±1 ss. Instead of measuring the tage generated by the rotating , the instrument compares this inst the output of a reference ac erator mounted on the same tor shaft.

awson Electrical Instrument Co., , Dept. ED, Cambridge, Mass.

oth 3313.

Preamplifier 472

Bandwidth is 20 mc

Designed for use in missile, space, telemetry applications, model f transistorized preamplifier has andwidth of 20 mc centered at mc It can be used with microe receiver mixers having an if ce impedance of 300 ohms and ut. The noise figure is better n 4.25 db.

El , Inc., Dept. ED, 380 Oak St., ia ue, N.Y.

e Availability: Available for -eek delivery, the unit is ed at $270 ea. Quantity disnts are available.

th 2102.

Precision Is The Standard At Coors

Ceramic Wafers for Micro-Modules

Micro-Module Wafers

The hottest news in extreme miniaturization of electronic equipment is the micro-module—an amazingly small combination of sub-miniature electronic circuit components. The fundamental unit of a micro-module is the high alumina ceramic base plate—a tiny ceramic wafer, approximately 0.300" square x 0.010" thick. Upon this is deposited or metalized a component of a circuit—a resistor, capacitor, transistor, diode, etc. The micro-module is a combination of several of these elements in a small space to serve a specific circuit function—amplifier, oscillator, etc.

Coors is manufacturing these precision wafers in large quantity production runs for several manufacturers working on the same project. Coors holds all dimensions of the tiny ceramic wafer to extremely close tolerances so that the micro-elements produced from them are entirely interchangeable from manufacturer to manufacturer .

Miniature Tube Envelopes

Tube Envelopes

Coors makes high strength ceramic envelopes to extremely close dimensional tolerances and in a wide range of sizes for use in modern electron tubes. Certain of the Coors ceramic compositions were developed specifically to meet the rigorous operating conditions and reliability requirements to which high power, high frequency tubes are subjected.

Illustrated here is one of the miniature ceramic envelopes in regular production. Coors regularly produces many other sizes up to 10" O.D. Larger sizes can be manufactured.

Coors ceramics have outstanding electrical and physical characteristics. These properties are not affected by high outgassing or high operating temperatures.

At the IRE Show!
Coors Beryllium Oxide Ceramic

Coors is now in regular production of beryllium oxide ceramic. This new ceramic material has outstanding refractory and nuclear properties. It has better resistance to thermal shock than most other ceramic materials and conducts heat better than any other ceramic material. A good electrical insulator at elevated temperatures, these components are meeting the many advanced needs of the electronic industry. See this Coors ceramic material at the IRE Show or write for new data. **Booth 4005-6**

Ceramic-to-Metal Standard Terminal Insulators

Standard Terminal Insulators

Coors furnishes *standard* terminal insulators—available from stock—in various ratings and, also, can manufacture custom made insulators to meet your specific requirements. In the range of standard sizes, metal parts are bonded to the ceramic by Coors High Temperature Metalizing Techniques, thus producing strong hermetic ceramic-to-metal seals. The result is standard terminal insulators available for a wide range of requirements—insulators that have superior electrical and mechanical characteristics. Production is on a large quantity basis—you do not pay a premium for high quality, precision terminals.

Coors
COORS PORCELAIN COMPANY
600 Ninth Street, Golden, Colorado

RC 174 ON READER-SERVICE CARD ➤

Pulse Modulators 392

Pulse width range is 1 to 15 μsec

Model 330 12-mw pulse modulator provides a continuously adjustable pulse width range of 1 to 15 μsec at repetition rates of 100 to 1000 pps. Pulse energy to the primary of the pulse transformer is 20 kw peak at 600 amp. Maximum average power delivered is 24 kw. The equipment includes monitoring circuits for observing both output pulse and current, as well as meters for all pertinent ac and dc voltages and currents. A low-capacity filament supply is used for the tube under test. Line power needed is 208 v, three phase.

Manson Laboratories, Inc., Dept. ED, P.O. Box 1214, Stamford, Conn.

Price & Availability: *Price is quoted on request; delivery is in 90 to 100 days.*

Booth 3923.

Connector 390

Multi-terminal type

The MTC series of multi-terminal connectors offers 40, 60, 80, and 100-pin sizes. They are designed for mounting such components as transistors, diodes, and condensers. Features include: easy locking bolt for securing the plug to the receptacle, easily removable cover, zinc-chromate finish on all hardware, and solder or taper tab terminals.

North Electric Co., Electronetics Div., Dept. ED, 553 S. Market St., Galion, Ohio.

Price & Availability: *Price is $7 to $8. Units will be available from stock in April, 1960. Delivery is in 30 days.*

Booth 2125.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN

ENGINEERED COMPONENTS
for the Electronic Industry

WHERE RELIABILITY IS CRITICAL

1. Chemelec* Stand-Off and Fee
Insulators are easy to install, res
to heat and breakage, and—abc ve
—reliable under severest conc itio
. . . ideal for critical electronic c rcu
such as missile guidance, fire c ntr
tracking, radar systems. Teflc n**
due to its excellent dielectric, me ha
cal and thermal properties—is used
the insulator body. And, Chem
Compression-Mounted Stand-Off
Feed Thru Insulators are designed
easy installation. You simply pr
them into pre-drilled holes; they
come self-fastening, requiring no ad
tional hardware or adjustment. Av
able in compression-mounted, met
base, miniature and sub-miniat
types . . . standard R.M.A. colors,
wide range of sizes and terminal desig

2. Chemelec Sub-miniature Tube
Transistor Sockets have body insu
ing material of Teflon; contact ma
rial of brass, silver-plated and g
flashed. Capacitance pin to pin
MMF—pin to 1/16" Chassis .7MM
Chassis retention 50 lbs min. in
panel. Contact retention 4 oz. per p

3. Chemelec Connectors are Tef
insulated for outstanding high f
quency service. Once installed, t
require no further adjustment
hardware. .040, .050, .064 pin s
female also in .080 size.

4. Plastic Stock Shapes and Intricate P
inserts, thin sections, threaded pa
to precision tolerances are availab
Excellent facilities and experience
compression and injection moldi
extruding, machining of Tefl
Nylon, Delrin**, Kel-F† or ot
industrial plastics.

Garlock facilities and personnel are
your disposal for design and devel
ment of new electronic products.

GARLOCK
ELECTRONIC PRODUCTS

Garlock maintains complete electri
chemical, and physical laborat
staffed by top-flight research
development engineers.

Find out more about what Gar
offers. Contact the Garlock Electr
Products representative near you.
him, or write for Catalog AD-
Garlock Electronic Products,
Garlock Packing Company, Ca
1, New Jersey.

*Registered Trademark **DuPont Trademark
†Trademark, Minnesota Mining & Manufacturing

VISIT US AT THE IRE SHOW—BOOTHS NO. 2814 and 2816

Constant Current Supply 391

Output is 0 to 20 v at 0.5 to 500 ma

Model 151 constant current supply delivers a variable output of 0 to 20 v at 0.5 to 500 ma. Applications are: semiconductor testing, diode aging, transistor beta tests, potentiometer and current sensitive relay testing, electrolytic work, and in strain gage systems. Regulation is 0.25% for load and 0.25% for a 105- to 125-v ac line. Input is 105 to 125 at 50 to 60 cps, 15 w. The unit measures 8.25 x 5 x 7.75 in. and weighs 7.75 lb.

Quan-Tech Laboratories, Dept. ED, Boonton, N.J.

Price & Availability: *Price is $275 fob Boonton. Unit is available from stock.*

Booth 3034.

Glass Inductor Kit 478

Range is 0.05 to 2 μh

This glass-inductor kit has tuning cores which provide for a range of inductances of 0.05 to 2 μh. Ten inductors, made by fusing metallic spirals into the surface of a low-loss glass coil form, are included. The inductors have a high stability, operate from −55 to +125 C, and have Q-factors from 120 to 200. Maximum dc current capacity is over 1 amp. Tolerance is ±10%. The kit also includes four tuning cores.

Corning Glass Works, Dept. ED, Bradford, Pa.

Price & Availability: *Price is $24.95. Available in March, the kit will be sold by the Erie Resistor Corp.*

Booth 2334, 2336, 2427 and 2429.

◄ CIRCLE 175 ON READER-SERVICE CARD

Power Supplies 493

Have outputs of 0 to 18 v up to 0 to 100 v

Operating from an input of 100 to 135 v ac, 60 cps, single phase, the ST series of power supplies has a line regulation of 0.005% of maximum rated voltages. The Units have the following load regulation: for 0 to 18 v, 0.05%; for 0 to 36 v, 0.03%; for 0 to 60 v, 0.02%; and for 0 to 100 v, 0.01%. The output is continuously variable down to 100 mv. Ripple is less than 500 mv rms and overshoot is less than 1%. Recovery time is 50 μsec. Units are made for rack mounting.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

***Availability:** From stock to three weeks.*

Booth 3009.

AC Voltage Standard 496

Output is 1 to 501 v ac rms

Model 601A voltage standard has an output of 1 to 501 v ac rms, adjustable in 10-v steps. Power output capability is 5 amp up to 5 v and 25 w above 5 v. Frequencies of 60, 400, and 1000 cps can be selected by front panel control. Voltage accuracy is 0.1% or ±5 mv and short term voltage stability is 0.01%. Frequency stability is 1% and harmonic distortion is less than 0.3%. The output impedance with a constant resistive load is about 0.01 ohms, which is essentially the resistance of the output terminals. The unit measures 19 x 12.25 x 18 in.

Kin Tel, Div. of Cohu Electronics, Inc., Dept. ED, 5725 Kearny Villa Road, Box 623, San Diego 12, Calif.

Booth 3613-3615-3617.

When it comes to SEMICONDUCTORS,

For the most complete line of semiconductors...

● Westinghouse has perfected the widest selection of rectifiers, transistors, and special semiconductor devices available in the industry. In Silicon power rectifiers, Westinghouse is the acknowledged leader in the field.

For the most dependable semiconductor devices...

● Every Westinghouse semiconductor device has been carefully designed, manufactured, and thoroughly tested to assure long life, high reliability, and excellent stability.

For true voltage ratings in silicon power transistors...

● Only Westinghouse 2N1015 and 2N1016 silicon power transistors offer *true* voltage ratings, guaranteed by 100% power testing—means they may be operated continuously at the V_{CE} listed provided the power dissipation of the transistor is not exceeded. Other conventional power transistors derate the V_{CE} voltage under comparable conditions.

For new and unusual ideas in semiconductors...

● Westinghouse is constantly pioneering in exciting new semiconductor devices. Among the latest: a new 50 ampere "TRINISTOR"* controlled rectifier; new thermoelectric cooling devices; an extremely rapid and sensitive infrared detector.

For quality, reliability, performance, and availability...

See Westinghouse Semiconductors
at the IRE Show
March 21 to 24
Booth 1408

● Come to *Westinghouse*! For more information call your Westinghouse representative, or write directly to Westinghouse Electric Corp., Semiconductor Department, Youngwood, Pa.

YOU CAN BE SURE...IF IT'S Westinghouse

Westinghouse Semiconductor Department, Youngwood, Pa.

*Westinghouse Trademark

COME TO WESTINGHOUSE!

SILICON RECTIFIERS		P.I.V.	Max. DC Current at T°C Resistive Load	Max. One Cycle 60 C.P.S. Surge Full Load	Max. Rev. Peak Current @ Max. Temp. & P.I.V.
LOW POWER RECT.	1N1217 SERIES	50-1000 V.	500 MA @ 110°C. AMB.	15 AMPS.	1.5 MA @ 150°C. JUNCTION
	1N1227 SERIES	50-1000 V.	1.6 A @ 140°C. CASE	15 AMPS.	
MEDIUM POWER RECT.	1N1341 SERIES	50-600 V.	6 A @ 150°C. CASE	170 AMPS.	10 MA @ 190°C. JUNCTION
	1N1199 SERIES	50-600 V.	12 A @ 150°C. CASE	220 AMPS.	
	1N1191 SERIES	50-600 V.	18 A @ 140°C. CASE	220 AMPS.	
	1N1183 SERIES	50-600 V.	35 A @ 140°C. CASE	220 AMPS.	
HIGH POWER RECT.	1N1396 SERIES	50-500 V.	70 A @ 150°C. CASE	1200 AMPS.	30 MA @ 190°C. JUNCTION
	1N1660 SERIES	50-500 V.	160 A @ 125°C. CASE	2000 AMPS.	40 MA @ 190°C. JUNCTION
	1N1670 SERIES	50-500 V.	240 A @ 125°C. CASE	3000 AMPS.	50 MA @ 190°C. JUNCTION
	439 SERIES	50-600 V.	240 A @ 125°C. CASE	3000 AMPS.	

GERMANIUM TRANSISTORS	Class	Typical Operation			Maximum Ratings			
		I_{CBO} µa	h_{FE}	f mc/s	V_{CE} V	I_C ma	P_C mw	T_J °C
2N59	AUDIO-PNP	10	100	1.2	20	200	180	85
2N60	AUDIO-PNP	10	70	1.1	20	200	180	85
2N403	AUDIO-PNP	10	33	0.85	20	200	180	85
2N614	IF -PNP	3	5	3	20	150	125	85
2N616	IF -PNP	3	20	9	20	150	125	85
2N617	IF -PNP	3	14	7	20	150	125	85

SILICON POWER TRANSISTORS	Type	h_{fe} or h_{FE}	$f_{\alpha mc}$	V_{CEX} Volts	I_C Amps	T_J °C
2N1015 SERIES—2 AMP.	NPN	10 (V_{CE}=4 V I_C=2 A)	ALPHA CUTOFF .300	30-200	7.5a	150
2N1016 SERIES—5 AMP.	NPN	10 (V_{CE}=4 V I_C=5 A)	ALPHA CUTOFF .300	30-200	7.5a	150

50 AMPERE SILICON "TRINISTOR"* CONTROLLED RECTIFIER	Breakover Voltage @ 125°C T_J	Reverse Blocking Voltage @ 125°C T_J	Turn-on Time	Turn-off Time
	TYPICAL			
	50-400 VOLTS	50-400 VOLTS	1.0 µ SEC.	15-20 µ SEC.

RECTIFIER ASSEMBLIES

Standard rectifier assemblies are available in all types of circuit configurations, and are designed for either forced air or natural convection cooling with a wide range of ratings. Nickel-plated copper plates and other materials used in these assemblies have been chosen to insure satisfactory performance in corrosive atmospheres and high ambient temperatures.

THERMOELECTRIC COOLING DEVICES

Two types are available in commercial quantities: WX814 (2.5 oz.) and WX816 (3.0 oz.). Both types measure about an inch and a half square and will find immediate application in cooling germanium transistors, infrared detectors, optical systems, mechanical and electric instruments, laboratory and portable medical equipment, and related fields where spot cooling below ambient is necessary.

TYPE 812 INFRARED DETECTORS	Noise Equivalent Power (NEP) Watts		Wave-length Response, Microns	Time Constant, µ SEC.	
	TYPICAL	LIMIT		TYPICAL	LIMIT
	5x10—11	10—10 MAX.	1-12	0.1	0.2 MAX.

The types listed are just a small sampling of the complete line which can be supplied in volume quantities for prompt deliveries.

CIRCLE 176 ON READER-SERVICE CARD

Pulse Generator 356

Range is 20 cps to 2 mc

Model B-7 pulse generator has a frequency range of 20 cps to 2 mc. Delay is from 0 to 10,000 µsec, pulse width is 0.05 to 10,000 µsec, and amplitude is 50 v into 50 ohms. Rise and fall time is better than 15 mµsec. The normal duty factor of 30% can be increased with a reduction in amplitude so that the instrument does not fan out. Attenuation is 50 db in 10-db steps or 20-db continuous, positive or negative pulses. A minimum external triggering of ±10 v is required. The synchronous output is 0.05 µsec wide and has an amplitude of 10 v; time lag is 0.2 µsec. The unit measures 19 x 8-3/4 x 12 in.

Rutherford Electronics Co., Dept. ED, 8944 Lindblade St., Culver City, Calif.

Price & Availability: *Price is $720; the unit is available from stock and can be delivered in 21 days.*

Booth 3834.

Silver Cadmium Battery 502

Weighs 1.44 oz.

Model 8YSO1 silver cadmium battery weighs only 1.44 oz and has a volume of 1.36 cu. in. A 9-v battery, it is made up of 8 cells having a 0.1 amp-hr nominal capacity and supplies power for continuous operation for 12 to 15 hr before recharging if necessary.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York, N.Y.

Availability: *The unit is made on order.*

Booth 2127.

NEW PRODUCTS
AT THE IRE SHOW

Frequency Decades 396

Measure up to 300 mc

The Schomandl type FAPR frequency decades provide for drift and other parameter measurements of frequencies up to 300 mc. They have decade intervals down to 1 cycle. Accuracy is 2 x 10^{-12} at one-cycle intervals. Applications include: development of circuit elements, type and series testing of quartz crystals, temperature compensation of oscillating circuits, and continuous monitoring of transmitter frequencies.

Electronic Applications, Inc., Dept. ED, 194 Richmond Hill Ave., Stamford, Conn.

Price & Availability: *Price is $6099; delivery is in 75 days.*

Booth 3929.

AC Power Supply 483

Provides 250 v

Model 250 power supply delivers 250 v ac at 400 cps ±0.25% or at a variable frequency from 350 to 450 cps. An input jack is provided for output frequencies from 50 to 4000 cps. Output voltage is continuously variable from 0 to 120 v. Output distortion is less than 1% and regulation from no-load to full-load is better than 1%. The use of silicon diodes in the plate-supply circuit reduces the heat dissipated. Panel size is 19 x 8-3/4 x 13-1/2 in.

Industrial Test Equipment Co., Dept. ED, 55 E. 11th St., New York, N.Y.

Booth 3513.

Laboratory Receiver 473

Incorporates high gain amplifier

Model LR 1297 laboratory receiver combines a high-gain if amplifier, a precision attenuator, a power supply, and an indicator. It is suitable for noise figure measurements, nuclear resonance work, antenna pattern recording, and other design applications. Used with the firm's mixer-preamplifier assembly, the unit will provide a microwave receiver operating from bands L through K.

LEL, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

Price & Availability: *Price is $2200. Delivery is in 30 to 60 days.*

Booth 2102.

Coil Winding Machine 476

Handles wires from 0.025 to 0.065 in. in diam

Model ME-301 coil winding machine handles wires ranging in size from 0.025 to 0.065 in. in diam or from No. 22 to 14 AWG. This high-speed device is claimed to perform perfect thread layer winding.

Associated American Winding Machinery, Inc., Dept. ED, 750 St. Ann's Ave., New York 56, N.Y.

Price & Availability: *Unit is available from stock. Price is $575 ea.*

Booth 4228-4230.

Component Kits 374

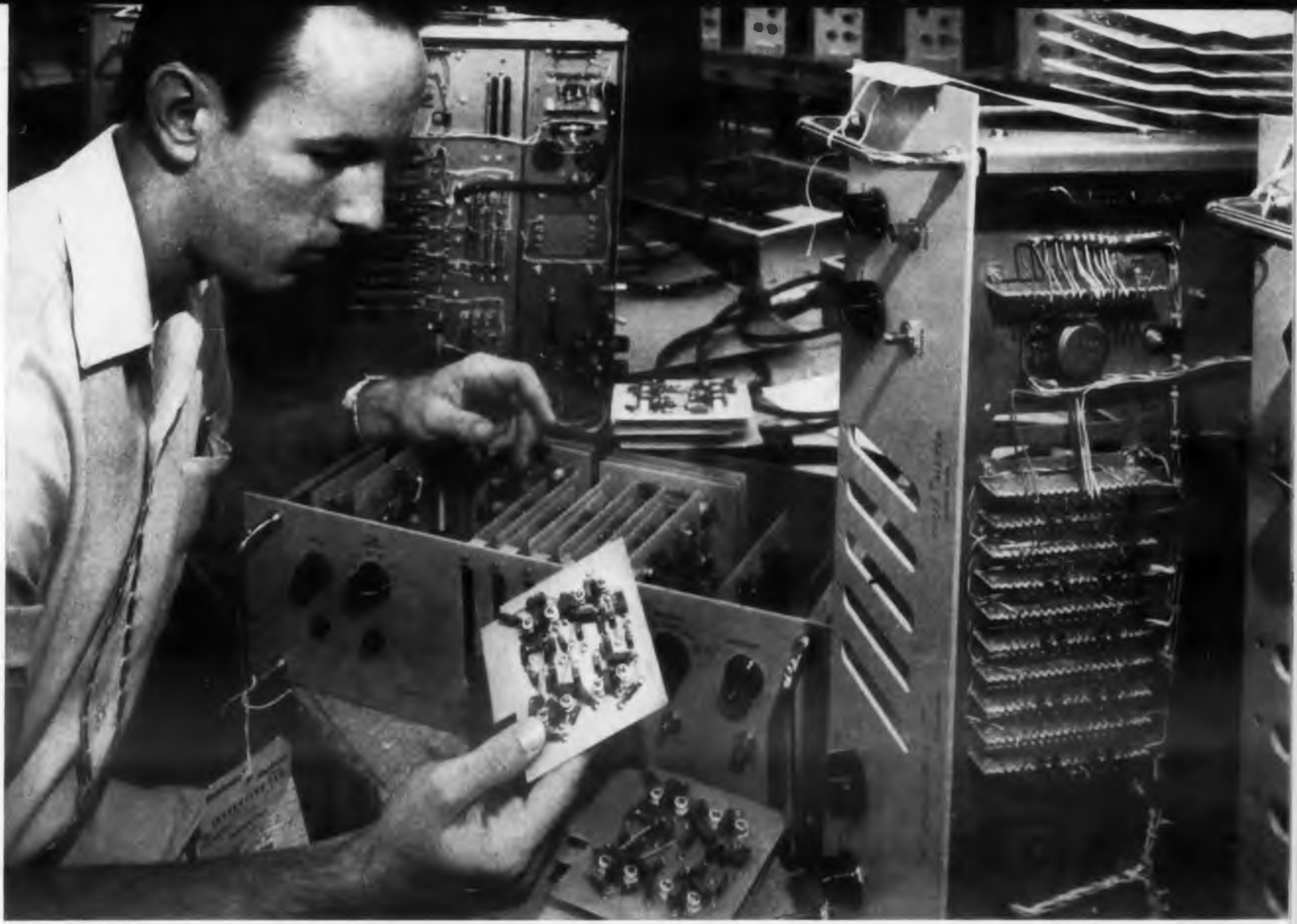
For development work

The Ferroxkits are made for developmental work requiring ferrite magnetic cores, voltage dependent resistors, negative temperature coefficient or light dependent resistors, and memory cores, planes, or stacks. The kits are composed of standard, off-the-shelf parts and contain complete technical data.

Ferroxcube Corp. of America, Dept. ED, Saugerties, N.Y.

Price & Availability: *Price ranges from $10 to $395. Kits are available for immediate delivery.*

Booth 2530.



CIRCLE 178 ON READER-SERVICE CARD ➤

Tung-Sol transistors handle four major jobs in

Beckman/Berkeley peak accuracy frequency counte

The Beckman/Berkeley Model 5310 EPUT Meter makes frequency measurements from 10 cps to 200 kc with an accuracy of up to 1 part in 10^6. In military applications, such as missile check-out, where operating time is brief but success "a must", the EPUT Meter "gets in and gets out" quickly with fire-away data. Where long-term service with minimum downtime is a critical requirement, as in industrial monitoring processes, the equipment is also ideally suited.

Naturally, this exacting combination of highest accuracy and greatest dependability demands the most reliable component performance. And that's precisely why Beckman/Berkeley chose Tung-Sol transistors to assume four of the unit's primary operations. Tung-Sol's 2N414 high speed computer logic germanium transistors handle time division and frequency counting. The tasks of conversion and current amplification for digital readout are assigned to Tung-Sol's 2N383 medium power germanium transistors.

Why don't you get the benefit of Tung-Sol's component know-how too? Whether it's tubes or semiconductors — and there's a premium Tung-Sol unit for virtually every military and industrial need — you'll be designing only the best components into your circuit. You'll be getting quality units that have made the name of Tung-Sol synonymous with the finest componentry. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193.

For prompt and competent technical consultation on Tung-Sol components call the Tung-Sol Commercial Engineering office nearest you. 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. Canada: Montreal, P. Q.

TUNG-SOL®

Voltmeter 387

Measures 1 mv to 1000 v ac and dc

Type R-2 voltmeter measures ac and dc voltages from 1 mv to 1000 v full scale in 14 ranges and mid-scale resistances from 10 ohms to 10 meg in 7 decade ranges. Accuracy is better than 1% on dc; ac accuracy is better than 2% from 20 cps to 100 kc and 5% from 10 cps to 1 mc. Residual noise is less than 20 mv on the 1-mv ac scale. The dc mv drift is less than 50 μv after warm-up.

Southwestern Industrial Electronics Co., Dept. ED, 10201 Westheimer Road, P.O. Box 13058, Houston 19, Tex.

Price & Availability: *Unit is available from stock at the price of $550.*

Booth 3307-3309.

Bridge 395

For capacitor checking to 100,000 μf

The Model EMT 543 bridge allows for electrolytic capacitor checking up to 100,000 μf. Accuracy is ±1% to 1000 μf and ±2% above 1000 μf. The unit has five ranges. The measuring voltage is 0.3 v ac or less. Capacity and loss angle are read directly. The measurement is normally made at 50 or 60 cps. The unit is manufactured in Germany.

Electronic Applications, Inc., Dept. ED, 194 Richmond Hill Ave., Stamford, Conn.

Price & Availability: *Price is $789. Delivery can be made in 60 days.*

Booth 3929.

FAIRCHILD
SENSING
DEVICES
PROVEN
IN
FLIGHT

THIS
ASTRONAUT
WILL
BREATHE
THANKS TO
FAIRCHILD
PRESSURE
TRANSDUCERS

Fairchild TPH-175 Pressure Transducer has a dual output, can take pressure from 0 to 10,000 psi and up to 100% over pressure without damage. It is hermetically sealed and filled with silicone oil. Takes 75G shocks and accelerations in each of three axes without damage. Twin spring design eliminates all linkages and pivots.

At the heart of the Capsule Pressurization System, built by Garrett Corporation's AiResearch Division for the McDonnell Aircraft Corporation — as part of NASA'S Project Mercury Space Vehicle — is a miniature (1.75" Diameter) FAIRCHILD TPH-175 PRESSURE TRANSDUCER. It monitors the pressure of oxygen remaining in the storage tank under the most severe environmental conditions.

A dual output transducer: One output goes to the astronaut's control panel, reassures him that plenty of oxygen is still available. The second output goes to the telemetering system for relay to ground control stations.

Another example of how Fairchild draws on the engineering skills that make them the foremost manufacturer of high-performance precision sensing devices.

Fairchild components . . . built and tested beyond the specs for Reliability in Performance. Write Dept. 383D.

225 Park Avenue
Hicksville, L. I., N. Y.

6111 E. Washington Blvd.
Los Angeles, Cal.

FAIRCHILD
CONTROLS CORPORATION
COMPONENTS DIVISION
A Subsidiary of Fairchild Camera and Instrument Corporation

GYROS
PRESSURE TRANSDUCERS
POTENTIOMETERS
ACCELEROMETERS

SUB-MINIATURE RATE GYROS

15/16" dia. by 2" long. Has uniform constant damping within ±15% from —40° to +200°F. Takes 150 g's of shock, at low maximum rates.

ACCELEROMETERS

Economical, pendulous accelerometer with torsion bar suspension and reliable pot pick-off. Accuracy values as low as ±½%. Acceleration range from ±¼ to ±50 G from 4-40 cps.

PRECISION POTENTIOMETERS

The linear motion single turn type shown is one of many high reliability types available. Also multi-turns and special designs. Functional accuracy over life is guaranteed.

CIRCLE 179 ON READER-SERVICE CARD

Signal Generator 386

Range is 2 cps to 200 kc

Model N-1 signal generator has a continuously variable range from 2 cps to 200 kc and provides 1 v rms with less than 1% distortion. A five-band unit, it is suitable for use in the design, test, and repair of audio and control equipment. Self-contained batteries make the unit portable and eliminate power-line transient effects, while providing instantaneous frequency and output stability without warm-up. Calibration accuracy is better than 2% for frequency and 5% for level on all ranges.

Southwestern Industrial Electronics Co., Dept. ED, 10201 Westheimer Road, P.O. Box 22187, Houston 27, Tex.

Price & Availability: *Unit is available from stock at the price of $310.*

Booth 3307-3309.

Printed Circuit Connectors 381

Meet mil specs

Series KZ and KZD printed circuit connectors are designed to meet MIL-C-21097 requirements for single and double entry connectors. Additional features are polarization and diallyl phthalate construction. Light entry contacts are standard.

Winchester Electronics, Inc., Dept. ED, 19 Willard Road, Norwalk, Conn.

Price & Availability: *Price is $2.78 ea, $1.69 ea in quantities of 1000, and $1.62 ea in quantities of 5000. Made on order, they can be delivered in 21 days.*

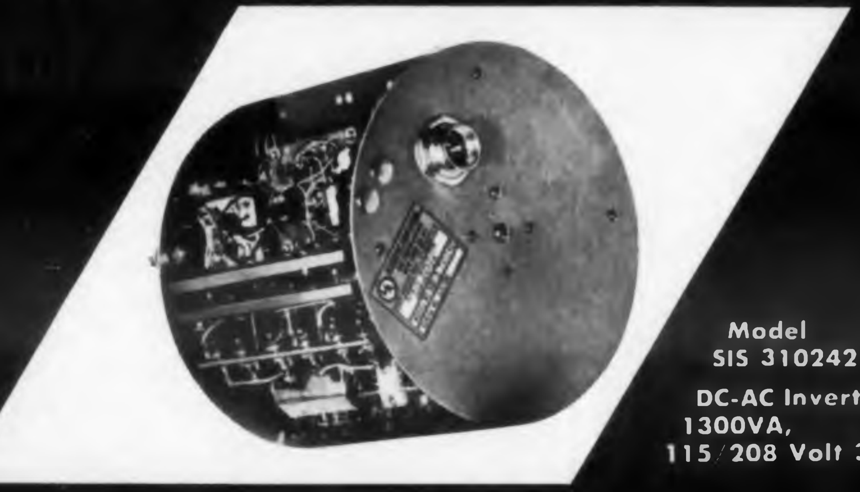
Booth 2121-2123.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

New **STANDARD LINE OF RELIABILITY ENGINEERED**

STATIC INVERTERS

FOR AIRCRAFT, MISSILE, AND SPACE VEHICLE APPLICATIONS



Inputs Nom. 28VDC Outputs Nom. 115V 400cps 1φ or 3φ
Power Ratings from 30VA to 1500VA

Space / Weight Designed To Yield Maximum Power Output Consistent With High Reliability And Performance

FEATURES

- PRECISION FREQUENCY
- OVERLOAD PROTECTION
- EXCELLENT WAVEFORM
- VOLTAGE REGULATED
- PHASE LOCKED CIRCUITRY
- REVERSE VOLTAGE PROTECTION

MODEL	POWER RATING	OUTPUT VOLTAGE	OUTPUT FREQUENCY	SPECIAL FEATURES
SIS-40311 series SIS-40511 series	30 VA 1φ 50 VA 1φ	115 VAC adjustable ± 10%	400 cps ± .01 to ± .05%	Precision frequency, excellent waveform, voltage regulated, ± 1% for line, ± 2% load.
SIS-408042 series	80 VA 1φ	115 VAC ± 5 V	400 cps ± 1%	Wide range stabilization, input 18-30 VDC, Voltage regulated ± 1½% no load to full load.
SIS-410042 series SIS-425041 series	100 VA 1φ 250 VA 1φ	115 VAC ± 5%	400 cps ± 1% LC. osc. tuneing fork	Magnetic Amplifier voltage regulated. Rapid on-off switching no transients high efficiency.
SIS-3-425042 series SIS-3-450022 series	250 VA 3φ 500 VA 3φ	115 VAC ± 2%	400 cps ± 2% ± 1%	Regulates to ± 2% with simultaneous variation of zero to full load, and line 25 volts to 29 volts.
SIS-3-47512 series	750 VA 3φ	208/115 V or 115/66.5 volts Adj. ± 5%	400 cps ± .002%	Extreme frequency accuracy. Phase lock circuitry. Magnetic voltage regulator.
SIS-3-40613 series	60 VA 3φ	26 VAC Adj. ± 5%	400 cps ± .01%	Short circuit protected, reverse voltage protection, high temp., + 100° C. Voltage regulated.

DESIGN NOTE any of the special features described may be combined in a single unit to meet your special requirements.

MA

MAGNETIC AMPLIFIERS, INC.

632 TINTON AVENUE
NEW YORK 55, N. Y.
CYPRESS 2-6610

136-140 KANSAS STREET
EL SEGUNDO, CALIFORNIA
OREGON 8-2665

CIRCLE 180 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Airborne Tape Recorder 447

Has 28 channels

Model 1-119 airborne tape recorder, having 28 channels, is cylindrical in form with a diameter of 6.25 in. and a length of 6.5 in. The unit weighs 10 lb. It is for data recording on recoverable missiles, satellites, and rocket sleds, but also has applications on conventional aircraft. Tape speed is 30 in. per sec. Frequency response is dc to 5000 cps and system accuracy is about 5%. Power requirement is 3 amp dc at 28 v.

Leach Corp., Special Products Div., Dept. ED, 516 E. Compton Blvd., Compton, Calif.
Booth 4052.

DC Power Supply 352

Provides 130 to 325 v

Operating from an input of 105 to 125 ±10 v ac, model PS4232 power supply delivers 130 to 325 v dc. For general purpose use, the unit has a load current of 0 to 1.5 amp, regulation of 0.2 v or less, and stabilization of less than ±0.2 for a line change of ±10 v with a constant load. Ripple and noise are less than 2 mv rms. Output impedance is less than 0.2 ohms from dc to 100 kc. Maximum ambient temperature is 50 C. The unit weighs 50 lb, measures 5.25 x 17 x 12 in., and has movable side brackets which permit rack mounting.

Power Sources, Inc., Dept. ED, Burlington, Mass.
Price & Availability: *Sample quantities are currently available; units will be available from stock by April 15, 1960. Price is $645, not including meters.*
Booth 1914.

GUDELACE is engineered for problem-free lacing

It's no accident that Gudelace is the best lacing tape you can buy. Excellence is *engineered* into Gudelace. A sturdy nylon mesh is meticulously combined with the optimum amount of special microcrystalline wax. Careful selection of raw materials and superior methods of combining them give Gudelace outstanding strength, toughness, and stability. Gudelace is the original *flat* lacing tape which distributes stress evenly over a wide area. It is engineered to stay flat; it will not stretch out of shape when pulled. Gudelace's nonskid surface prevents slipping, eliminating the too-tight pull that causes strangulation and cold flow. Durability and dependability make Gudelace your most economic buy—with no cut insulation, fingers, or feelings.

Write for Data Book with specifications on Gudelace and Gudebrod's complete line of braided lacing tapes and dial cords—Temp-Lace, Stur-D-Lace, and Gude-Glass.

Visit Gudebrod Booth 4025 at the IRE Show.

GUDEBROD BROS. SILK CO., INC.

Electronic Division
225 West 34th Street, New York 1, N.Y.

Executive Offices
12 South 12th Street, Philadelphia 7, Pa.

CIRCLE 181 ON READER-SERVICE CARD

Fabricator 376

Punches sheet metal parts and printed circuit boards

For punching sheet metal parts and printed circuit boards, the Super 30 fabricator can be used for short run punching and production runs. The machine uses an electric head which eliminates the need for pressurized air. It can punch holes from 0.5 in. in diam in 0.25 in. mild steel to 3.5 in. in diam in 16 gage steel. It can also make corner and edge notching, straight line nibbling, and contour shearing.

Wales Strippit, Inc., Dept. ED, Akron, N.Y.

Price & Availability: *Prices range from $9000 to $10,000; the unit will be available from stock after April 30, 1960.*

Booth 4010.

Transistorized Mixer-Preamplifier 471

Range is 8.5 to 9.6 kmc

Model MMX-4 transistorized mixer-preamplifier assembly covers the range of 8.5 to 9.6 kmc. The unit has a 15-mc bandwidth centered at 60-mc output frequency, a 20-db over-all gain, and an over-all noise figure of 10 db. Used with the firm's if amplifiers, the unit permits the production of solid state microwave receivers.

LEL, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

Price & Availability: *Sample quantities are available for 30-day delivery. Price is $995 ea.*

Booth 2102.

Epoxy Casting Resin 481

May be cured at room temperature

This fire-retardant epoxy casting resin, called Stycast 1231, may be cured at room temperature and is stable from −100 to +350 F. It has a low-thermal-coefficient of expansion. The material has good adhesion to metals, plastics, and ceramics.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Booth 1111.

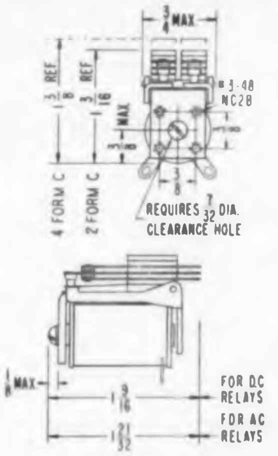
COMPACT, RELIABLE, VERSATILE . . .
this is P&B's miniature MH relay

The MH is not a new relay.

As a matter of fact, we've been building and selling this series for seven or eight years. Its reliability and exceptional longevity have been proved in business machines, airborne computers and a host of other products.

Engineers like its fast action, its small size, its light weight. They like the wide selection of contact forms . . . up to 18 springs (9 per stack, DC) as well as the fact MH relays can be furnished to switch loads ranging from dry circuit to over 5 amps at 115 volts, 60 cycle resistive.

A multiple choice of terminations add to the MH's versatility. This relay, for example, can be adapted for printed circuits, furnished with taper tabs or a long list of other terminals. Get all the facts by calling your nearest P&B sales engineer today.



MH ENGINEERING DATA

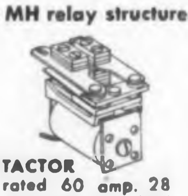
GENERAL:
Breakdown Voltage: 500 volts RMS between all elements.
Ambient Temperatures: −45° C to +85° C.(−65° C to +125° C on special order.)
Shock: 30g on special order.
Vibration: 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps. on special order.
Weight: 2½ ozs. max. (open relay)
Terminals: Pierced solder lugs; special lugs for printed circuits, taper tab (AMP #78).

CONTACTS:
Arrangements: Up to 9 springs per stack.
Material: ⅛" silver standard: Palladium or gold alloy also available.
Load: Dry circuits to 5 amps @ 115V AC res.

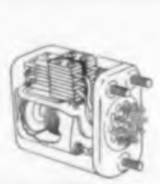
COILS:
Resistance: 22,000 ohms max.
Power: 100 mw per movable min. to 4 watts at 25° C max.(200 mw min. to meet max. shock/vibration spec.)
Duty: DC: Continuous. AC: Intermittent (Two pole relay max.) open. Sealed units supplied with full wave rectifier inside can.
Voltages: DC: Up to 110 volts. AC: Up to 230 volts 60 cycles.

The relays below are variations of the MH relay structure.

MA LATCHING
Electrical latch, mechanical reset. Small, versatile and offered with selection of contact arrangements.



MB CONTACTOR
Contacts rated 60 amp. 28 volts DC non-inductive. Will carry 150 amp. surge for a duration of 0.3 seconds.



MH SEAL-TEMP
Features sealed coil to minimize contact contamination. Available as hermetically sealed relay only.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD
DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

NEW PRODUCTS
AT THE IRE SHOW

Magnetic Amplifier 398

Delivers 0 to ±5 v

Series 5800 magnetic preamplifier delivers 0 to ±5 v, using thermocouple, strain gage, or other low level sources. The unit has a null stability of 28 mv or less. Other features are: built-in temperature compensation, filtered output, and high gain. Applications include linear amplification, null and error detection, summing with electrical isolation, integrating, and measurement of mv and μv.

Airpax Electronics, Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

Price & Availability: *For orders of one to six units, price is $177. Delivery is in 25 to 30 days.*

Booth 2306-2308.

Digital Voltmeter 365

Accuracy is 0.05%

Model 1231 digital voltmeter features accuracies to better than 0.05%, 20-msec conversion, in-line readout, and automatic polarity. Four-digit indication, from ±0.0001 to 99.99 v, is provided. The instrument has no stepping switches. Converters are available for use with this unit for automatic testing of diodes, capacitors, and resistors.

Systron Corp., Dept. ED, 950 Galindo St., Concord, Calif.

Price & Availability: *Price is $1895 per unit; delivery is 30 days after order is received.*

Booth 3838.

◄ CIRCLE 183 ON READER-SERVICE CARD

Printed Circuit Resistors 468

Come in sizes of 2, 5, 7, and 10 w

The PRS series of wirewound printed circuit resistors come in sizes of 2, 5, 7, and 10 w. Measuring from 1/4 x 5/8 in. to 3/8 x 1-25/32 in., these vertically mounted units have two parallel leads at one end to facilitate soldering. The temperature coefficient is 0.00002 per deg C. The resistance range is 10 ohms to 175 K with tolerances of 0.05%, 0.1%, 0.25%, 0.5%, 1% and 3%. The units meet MIL-R-26C.

Dale Products, Inc., Dept. ED, Columbus, Nebr.
Booth 2627-2629.

Slide Switches 367

Are rated at 0.5 amp at 125 v dc

These slide switches are rated at 0.5 amp at 125 v dc and 3 amp at 125 v ac. Both spdt and dpdt types are offered; some have spring return design. Designated types SLS-1 through SLS-6, they are designed for long service and show no loss in efficiency after 6000 cycles. Contacts are silver plated.

Industrial Electronic Hardware Corp., Dept. ED, 109 Prince St., New York 12, N.Y.
Price & Availability: *Units are made on order and can be delivered in two to three weeks. Prices are furnished on request.*
Booth 2837.

Single-Turn Potentiometers 474

Life is 1,000,000 cycles

Series 500 single-turn potentiometers, able to operate to 105 C, have a life of 1,000,000 cycles. The units are of all metal construction and have glass-to-metal terminals. Applications are in computers, servo loop systems, and standard industrial applications where high, operating temperatures are not needed.

Kintronic Division of Chicago Aerial Industries, Inc., Dept. ED, Franklin Park, Ill.
Booth M-23.

CIRCLE 184 ON READER-SERVICE CARD ➤

Environmental Chamber 394

Temperature range is —90 to +300 F

Type RAC 19 environmental chamber has a temperature range of +300 to —90 F, with —100 F attainable. Offering 2.3 cu ft of test space and measuring 16 x 16 x 16 in. inside, the chamber requires a floor space of 24 x 26 in. The unit is caster mounted and is portable. It operates on 220 v, single phase, 60 cps.

Conrad, Inc., Dept. ED, Holland, Mich.

***Price & Availability:** Price is $1760, not including accessory items. Units are available from stock.*

Booth 3848.

Antenna Systems 477

For 2 and 6-kmc bands

Type P4-59 cross-polarized parabolic antenna is for 2 and 6-kmc band use. It has a vswr of less than 1.1 v at both inputs. Accessories are made for use with this antenna.

Andrew Corp., Dept. ED, 363 E. 75th St., Chicago 19, Ill.

Booth 1502-1504.

Microwave Antenna 369

Uses simplified reflector design

For use from 400 to 2700 mc, the Hubloc antenna uses a simplified reflector design. The reflector back-up frame consists of tubular, bar, or

Here is Francis Alterman, Manager of General Mills Digital Computer Laboratory, checking one of our newest computers which he helped design. General Mills computers, both analog and digital, are being used in missile guidance, bombing and navigation systems, automatic surveying and in industrial control. In future space travel, computers will help control navigational systems of space vehicles and will process data gathered in outer space.

General Mills engineers work today

General Mills has been producing computers for nearly 20 years. Exciting new concepts in high speed magnetic tape units, ultra-high precision analog to digital converters and optical keyboards are examples of continuous developments in our over-all computer program. We work to improve reliability, increase speed, cut cost.

Our research activities cover broad areas in physics, chemistry, mechanics, electronics and mathematics. Some of the studies representative of these activities are: ions in vacuum, deuterium sputtering, dust erosion, magnetic materials, stress measurements, surface friction and phenomena, trajectory data and infrared surveillance.

In our engineering department, current projects include: specialized inflatable vehicles and structures, airborne early warning systems, micro wave radar test equipment,

strap type structural elements and connecting hubs. The hubs have a number of formed keyways; the structural member ends are embossed with a corresponding pattern which provides a press fit in the hub keyways. The reflector measures 28 ft in diam, has a focal length of 10-1/2 ft, and weighs 1575 lb. Rib sections are completely fabricated; only peripheral and diagonal members are installed at the site. various wind and ice loading conditions can be accommodated.

Andrew Corp., Dept. ED, 363 E. 75th St., Chicago 19, Ill.

Price & Availability: *The product is built to customer specifications and price is furnished on request. It can be delivered in 90 to 120 days.*

Booth 1502-1504.

Transistor Transformers 470

Meet Mil-T-27A

These miniature, molded, transistor transformers are designed to meet MIL-T-27A and have a life of 10,000 hr. They measure 0.5 in. in diameter and are 0.5-in high. Weight is 4 g. Primary impedances are 400 to 100,000 ohms and secondary impedances are 11 to 2500 ohms. Construction for operation at 130 C is available on special order.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

Price & Availability: *Units are available for 24-hr delivery. Price is about $5 ea for small quantity orders.*

Booth 2315.

Vibration Pickup 372

Compact in design

Model TD-6 vibration pickup, having a wide frequency range, is about half the size of the previous model. The threshold velocity of this unit is essentially zero.

Southwestern Industrial Electronics Co., Dept. ED, 10201 Westheimer Rd., P.O. Box 13058, Houston 18, Tex.

Booth 3307-3309.

Switching Transistors 49

Medium power type

Types 2N696 and 2N697 diffused-silicon mesa transistors are for medium-power, small-signal amplifier and switching applications. Collector-to-emitter voltage is 40 v and collector power dissipation at 25 C is 2 w. Type 2N696 has a dc gain of 20 to 60 and type 2N697, 40 to 120. For both units, the small-signal current gain is typically 5. Collector saturation resistance is 3.5 to 10 ohms. Requirements of MIL-S-19500B are met.

Industro Transistor Corp, Dept. ED, 35-10 36th Ave., Long Island City 6, N.Y.

Price & Availability: *Price is $22.70 ea for 1 to 99 units; $15.15 for 100 to 999 units. They are available from stock.*

Booth 1628.

Wideband Mixer-Preamplifier 445

Range is 8.5 to 9.6 kmc

Model MMX-5 matched microwave-mixer assembly covers the range of 8.5 to 9.6 kmc and provides an if output-bandwidth of 100 mc. The if center frequency is 250 mc, gain is 15 db, and over-all noise figure is 10 db. The microwave receiver's front end is capable of handling the short pulses required for high resolution radar systems.

LEL, Inc., Dept. ED, 380 Oak St., Copiague, N.Y.

Price & Availability: *Price is $925 ea when one unit is ordered. Discounts are furnished for quantities. Delivery is in 30 days.*

Booth 2102.

CIRCLE 187 ON READER-SERVICE CARD ➤

superb new
NULL
DETECTOR

The new Keithley 151, incorporating a unique photo-conductive modulator of Keithley design, is useful wherever a suspension galvanometer can be used, and where a galvanometer is not sufficiently sensitive, fast or rugged. Currents as low as 2 x 10^{-13} ampere can be detected.

Ranges: 11 linear ranges in 1x and 3x steps, from 100 μv to 10 v f.s.; 5 non-linear ranges, 0.001 to 10 v f.s., each covering three decades.

Accuracy: Linear ranges, ±3% of f.s.; non-linear, ±10% of input.

Input Resistance: 10 megohms on all ranges. Max. power sensitivity over 10^{-17} watt.

Response Speed: On 100 μv range, 2.5-sec.; 1-sec. on all others.

Noise: Below 2% f.s. all ranges.

Zero Drift: Less than 10 μv per day.

Output: 10 volts at 1 ma f.s.

Price: 151 Cabinet Model . $395.00
151R Rack Model . $385.00

For full details write:

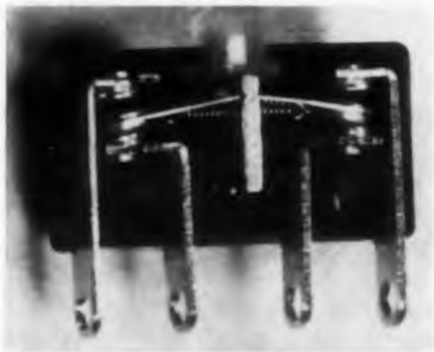
K.
KEITHLEY
INSTRUMENTS

12415 EUCLID AVENUE
CLEVELAND 6, OHIO
CIRCLE 188 ON READER-SERVICE CARD

◂ CIRCLE 187 ON READER-SERVICE CARD

Subminiature Switch 354

Rating is 10 amp at 30 v dc



Type 16 subminiature switch is rated at 10 amp at 30 v dc, inductive. Mechanical life is over 20,000,000 cycles and electrical life is over 940,000 cycles at 5 amp, 115 v ac and 140 cycles at 10 amp, 30 v dc. The unit has double break contacts and can operate from —100 to +300 F. It meets MIL-S-6743 as well as some of the requirements of MIL-E-5272. Solder, screw, or quick-disconnect type terminals are offered; they may extend from the bottom, the side, or the ends of the case.

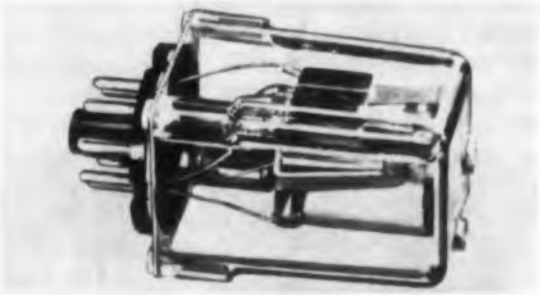
Illinois Tool Works., Licon Div., Dept. ED, 6606 W. Dakin St., Chicago 34, Ill.

Price & Availability: *Standard units are available from stock; others can be supplied in six to eight weeks. Price is quoted on request.*

Booth 1506.

Miniature Plug-In Relay 353

Has transparent cover



This class 33 plug-in mounted relay is furnished with a transparent styrene cover, which permits operating visibility, insulates the relay from electrical interference, and offers protection from dust or iron filings. The relay can be furnished for dc operation with contact combinations up to 3pdt. The enclosure is available with 8- or 12-pin octal style plugs. Over-all dimensions, including plug, are 2-11/12 x 1-3/8 x 1-3/8 in.

Magnecraft Electric Co., Dept. ED, 3350D W. Grand Ave., Chicago 51, Ill.

Price & Availability: *Price is $3.50 to $9.50 ea, depending on quantity and specifications. Delivery is in two to four weeks.*

Booth 2525.

CIRCLE 189 ON READER-SERVICE CARD ▸

LOOK INTO CEC CONNECTORS

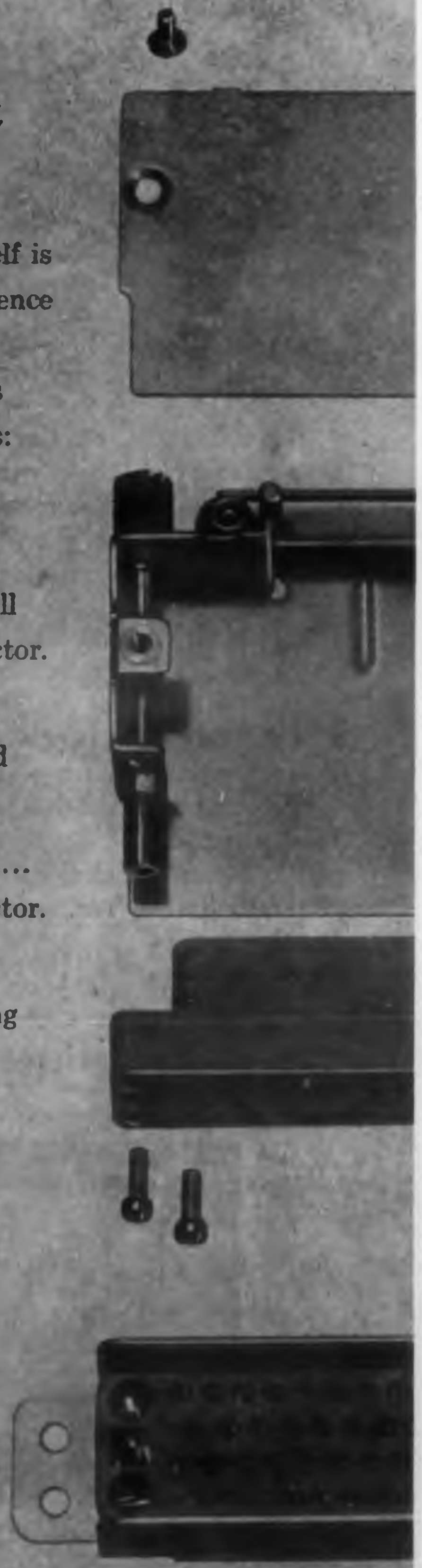
...see why they're guaranteed to give you highest reliability

The only thing you can't see for yourself is CEC's design and manufacturing experience in multi-contact rectangular connectors with snap-in contacts. That experience is well represented in the following features:

- Portal-hood speeds final assembly, permits full inspection of interior.
- Firmly attached cable clamp secures all wires to each other and to the connector.
- Jackscrews lock plug and receptacle together to withstand 50 g shock and cycling from 54 to 2,000 cps.
- Sturdy hood holds the insulator block... houses and protects the mated connector.
- Insulator block has deeply recessed contact openings and an unusually long insulation creepage path.

Yes, we can deliver. The 50-contact unit shown here is among many CEC types with 26, 34, 42, 50, 75 and 104 contacts.

For complete information, write for Bulletin CEC 4004-X21. Ask about CEC connector designs to your exact requirements.



Four-prong retention springs on pin and socket allow each contact to snap into insulator blocks easily, yet resist an axial pull of more than 20 lb. Inspection holes provide built-in quality control, permit visual checking of each wire for proper contact prior to assembly of connector.

Electro Mechanical Instrument Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

Timing System 455

Has 60-cps generator

This transistorized timing-system provides a time accuracy of 0.1 sec per week. The system incorporates a generator which provides 60-cps power, a power amplifier which boosts the 60 cps to 15 w for chart drives and other motors, and a clock and photocell-gated programmer providing 10-sec, 1-min, 30-min, and 1-hr timing pulses. A stroboscope has a scale displaying WWV signals so that system time can be compared and corrected. The system is powered by 24-v batteries. It operates over the temperature range of —10 to +50 C and with relative humidity of 0% to 95%. It weighs 25 lb.

The Geotechnical Corp., Dept. ED, P.O. Box 28277, Dallas 28, Tex.
Booth 3240.

Rheostat Potentiometers 361

Come in sizes of 25 to 150 w

These rheostat potentiometers come in sizes of 25, 50, 75, 100, and 150 w with variations of shafts, tolerances, and off positions. The units are designed to meet MIL-R-22. Large cores allow for longer life and prevent burnouts. Other characteristics are: no backlash in shaft, precise winding, insulated shaft, high temperature enamel, and rugged construction.

Tru-Ohm Products, Div. of Model Engineering & Manufacturing, Inc., Dept. ED, 2800 N. Milwaukee Ave., Chicago 18, Ill.
Booth 2305.

See these new Raytheon Product

INDUSTRIAL COMPONENTS DIVISION

New Kilo-line recording storage tubes provide 1000 TV lines at 50% modulation. These high-resolution, low-noise tubes for frequency and scan conversion utilize a specially designed tetrode electron gun for a resolution of 1,000 TV lines at 50% modulation and provide better control over beam cut-off than conventional triode guns. Applications include: (1) scan conversion for bright display radar and moving target indicators, (2) slow-down video for still picture telephone transmission, (3) stop-motion video.

CIRCLE 832

New pointer knobs virtually eliminate parallax. Two new sloping pointer style control knobs have been added to Raytheon's widely used commercial and military knob line. The new pointer series complies fully with military specifications and is available in black or grey, with or without dial skirts; in mirror or non-reflective matte finish. Colors are available on special order. Raytheon's complete line of knobs includes 206 styles —9 standard types in 6 sizes, plus tactile shapes, color and color caps.

CIRCLE 833

COMMERCIAL APPARATUS & SYSTEMS DIVISION

New Voltage-regulating PF transformer holds voltages to within ± 3%. The new Raytheon voltage regulating PF transformer maintains plate and filament voltages to within ± 3% of rated output with line voltage variation of from 100 to 130 volts. PF transformers are now available in three standard models with ratings up to 380 VDC at 250 MA. They eliminate need for VR tubes and special circuitry.

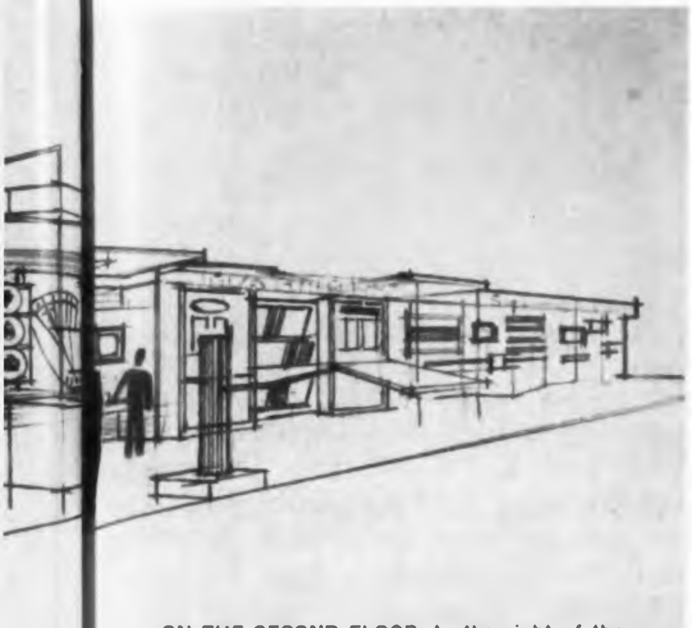
CIRCLE 834

Sorensen Series Q line of power supplies for 6, 12 or 28 VDC regulated. The Sorensen Series Q power supply line is comprised of 15 different models with outputs of 6, 12 or 28 VDC, adjustable approximately ± 25%. Voltages are regulated within ± 0.05% for load and line combined. Power capacities range up to 200 watts. The complete line of Sorensen power supplies covers requirements from 600,000 volts down to 3 volts. Sorensen also offers a line of frequency changers and line voltage regulators.

CIRCLE 835

Visit us at the New York Coliseum, Booths 2604-2614

Developments at the IRE Show

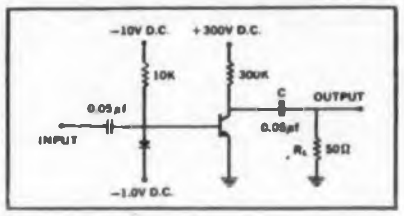


ON THE SECOND FLOOR, to the right of the escalator, you'll find this Raytheon exhibit of electronic component and equipment advances—N. Y. Coliseum, Booths 2604-2614.

SEMICONDUCTOR DIVISION

New "Avalanche Mode" Silicon Transistor switches in 2½ milli-μsec.

A guaranteed switching time of 10 millimicroseconds maximum (when used in the switching circuit shown) with speeds faster than 1½ milli-microseconds in some applications is now possible with Raytheon's new



2N1468 Silicon NPN transistor for avalanche mode operations. Other features: 40 watts peak power, average power dissipation of 250 milliwatts, maximum operating temperature of 125°C.

CIRCLE 836

New Silicon Mesa Transistor in Subminiature Package.

Raytheon's Semiconductor Division announces the availability of high-performance Silicon Mesa transistors in subminiature packages (.130" D., .160" H.). These units feature the reliable "Mesa" construction, alpha cut-off frequencies up to 50 megacycles and close control of DC base-current gain in high-speed switching types.

CIRCLE 864

MICROWAVE AND POWER TUBE DIVISION

Four new ruggedized backward wave oscillators cover 1-12.4 kmc. Four compatible Raytheon BWO's now provide continuous frequency coverage from 1 to 12.4 kmc. They utilize interdigital delay-line structures for greater ruggedness and heat dissipating characteristics, are smaller and lighter than their predecessors and have improved fine-grain tuning variations with minimized fine-grain power output variations. Forced air cooling is not required under normal operating conditions.

CIRCLE 860

New ferrite circulators for masers, parametric amplifiers and radio astronomy. A standard line of extremely compact, low-frequency, three-port ferrite circulators is now available from Raytheon. Now, a total of twenty-eight units are available – for UHF as well as S- and L-band applications. The new UHF unit extends the frequency range down to 400 mc. These circulators are supplied with fixed permanent magnet fields (as illustrated) or with tuned magnetic fields for full performance over a broader band.

CIRCLE 861

MACHLETT LABORATORIES

UHF planar triode has 60% more cathode current capacity. This unique, Machlett developed UHF planar triode with ceramic envelope has 1.6 times the cathode current rating of the more conventional tubes in current use. The new ML-7211 has applications in communications, navigation, telemetering, radar and missile equipment of the most advanced design.

CIRCLE 862

Improved camera tube for general closed-circuit TV applications. Machlett's novel vidicon camera tube features photoconductor guard and self-aligning beam eliminating the need for permanent magnets or coils. This tube will be exhibited at the IRE along with Machlett's water-cooled triode rated at 20-megawatts peak power, a scan conversion tube for conversion of radar information to TV display, and a high-power vapor cooled tube for general purpose modulator, amplifier and oscillator services.

CIRCLE 863

RAYTHEON COMPANY
Waltham, Massachusetts

RAYTHEON

Excellence in Electronics

CIRCLE 832 THRU 836 AND 860 THRU 864

Crystal Frequency Synthesizer 393

Output range is 2 to 34 mc

Model N317 crystal frequency synthesizer has an output range of 2 to 34 mc, covered in four bands. Stability is better than 1 x 10^{-8} per day. Spurious signals, except harmonics of the output, are suppressed to —80 db. Minimum tuning increment is 125 cps; rapid tuning in 10-kc steps is also permitted. Power output at any setting is 100 mw min into a 50-ohm load. Input is 200 w, 117 v, 60 cps. Applications include: transmitter exciters, frequency standards, signal generators, frequency meters, and sideband receivers. Both bench and rack models are offered.

Manson Laboratories, Inc., Dept. ED, P.O. Box 1214, Stamford, Conn.

Price & Availability: Price is $9500; delivery time is 120 days.

Booth 3923.

Subminiature Crystal Case Relay 364

Is dpdt type

This dpdt subminiature crystal case relay meets severe industrial and military specifications and exceeds the requirements of MIL-R-25018, MIL-R-5757C, and MS24250. It can be used in control systems, computers, airborne and guided missile equipment, and similar applications. Bifurcated contact structure is used to improve reliability and efficiency in dry circuit applications. The relay is designed for continuous operation from —65 to +125 C and has a life expectancy of 100,000 operations. It is slightly more than 1 in. long and weighs about 0.5 oz.

Union Switch & Signal, Div. of Westinghouse Air Brake Co., Dept. ED, Swissvale, Pa.

Price & Availability: Information on request.

Booth 2122-2124.

Tensolite's

CABLE
CAPABILITIES

did the rest!

With solid core and air dielectric coaxial cable, and hook-up wire of several AWG sizes—*all insulated with Teflon®*—these complex cables are typical of the work Tensolite is doing in the exacting cable and cable assembly fields.

Our design engineers were given the problems by the equipment manufacturers. Jointly, their engineers and ours developed specs, and Tensolite took it from there. Tensolite translated these requirements, utilizing components manufactured in our own plants, into highly reliable cable.

Many leading aircraft and electronic manufacturers are taking advantage of Tensolite's cable design and production facilities. We'd like to work with you on your high temperature cable problems. Contact your local Tensolite representative or write to:

Tensolite
INSULATED WIRE CO., INC.
A subsidiary of Carlisle Corporation
West Main Street, Tarrytown, N.Y.
Pacific Division: 1516 N. Gardner St., Los Angeles, Calif.

®DuPont

View of a portion of a SAGE Display Console. Nearly a mile of wire and cable is used in each of these consoles. Tensolite supplies wire and cable to meet the specified requirements.

Interior view of Hawk guided missile Battery Control Center Cable Entry Enclosure developed by *Raytheon Company*, shows Tensolite-built cables of several sizes and types. *Raytheon Missile System Division* is prime contractor for the Army's Hawk system.

SEE US AT BOOTH 4330 AT THE I.R.E. SHOW
CIRCLE 191 ON READER-SERVICE CARD

DC Limit Bridge 44

Range extends to 11,111 meg

Model AB-4-4 dc limit-bridge has a usable range extending to 11,111 meg. Decade steps are: 1 meg, 100 K, 10 K, 1 K, 100 ohms, 10 ohms, 1 ohm, and 0.1 ohms. A built-in 8-dial resistance decade is used for setting the value of the resistance to be tested. Accuracy is from ±0.1% to ±0.3%. The bridge voltage is variable from 1.5 to 24 v. The unit is suitable for testing precision wirewound, metal, or carbon film resistors, as well as composition resistance elements. It performs GO/NO-GO testing.

Industrial Instruments Automation Corp., Dept. ED, 89 Commerce Rd., Cedar Grove, Essex County, N.J.
Booth 3227-3229.

Power Oscillator 355

Has outputs of 100 and 1000 v

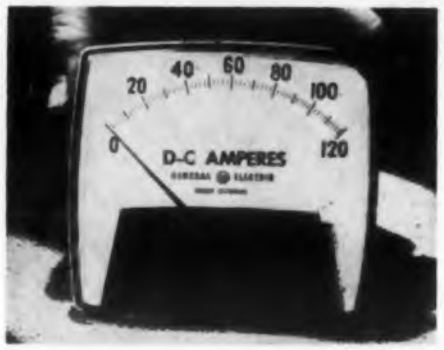
Model DK-115-14 precision power oscillator is a 15-w unit with outputs of 100 and 1000 v. Regulation on both outputs is better than 0.1%. The temperature-sensitive bridge elements are encapsulated in a constant temperature oven to provide voltage stability. Frequency range of the unit is 200 cps to 10 kc. For relay rack mounting, the unit has dimensions of 5.25 x 8 x 19 in. Other voltage arrangements can be provided.

International Electronic Research Corp., Elin Div., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

Price & Availability: *Price is $795. Delivery time is four weeks.*
Booth 3018.

Panel Meters 358

For standard voltage and current ratings



For all standard ac and dc voltage ratings as well as current ratings, the Big Look panel meters have a 3.93-in. scale length. Scales are custom made to meet customer requirements. Mounting conforms to ASA C39.1. They are 4.5-in. units.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

Price & Availability: *The product will be available from stock by May 1, 1960. Price has not been determined.*

Booth 2904-2932.

Vane Axial Blower 360

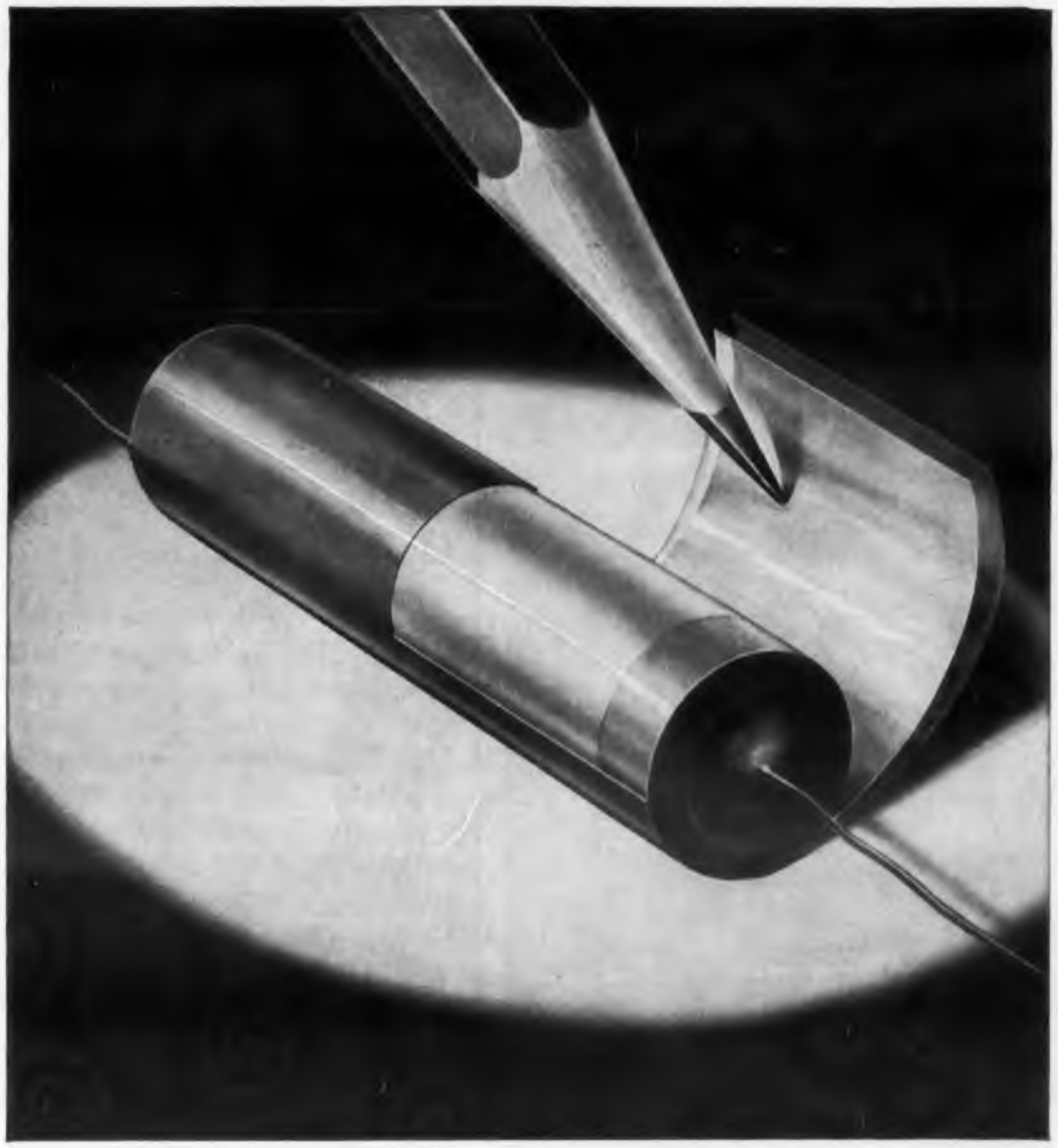
Delivers 200 cfm

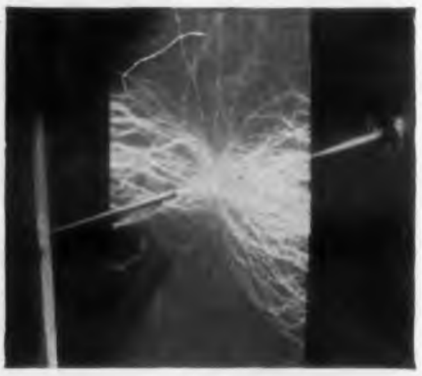
Model E2543-200 vane axial blower operating at 10,500 rpm delivers 200 cfm at 3/4-in. water gage. It is for use where maximum air and medium static pressure are important. Having class F insulation, the unit stands ambient temperatures to 85 C and has a life in excess of 5000 hr. It also meets MIL-E-5400B. Weighing 3.5 lb, the unit utilizes a motor with a 2-5/16 in. diam and has over-all dimensions of 4 in. in diameter and 4-1/2 in. in length.

Air-Marine Motors, Inc., Dept. ED, 369 Bayview Ave., Amityville, L.I., N.Y.

Booth 2601.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN





PROPERTIES OF "MYLAR"

"Mylar" offers a unique combination of properties that may help you improve performance and lower costs of your product. Here are two of the many important properties for evaluation.

HIGH DIELECTRIC STRENGTH: Average of 4,000 volts per mil† . . . average power factor of 0.003 at 60 cycles.

SUPERIOR CHEMICAL RESISTANCE: Unaffected by oils, grease, most acids and alkalis, moisture and solvents.

Western Electric reports . . .

Du Pont MYLAR® cuts capacitor costs

PROBLEM: Western Electric was searching for a dielectric material which, when used in film-foil construction, would lower manufacturing costs.

SOLUTION: Du Pont "Mylar"* polyester film. According to Western Electric, the moisture resistance of "Mylar" minimized the need for costly encapsulation; high dielectric and physical strength in thin gauges helped reduce over-all size; capacitance stability under normal voltage stress maintains long life.

RESULTS: Capacitors insulated with "Mylar" provide excellent performance for selected types of equipment produced by Western Electric. These new capacitors achieve high reliability and long life. Materials savings have been realized through reductions in size and use of less costly encapsulation.

HOW CAN "MYLAR" HELP YOU? Whether your product uses miniaturized capacitors or heavy-duty cables, it will pay you to investigate the performance benefits of "Mylar". . . and products made with "Mylar". Component makers find this tough, thin polyester film will often cost less on an area basis than present insulating materials. For more detailed information, send in the coupon.

See Du Pont specialized films for the electronics industry—Booth 4329A, 4329B, I. R. E. Show.

*"MYLAR" *is Du Pont's registered trademark for its brand of polyester film.*
†*Per ASTM D-149.*

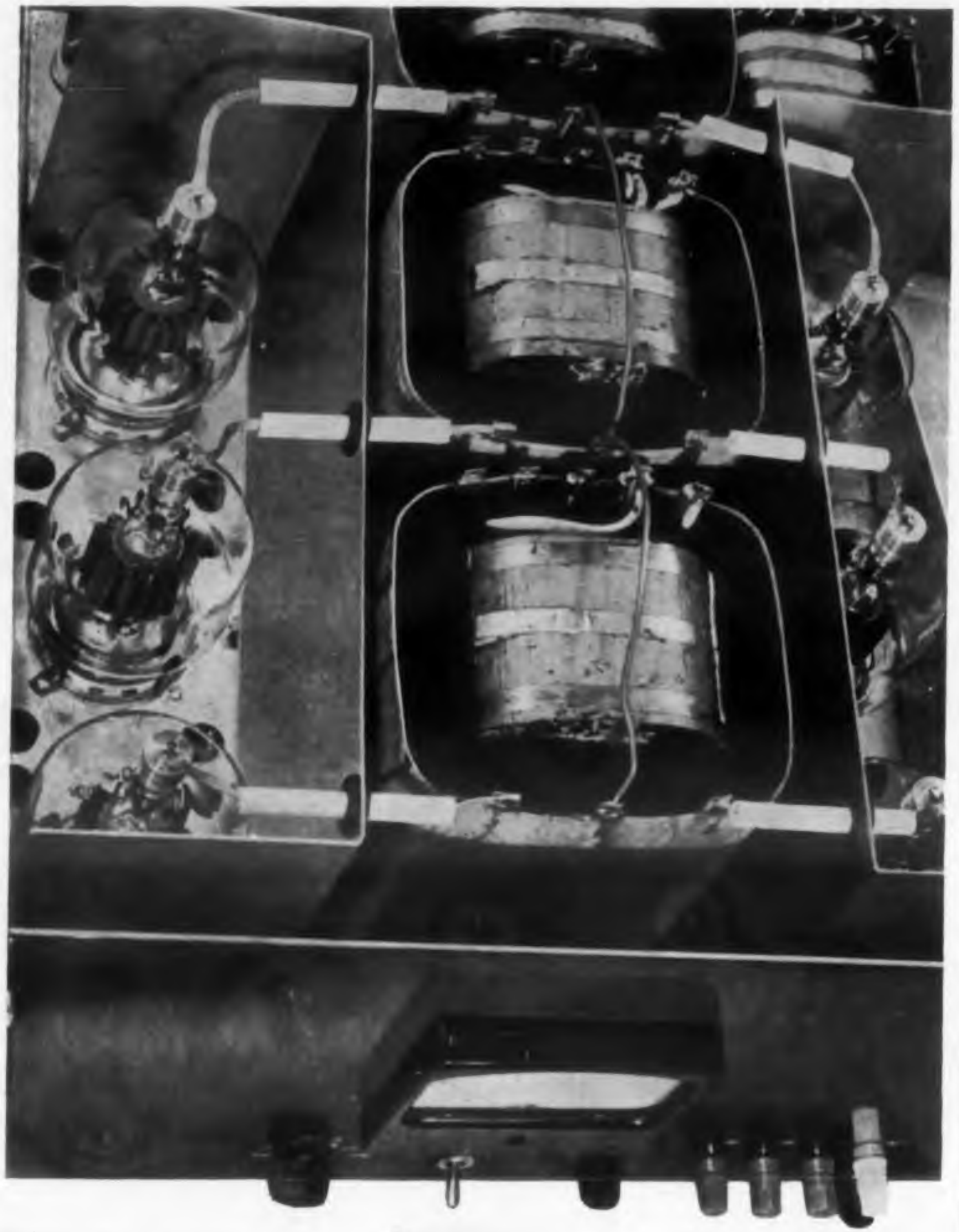
DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

DU PONT
MYLAR®
POLYESTER FILM

E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room ED-3, Nemours Bldg., Wilmington 98, Del.
Please send booklet listing properties, applications and types of "Mylar" polyester film available.

Application ____________________
Name ____________________ Title ____________
Company ____________________
Address ____________________
City ____________________ State ____________

CIRCLE 192 ON READER-SERVICE CARD



"When we get reports from a large customer that the Penta power tubes in our Invertron last about 10,000 hours at full power and give the highest reliability, you can see why we use them," says Behlman Engineering Company, Burbank, Calif.

Penta power tubes are used in the majority of the many models of the Invertron AC power supplies, which cover the range from milliwatts to kilowatts. Like every other Invertron component, they were chosen after the most rigorous competitive testing.

'PENTA POWER TUBES GIVE US LONG LIFE AND RELIABILITY'

...THAT'S WHY THEY'RE USED IN BEHLMAN ENGINEERING'S INVERTRON®

The same Penta tubes, proved through use by major manufacturers, are available to you right off the shelf. Whether you're a volume manufacturer or a ham building a rig, you'll find Penta power tubes unsurpassed for long life and reliability. Call or write now for full information.

Featuring frequency accuracy, exceptional regulation, and low noise, Invertrons use either Penta PL-177A, PL-4D21, PL-4D21A, PL-4-400A or PL-5D22 power tubes, depending on the output.

Penta
PL-177A
Power Tube

Penta
PL-4D21A
Power Tube

Penta
PL-4-400A
Power Tube

Penta
PL-5D22
Power Tube

PENTA LABORATORIES INC.

312 N. Nopal St. Santa Barbara, Calif. WOodland 5-4581

CIRCLE 193 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Traveling Wave Tube 351

Frequency range is 1 to 2 kmc

Type STL-222 traveling wave tube has a frequency range of 1 to 2 kmc. Signal gain is 48 db min and saturated power output is 2 w nominal. Metal and ceramic construction is used to permit applications in a wide range of environmental conditions. Periodic permanent magnet focusing, requiring no power supply, is used. Beam voltage is 1000 v, beam current is 35 ma, grid bias is 35 v, grid current is 5 ma, and grid cut-off signal is —20 v max. The input-output isolation is 75 db min. It is suited for airborne applications. Other units are available, covering the complete range of P to X bands.

Sperry Electronic Tube Div., Sperry Rand Corp., Dept. ED, Gainesville, Fla.

Price & Availability: *Delivery is in 60 days; Price is quoted on request.*

Booth 2432-2438.

Printed Circuit Connectors 457

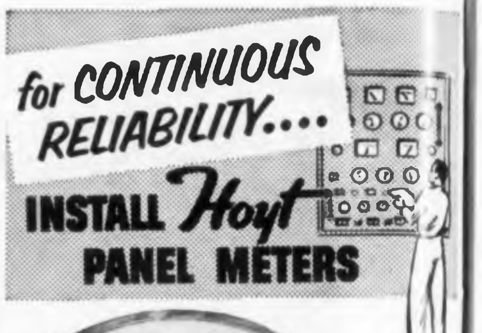
Have 28 contacts

Series 200-70-15, 14, and 13 right-angle plug and socket printed circuit connector has 28 contacts. It can be supplied with or without threaded mounting-holes for dip soldering. The body material is glass-reinforced with diallyl phthalate as per MIL-M-19833. A polarizing key can be placed in any socket contact from 2 to 27 after the mating-pin contact has been removed.

Continental Connector Corp., Dept. ED, 34-63 56th St., Woodside 77, N.Y.

Price & Availability: *Delivery is in 45 to 60 days; price varies with specifications.*

Booth 2307-2309.



Model 1035
Transparent Polystyrene

Quality meters on the panel indicate quality throughout—and HOYT Panel Meters are quality in appearance and function . . . the complete Line of matching AC and DC Meters for original equipment and replacement applications. Get accuracy, readability, and reliability; plus economy. Specify HOYT Electrical Instruments—compatible components for production, research, and test requirements.

Model 647
Black Bakelite

Moving coil, rectifier, and repulsion types available promptly in a wide assortment of sizes, ranges, cases, shapes, and colors; some with parallax-free mirror scales—all with standard mounting dimensions. Or custom designed to the most exacting specifications.

Model 17/3
Black Bakelite

Send for latest fully illustrated brochu with descriptions, engineering dat and moderate prices.

VISIT OUR DISPLAY AT THE IRE SHOW

Hoyt SINCE 1904 ELECTRICAL INSTRUMENTS

BURTON-ROGERS COMPANY
Sales Division—Dept. ED
42 Carleton Street, Cambridge 42, Mass

CIRCLE 194 ON READER-SERVICE CARD

Time Delay Relay 363

Delay times are 50 msec to 3 min

Series 1100 time delay relay has standard delay times of 50 msec to 3 min during operate or release cycle. Accuracies of 10% or better can be obtained under the following operating conditions: vibration, 20 g at up to 2000 cps; temperature, —65 to +125 C; and shock, 50 g. Contact ratings to 10 amp are offered. Units are supplied for either ac or dc source voltages. Relays with longer delays or with delay during operate or release time can also be furnished.

Hi-G, Inc., Dept. ED, Bradley Field, Windsor Locks, Conn.

Price & Availability: Units are made on order and can be delivered in 30 to 60 days. Price is quoted on request.

Booth 2227.

Amplifier 454

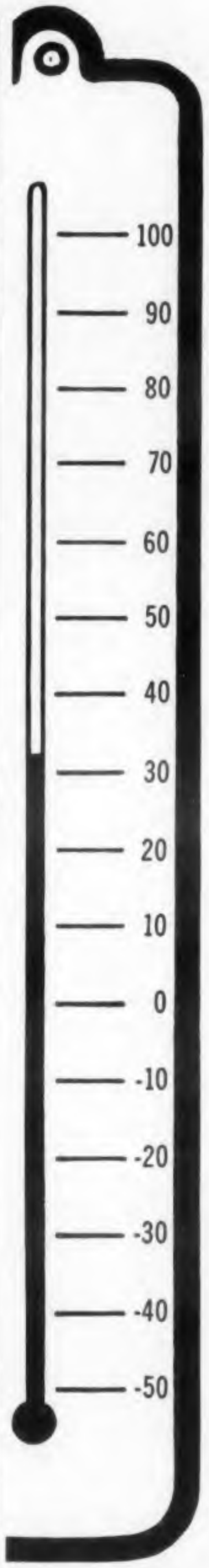
Range is 30 to 300 mc

Model UH-2(A)S amplifier, designed to have a minimum noise-figure, operates in the range of 30 to 300 mc. The unit uses coplanar triodes in a cascade circuit. Broadband response is 5% to 10% of center frequency. Gain is up to 25 db, input impedance is 50 ohms, and output impedance is 50 ohms. The unit measures 6.75 x 3.5 x 3.5 in. and weighs 2-7/8 lb.

Applied Research Inc., Dept. ED, Port Washington, N.Y.

Availability: The unit is made on order and can be delivered in 30 days.

Booth 1110.



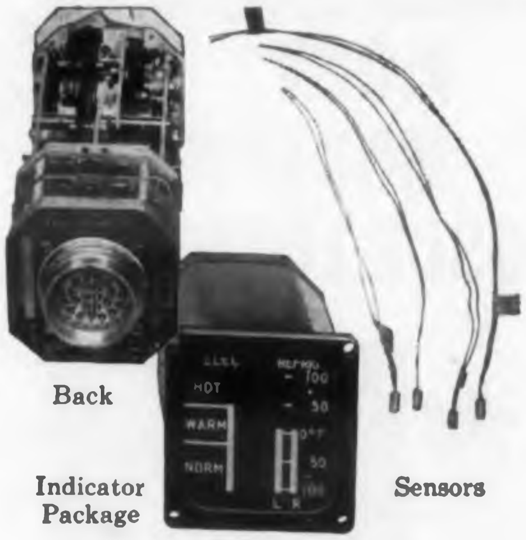
1 or 6...

How do you take the temperature of an electronic system?

Use ONE Compact, Accurate, Lightweight, Completely Transistorized Oster-Developed Temperature Indicating System. Replaces 6 Indicating Systems.

The device illustrated senses and displays the highest of 4 temperature sensor signals on the Convair B-58 supersonic bomber. It also reads out the temperature of the plane's 2 refrigeration systems. However, the unit can monitor temperature of any military or commercial electronic system. Special versions can be furnished to monitor any analog voltage signal.

Oster®



Back

Indicator Package

Front

Sensors

Entire unit (component parts illustrated) has an accuracy of 1½%, weighs only 3.85 lbs. max., requires only 2⅜" panel space, and does the work of 6 indicating systems. Component parts consist of 4 sensors, a computer package with 6 channels, and a hermetically sealed indicator package.

The unit is typical of Oster designed equipment.

Computer Package

For help with your instrumentation and display problems, talk to the specialists at the Avionic Division.

Burton Browne Advertising

OTHER PRODUCTS INCLUDE:

Servos
Synchros
Resolvers
Motor Tachs
DC Motors
Computers
Indicators
Servo Mechanisms
Servo Torque Units

John Oster MANUFACTURING CO.
Specialists in Instrumentation and Display
Avionic Division
Racine, Wisconsin

EASTERN OFFICE 310 Northern Blvd. • Great Neck, Long Island, New York
Phone: HUnter 7-9030 • TWX Great Neck N.Y. 2980

WESTERN OFFICE 5333 South Sepulveda Blvd. • Culver City, California
Phone: EXmont 1-5742 • UPton 0-1194 • TWX S. Mon. 7671

Engineers For Advanced Projects: Interesting, varied work on designing transistor circuits and servo mechanisms.
Contact Mr. Robert Burns, Personnel Manager, in confidence.

CIRCLE 195 ON READER-SERVICE CARD

MOST MODERN OSCILLOSCOPE COMMERCIALLY AVAILABLE

the DU MONT® 425

The first oscilloscope with digital and printed ReadOut, and versatility exceeding all other commercial models.

- DC to 35 mc—useful to 60 mc
- Accurately repeatable measurements—even by untrained personnel
- Direct reading digital ReadOut of measurements
- Analog to digital converter—external recorders of all types
- Largest useful viewing area—5 x 10 cm.
- Modular construction—replaceable modules
- Two plug-ins used simultaneously
- Electronic switches in X, Y and Z axis
- No tube selection required

The Du Mont 425 will outperform any commercially available oscilloscope in its class. The 425 is not only a dc to 35 mc scope (useful to 60 mc now, 600 soon), but simultaneous use of two plug-ins from a large selection of functional plug-ins extends its versatility to infinity—it defies obsolescence. Add to this such features as: digital ReadOut of measurements, a unique two-dot system for making accurately repeatable measurements by minimizing human error, joystick control of traces, replaceable modular construction, and many others. **The more you know about scopes—the more you'll want the 425 by Du Mont.** Write for complete technical details.

PRICE: $2750⁰⁰
(without plug-ins)

DU MONT®

See us at the IRE Show, Booth 3901-2

precision electronics is our business

ELECTRONIC TUBES/INDUSTRIAL TV/MILITARY ELECTRONICS/MOBILE COMMUNICATIONS/SCIENTIFIC INSTRUMENTS/AUTOMOTIVE TEST EQUIPMENT

Allen B. DuMont

ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J., U. S. A.
INTERNATIONAL DIVISION • 515 MADISON AVENUE, NEW YORK 22, N. Y. • CABLES: ALBEEDU, NEW YORK

CIRCLE 196 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

1-Kc Limit Bridge 522

Accuracy is ±0.3%

Model AB-3-5 1-kc limit bridge has an accuracy of ±0.3%. For testing capacity, resistance, and impedance, ranges are 100 μμf to 15 μf, 10 ohms to 5 meg, and 10 ohms to 5 meg. Such components as resistors and capacitors, can be tested at a rate of 1500 pieces per hr. The instrument performs GO/NO-GO tests. Decade type units or individual units can be supplied.

Industrial Instruments Automation Corp., Dept. ED, 89 Commerce Rd., Cedar Grove, Essex County, N.J.
Booth 3227-3229.

Spectrum Analyzer 507

Range is 7 cps to 23 kc

Model SS-20 spectrum analyzer gives a high-resolution Fourier analysis in the range of 7 cps to 23 kc. The unit is for use with vibration systems, tape recorder testing, and magnetic tape analysis. Characteristics include: a continuously variable sweep width of 50 cps to 6 kc with automatic optimum resolution, 500-μv full scale sensitivity, 60-db dynamic range, and a linear and log amplitude scale.

Probescope Co., Inc., Dept. ED, 8 Sagamore Hill Drive, Port Washington, N.Y.
Booth 3116-3118.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

When you want'em ...you've got'em!

Good-All
CAPACITORS

AUTHORIZED INDUSTRIAL
DISTRIBUTORS

ALBANY
E. E. Taylor Inc.
BALTIMORE
Kann-Ellert Electronics, Inc.
BATTLE CREEK
Electronic Supply Corp.
BIRMINGHAM
M. G. Electrical Equipment Co.
BUFFALO
Radio Equipment Corp.
BOSTON - CAMBRIDGE
Electrical Supply Corp.
CHICAGO
Lukko Sales Corp.
Newark Electric Co.
CLEVELAND
Pioneer Electronic Supply
DALLAS
Engineering Supply Co.
DAYTON
Screpco Inc.
DENVER
Denver Electronic Supply, Inc.
FORT WAYNE
Fort Wayne Electronics Supply, Inc.
HOUSTON
Harrison Equipment Co. Inc
INDIANAPOLIS
Graham Electronics Supply Inc.
KANSAS CITY
Burstein-Applebee Co.
LOS ANGELES
Radio Products Sales
MIAMI
Electronic Equipment Co., Inc.
MINNEAPOLIS - ST. PAUL
Northport Electronics, Inc.
NEW YORK - NEW JERSEY
Arrow Electronics Inc. (Mineola)
Eastern Radio Corp.
Electronics Center Inc.
PHILADELPHIA - CAMDEN
General Radio Supply Co.
Phila., Electronics, Inc.
POUGHKEEPSIE
Higgins & Sheer Electronic Distributors
ROME
Rome Electronics, Inc.
SAN DIEGO
Radio Parts Co.
SAN FRANCISCO
Fortune Electronics
SCRANTON
Fred P. Pursell
SEATTLE
C & G Radio Supply Co.
SOUTH BEND
Radio Dist. Co., Inc.
SPRINGFIELD
T. F. Cushing Inc.
ST. LOUIS
Interstate Supply Corp.
TULSA
Oil Capitol Electronics Corp.
WASHINGTON, D.C. - ARLINGTON
Industry Services Inc.
WATERBURY
Bond Radio Supply Inc.

GOOD-ALL ELECTRIC MFG. CO.
Distributors' Div.
26 Rittenhouse Pl. Ardmore, Pa.

CIRCLE 197 ON READER-SERVICE CARD

Static Inverter 506

For missile and aircraft use

Model 4314 regulated, 400-cps, sine-wave, static inverter is for missile and aircraft use. It drives hysteresis motors, gyros, and other single-phase loads. Operating from a 28-v dc source, it develops 18 va. Frequency regulation is ±1%, voltage regulation of 26 v is ±2%, maximum harmonic content is 5%, and over-all efficiency is 70%. Silicon transistor circuitry is used. Environmental specifications include altitudes to 100,000 ft, temperatures from —54 to +100 C, and a vibration level of 10 g from 55 to 2000 cps. The complete package weighs less than 2 lb.

Varo Manufacturing Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

Booth 1731.

Electronic Counter 501

Frequency range is 1 cps to 120 kc

Model 521E electronic counter, having a count capacity of 99,999, has a frequency range of 1 cps to 120 kc. The crystal time base assures an accuracy of 0.01% ±1 count. Display time can be adjusted from the gate time selected to about 15 sec, or it can be held until reset. Besides measuring frequency and random events per unit of time, the instrument can be used to measure weight, pressure, temperature, acceleration, and other quantities.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palo Alto, Calif.

***Price & Availability:** Price is $875. The unit can be delivered in one week.*

Booth 3302-3306, 3401-3405.

Good-All CAPACITORS

50-Volt SUBMINIATURES for Transistor Circuitry

METAL ENCLOSED • MYLAR DIELECTRIC • HERMETICALLY SEALED

These space-saving designs are conservatively rated and capable of being produced to comply with **HIGH RELIABILITY SPECIFICATIONS** comparable to MIL-C-14157 and MIL-C-26244 (USAF)

Full Rated to 85°C

Types **626G - 627G** (Extended foil)
Types **628G - 629G** (Inserted tab)

Temperature Range—Full rating at 85°C — to 125°C with 50% derating.
Life Test—500 hours at 85°C and 125% of rated voltage.
Capacity Tolerance—All tolerances to ± 1%.
Insulation Resistance—40,000 meg. x mfd. at 25°C but need not exceed 70,000 megohms.
Case Styles—Available in all case style variations in MIL-C-25A.

Full rated to 125°C

Type **616G** (Extended foil)
Type **617G** (Extended foil)

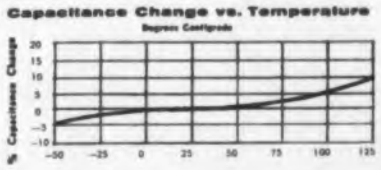
Temperature Range—Full rating to 125°C - to 150°C with 50% derating.
Life Test—500 hours at 125°C and 125% of rated voltage.
Capacity Tolerance—All tolerances to ± 1%.
Insulation Resistance—50,000 meg. x mfd. at 25°C but need not exceed 100,000 megohms.
Case Styles—Available in all case style variations in MIL-C-25A.

50-VOLT DIMENSIONS

Capacitance in Mfds.	626G*	627G	628G*	629G	616G*†	617G†
	D L	D L	D L	D L	D L	D L
.001	.173 x 21/32	.173 x 23/32	.173 x 1/2	.173 x 9/16	.173 x 11/16	.173 x 3/4
.0022	.173 x 21/32	.173 x 23/32	.173 x 1/2	.173 x 9/16	.173 x 11/16	.173 x 3/4
.0047	.173 x 21/32	.173 x 23/32	.173 x 1/2	.173 x 9/16	.193 x 11/32	.193 x 3/4
.01	.173 x 21/32	.173 x 25/32	.173 x 1/2	.173 x 9/16	.193 x 11/32	.193 x 3/4
.022	.233 x 21/32	.233 x 25/32	.193 x 21/32	.193 x 23/32	.233 x 7/8	.233 x 15/16
.047	.312 x 21/32	.312 x 25/32	.233 x 21/32	.233 x 25/32	.312 x 11/16	.312 x 3/4
.1	.312 x 25/32	.312 x 31/32	.312 x 21/32	.312 x 25/32	.400 x 7/8	.400 x 7/8
.22	.400 x 1	.400 x 1 1/16	.400 x 7/8	.400 x 15/16	.500 x 1	.500 x 1 1/8
.47	.500 x 1 1/8	.500 x 1 5/16	.500 x 1	.500 x 1 1/16	.562 x 1 1/8	.562 x 1 1/8
1.0	.560 x 1 11/16	.560 x 1 15/32	.560 x 1 13/32	.560 x 1 13/32	—	—

*These types have one lead grounded to the case. Others have both leads insulated.

†Also available in 150V, 400V & 600V ranges.



Write for literature on these new types.

GOOD-ALL ELECTRIC MFG. CO. • OGALLALA, NEBRASKA

GOOD-ALL CAPACITORS NOW AVAILABLE
AT YOUR LOCAL DISTRIBUTOR

SEE LIST OF
AUTHORIZED DISTRIBUTORS
ON FACING PAGE

CIRCLE 198 ON READER-SERVICE CARD

save costs, save labor, save design time with

SORENSEN "SOLDER-IN'S"

Miniature transistorized, component-type power-packs • DC-to-DC Converters (Series QC) • DC-to-AC Inverters (Series QI) • Highly-regulated D-C Supplies (Series QM)

MORE THAN 180 MODELS!

■ If you have 117 vac, 60 or 400 cps, available, and need 3-36 vdc regulated to ±0.05% . . . ■ If you have available standard 6-, 12-, or 28-volt d-c sources and . . . ■ If you need 115 vac, 60 cps, at up to 200 watts, or . . . ■ If you need 115 vac, 400 cps, at up to 240 watts, or . . . ■ If you need d-c voltage in the range 30 to 1000 vdc . . .

Then you should get complete data on Sorensen miniature transistorized dc-to-ac inverters (Series QI), dc-to-dc converters (Series QC) and highly-regulated supplies (Series QM). They're completely tubeless; no moving parts. They can replace vibrator-type supplies, rotary inverters or dynamotors—with greatly reduced weight, size, complexity, and cost.

Write for bulletins on these compact, low-cost power sources, or see your Sorensen representative. Sorensen & Company, Richards Avenue, South Norwalk, Connecticut. 9.40

Sorensen

CONTROLLED POWER PRODUCTS

. . . the widest line lets you make the wisest choice

Visit the Sorensen Booth at the IRE Show—March 21-24
CIRCLE 199 ON READER-SERVICE CARD

NEW PRODUCTS

Metallized Inductors 448

Range is 2 to 0.05 μh

These compact, metallized inductors offer an inductance of 2 to 0.05 μh, in steps of 0.5 μh. Length of the units is from 1-19/32 to 9/16 in., depending on inductance. They have a low temperature coefficient of inductance and frequency. Both fixed and variable types are available. Pistons are brass, invar, powdered iron, or ferrite.

JFD Electronics Corp., Dept. ED, 6101 Sixteenth Ave., Brooklyn 4, N.Y.

Availability: *Units are available for 7-day delivery.*

Booth 1622.

VTVM 627

Full scale sensitivity is 3 mv

This ac vtvm has a sensitivity of 3 mv full scale and provides 11 ranges which extend to 300 v. Response range is 20 cps to 2.5 mc and accuracy is within 3% over the frequency range. The proper range is automatically selected when the probes touch the circuit. The instrument is for operation on 105 to 125 v ac, measures 10-1/4 x 6-5/8 x 10-1/4 in., and weighs 13-1/2 lb.

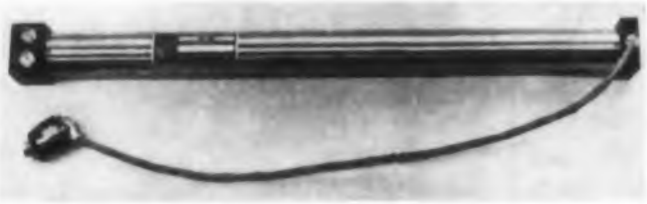
Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.

Price & Availability: *Available from stock, the unit is priced at $99.50.*

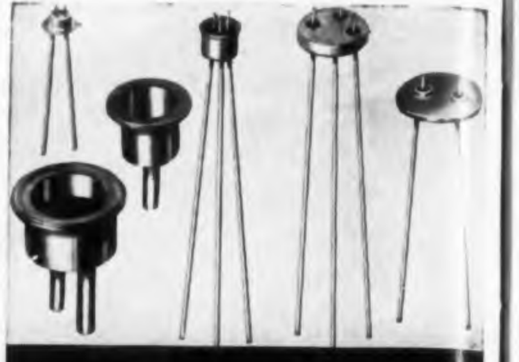
Booth 3915-3917.

Traveling Wave Tube 444

Gain is 30 db min



Type HA 58 traveling wave tube operating in the frequency range of 500 to 1000 mc, has a signal gain of 30 db min and a saturation gain of 28 db min. Electrostatically focused, this tube is rated at 1 w. No magnetic structure or solenoid



Quality
Is The Constant In
GLASS-TITE
HERMETIC SEALS

Glass-Tite's story is simple and successful. They make a custom seal to your most minute specifications or they supply standard glass-to-metal seals — either way they make only one quality . . . THE BEST. No design requirement is too tough, no reasonable delivery date is impossible.

Specify Glass-Tite in Kovar and compression seals, diodes and rectifier enclosures for the semi-conductor industry and all electronic applications.

Write Dept. 727 for literature and send details of your design requirements.

I.R.E. BOOTH 1109 563-9

GLASS-TITE
INDUSTRIES, INC.
725 BRANCH AVENUE
PROVIDENCE, R. I.

CIRCLE 200 ON READER-SERVICE CARD

or permanent magnet is needed. Dimensions are 1.25 in. in diam and 18 in. in length. Operating temperature range, vibration, and shock performance meet Mil specs.

Huggins Laboratories, Dept. ED, 999 E. Arques Ave., Sunnyvale, Calif.
Booth 2971-2918.

Signal Generator 388

Range is 1 cps to 1 mc

Model N-2 signal generator has a frequency range of 1 cps to 1 mc. Its distortion is 0.2%. The built-in meter and attenuator permit the output amplitude to be set at any value, eliminating the necessity for a voltmeter to monitor the output. This unit replaces model M-2.

Southwestern Industrial Electronics Co., Dept. ED, 10201 Westheimer Road, P.O. Box 13058, Houston 19, Tex.
Booth 3307-3309.

Blower Unit 511

Provides 350 cfm

Model MSA 11000 blower unit provides 350 cfm at 5.8 SP at a density of 0.075. It can be furnished in speeds of 5400, 7500, and 11,500 rpm at 115, 200, 208, and 440 v. The unit weighs 5-3/4 lb, and meets military requirements for environmental conditions.

Torrington Manufacturing Co., Dept. ED, Torrington, Conn.
***Price & Availability:** The unit is made on order.*
Booth 1919.

Firm price and delivery on low noise parametric amplifiers

Firm price and delivery schedules are available for negative resistance, cavity type amplifiers in the L, S, C, and Lower X-Bands. You can choose from either development models for evaluation in your system, or custom designed, fully qualified units in production quantities. The table at right shows typical amplifier characteristics now being obtained in development models.

With noise figures as low as 2 db, these amplifiers are ideally suited to radar acquisition and tracking systems, tropo-scatter communications, telemetering, satellite tracking, and microwave relay links.

They recover from overload in milliseconds—are resistant to deterioration and failure from high power. Phase jitter and gain stability characteristics are excellent, and with the associated ferrite circulator, the amplifier is fail-safe in case of pump or diode failure.

Small in size and weight, the amplifier can easily be retrofitted to many existing systems.

Hughes Microwave Products can provide complete retrofit kits, including ferrite circulator, amplifier, pump circuitry, and pump klystron, custom fitted to your system configuration.

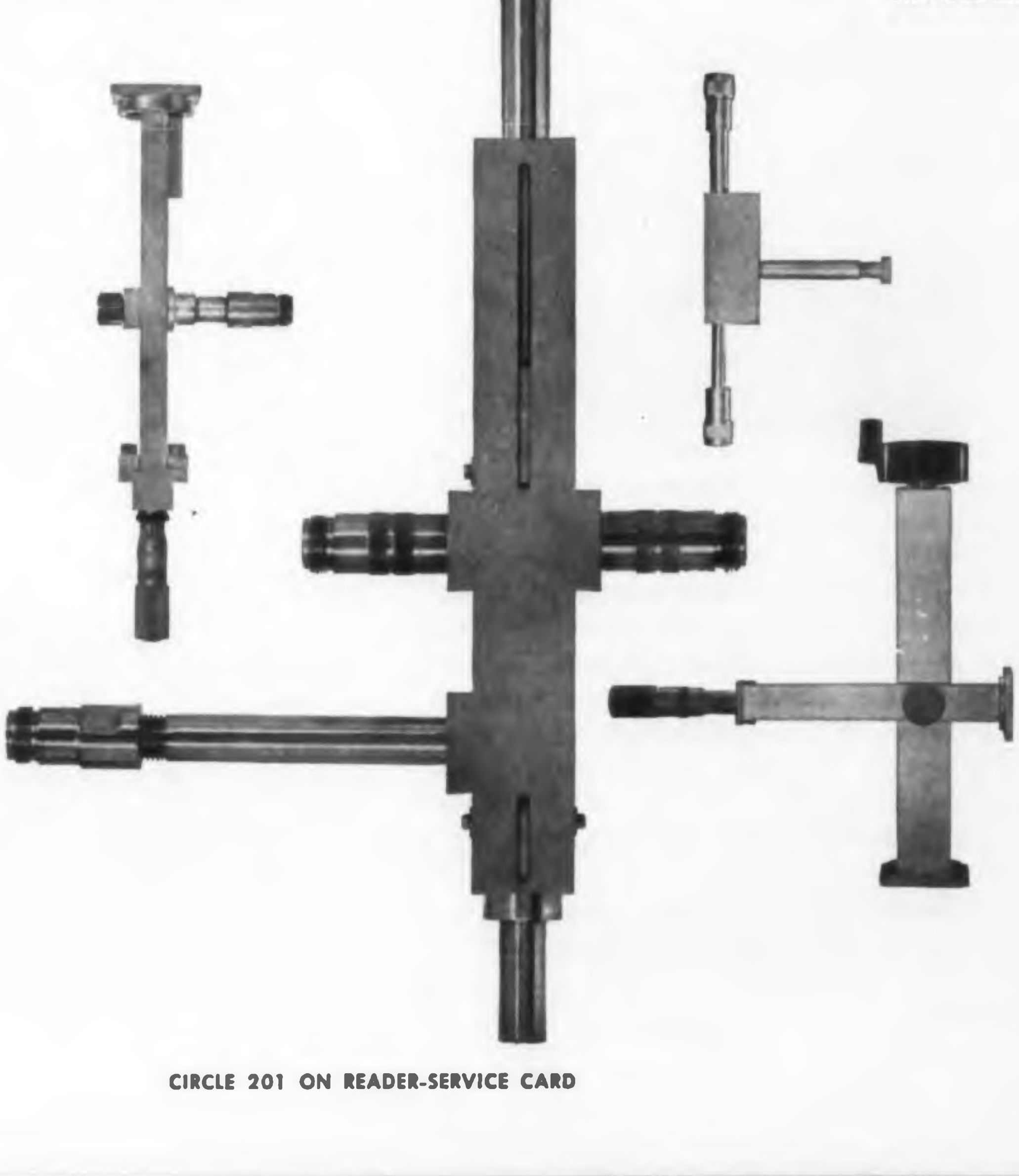
HUGHES PARAMETRIC AMPLIFIERS—Typical Characteristics

	L Band	S Band	C Band	X Band
Pump	50 mw at S or C Band	100 mw at X Band	100 mw at X or K_U Band	150 mw at K_U Band
Gain	15 to 20 db	15 to 25 db	15 to 25 db	15 to 20 db
Bandwidth	2 to 10 mc	Up to 25 mc	Up to 25 mc	2 to 8 mc
Noise Figure	2 to 4 db	2 to 4 db	2 to 4 db	6 db
Remarks	Non-degenerate	Non-degenerate	Non-degenerate	Quasi-degenerate

For information on price and delivery dates, or for further technical data, write Microwave Products, Advanced Program Development, Hughes Aircraft Company, Culver City 4, Calif., or phone UPton 0-7111, Ext. 4727.

HUGHES

© 1959 HUGHES AIRCRAFT COMPANY



CIRCLE 201 ON READER-SERVICE CARD

Voltmeter 385

Measures 1 mv to 1000 v ac and 1 to 1000 v dc

Model R-3 transistorized voltmeter measures from 1 mv to 1000 v ac full scale in 14 ranges over a range of 10 cps to 200 kc; it measures positive and negative dc voltages from 1 to 1000 v full scale in 7 ranges, electrometer input from 0 to 1 v dc, and center-scale resistances from 10 ohms to 10 meg in 7 steps. Over-all accuracy is better than 3% on all voltage readings. Self-contained batteries and transistor circuitry are used.

Southwestern Industrial Electronics Co., Dept. ED, 10201 Westheimer Road, P.O. Box 13058, Houston 19, Tex.

Price & Availability: *Unit is available from stock at a price of $335.*
Booth 3307-3309.

Power Supplies 357

Regulation is ±0.01%

Power supplies in the 120 series have ±0.01% or ±3 mv regulation from no load to full load or from 105 to 125 v. Ripple is less than 500 μv rms. Four units, models 121 through 124, provide from 0.1 to 50 v dc at 0 to 5 amp. Current levels can be preset to protect external equipment. Provision for remote error sensing is through a terminal strip at the rear of each chassis. Each unit is supplied in a rack mounting version and can be adapted for bench use.

Quan-Tech Laboratories, Dept. ED, 60 Parsippany Blvd., Boonton, N.J.

Price & Availability: *Units are or soon will be available from stock. Price ranges from $475 to $645.*
Booth 3034.

Sola Sinusoidal type Constant Voltage Transformers for universal application, now moderately priced

Housed unit with mounting plate typical of structures employed in 60va to 1kva ratings.

Price reductions extend scope o

An important advance in the field of voltage regulation is the development of a new line of Sola Standard Constant Voltage Transformers with sinusoidal output. New design enables us to price them about the same as previous models not having sine-wave output. Now you can have the advantages of ±1% static-magnetic voltage regulation in new applications requiring harmonic-free input where previously the cost was a deterrent.

These new units provide output voltage regulation of ±1% for line voltage variations as great as ±15%. They regulate automatically and continuously. Fast response time averages 1.5 cycles or less. Output has less than 3% total rms harmonic content, and formulae based on sinusoidal wave shape may be used in designing related load circuitry.

Design and production innovations make these new units substantially smaller and lighter than previous models. They are relatively compact compared to other equipment for comparable ac voltage regulation. They are easy to select and order —the buyer merely selects the stock unit whose output capacity equals or exceeds the desired equipment input. Sola Standard Sinusoidal CV Transformers are available in nine stock output ratings from 60va to 7500va. Custom designs to meet specialized requirements are available in production quantities.

Write for full information . . .

With electrical control systems and components continuing to increase in number and complexity, and imposing more rigid reliability requirements, these new Sola Constant Voltage Transformers provide many advantages and virtually unlimited application. They are the result of over four years of development, design, and production engineering in the Sola laboratories and plant.

These developments mean superior voltage regulation, giving you a bonus in equipment reliability and performance at no increase in cost.

For full information, please write for technical literature on Sola Constant Voltage Transformers. We will mail it promptly, or if you wish, we will have a representative call on you.

Sola Normal-Harmonic type Constant Voltage Transformers now specifically designed and priced for component use

End-bell unit with separate capacitor typical of structures engineered for component use.

of Sola voltage regulation

Re-design of Sola "Normal-Harmonic" type static-magnetic voltage regulators has resulted in a significant reduction in their size and weight. Prices on many of these units have been reduced. Now it's possible for you to improve equipment performance by using them in many new fields at less cost than ever before. Re-design has in no way sacrificed the performance of these units—they provide all the outstanding benefits which have made them the standard of the industry for more than fifteen years.

Sola Normal-Harmonic type voltage regulators provide ±1% output voltage with line voltage variations as great as ±15%. This group has an average of 14% total rms harmonic content in its output voltages and is suited to equipment not extremely sensitive to voltage wave shape.

Sola Normal-Harmonic type voltage regulators are available in nineteen stock ratings from 15va to 10kva, including those mechanical designs specially engineered for use as built-in components. With many of the most popular ratings now reduced in price, these Sola Constant Voltage Transformers provide one of the most economical means of close voltage regulation in a broad range of applications.

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

SOLA

A DIVISION OF BPC BASIC PRODUCTS CORPORATION

OLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois

Sales Offices in all principal cities

N CANADA, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ontario

CIRCLE 202 ON READER-SERVICE CARD

Battery Chargers 500

Models range from 6 to 120 v

This line of battery chargers features models ranging in output from 6 to 120 v at 0 to 125 amp. These fully-automatic units have silicon rectifiers and silicon diodes; they use no moving parts. The close-end voltage regulation of ±1% is maintained to accommodate line changes of ±10%. Each unit includes a moving coil type dc voltmeter and ammeter.

Christie Electric Corp., Dept. ED, 3401 W. 67th St., Los Angeles 43, Calif.
Booth 2911.

Subcarrier Discriminator 504

Needs no input attenuator

This subcarrier discriminator is for use in fm-fm RDB/IRIG telemetry, for ground checkout of airborne systems, and for long distance transmission of multi-channel analog data. No input attenuator is required. The input range is 3 v to 5 mv rms. Input impedance is over 1 meg, shunted by 20 μμf; output impedance is 0 ±10 ohms. Standard linearities are ±0.25% and ±0.5%. The power output from the operational amplifier is to ±100 v at 30 ma into 3300 ohms. The unit measures 5.25 x 19 x 16.375 in.

The Geotechnical Corp., Dept. ED, P.O. Box 28277, Dallas 28, Tex.
Booth 2340.

Don't miss an issue of ELECTRONIC DESIGN; return your renewal card today.

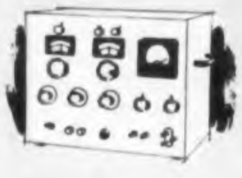
Wide-Range Self-Contained Precision Inductance Bridge

MODEL 63A PRICE $1500

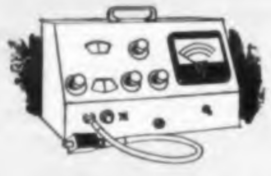
- Inductance Range: .002 Microhenry to 1.1 Henry.
- Series Resistance Range: .002 Ohm to 110K Ohm.
- Built-in 1 to 100 KC Oscillator - Detector.
- No False or Sliding Nulls.

ALSO MANUFACTURERS OF THESE FINE INSTRUMENTS

DC Millivoltmeter



Capacitance Bridge



RF Distortion Meter

UHF Grid Dip Meter

Boonton *ELECTRONICS* Corp.

Morris Plains, New Jersey • Phone: JEfferson 9-4210

SEE US AT THE SHOW, BOOTH #3114

CIRCLE 203 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Delay Line 460

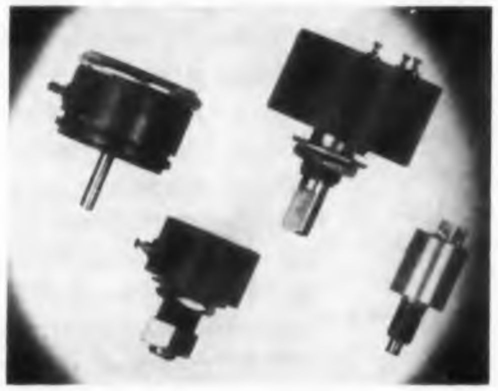
Total delay is 6.5 µsec ±0.5%

Type L748C delay line has a total delay of 6.5 µsec ±0.5% and a rise time of 0.135 µsec. A lumped parameter network, it is equipped with 32 equally spaced taps. Impedance is 470 ohms, insertion loss is 0.7 db, and temperature coefficient of delay is 25 ppm per deg C. Dimensions of the unit are 6 x 3 x 2-7/8 in. and weight is 3 lb.

Columbia Technical Corp., Dept. ED, 61-02 31st Ave., Woodside 77, N.Y.
Booth 1112.

Plastic Potentiometers 494

Resistance is 250 ohms to 150 k



These 1/2-in. plastic potentiometers have a resistance range of 250 ohms to 150 K. The power rating is up to 3 w at 65 C, life expectancy is 10,000,000 cycles, and resolution is essentially infinite. Standard independent linearity is ±0.5%; linearity can be lower on special orders. Units meet Mil specs.

Ace Electronics Associates, Inc., Dept. ED, Somerville, Mass.
Booth 1813-1815.

Test Point Connectors 451

Have 28 contacts

The 672-8 series of 28-contact test point connectors has right angle pins for dip soldering to

BINARY COUNTERS

TRANSISTORIZED

ACTUAL SIZE

7/8" DIA. x 2 1/8" SEATED

IF YOU USE BINARY COUNTERS . . . You should select from Walkirt's big assortment of proved reliability, encapsulated counters. We make NPN and PNP types, Germanium or Silicon, in many physical configurations. We'd like you to compare our circuit performance and our price list with any other counter. For example, compare these brief specifications of the type PM7253 "ECONOMY LINE" binary pictured.

- MAX. FREQUENCY............Over 800 KC
- RISE TIME..............Less Than 0.25µS
- LOAD...................Will Directly Drive 2 Triggered Circuits Per Output Without Emitter Followers
- HAS "SET" AND "RESET" TERMINALS

Write for technical information on DIGITAL and LOGIC circuitry.

SALES OFFICES IN PRINCIPAL CITIES

WALKIRT

COUNTER MANUFACTURERS SINCE 1949
141 W. HAZEL ST., INGLEWOOD 3, CALIF.

CIRCLE 204 ON READER-SERVICE CARD

Dependability
Reliability
Stability

are the key words for

THERMAL
Time Delay
RELAYS

designed and produced by

TCi

See us at the show, Booth #1223

THERMAL
CONTROLS, INC.
and O.K. ELECTRONICS
41 RIVER ROAD
NORTH ARLINGTON, N. J.

CIRCLE 205 ON READER-SERVICE CARD

a printed circuit board. Closed-entry contacts accept a 0.08-in. test probe. Three stainless steel, threaded mounting-holes are integrally molded into the body. Contacts are phosphor bronze, gold plate over silver plate. Molding material is glass filled diallyl phthalate as per MIL-M-19833.

Continental Connector Corp., Dept. ED, 34-63 56th St., Woodside 77, N.Y.
Price & Availability: Price varies with quantity and specifications. Delivery is in 45 to 60 days.
Booth 2307-2309.

Phase-Angle Meter 450

For measuring in the vicinity of 90 deg

Designed for measuring phase angles in the vicinity of 90 deg, model OPS-100 phase-angle meter consists of an 8-w power oscillator and a variable phase-shifter having a range of 90 ±10 deg. The resolution and incremental accuracy is 0.05 deg. The absolute accuracy is better than 0.1 deg at 90 deg and better than 0.25 deg throughout the range.

Industrial Test Equipment Co., Dept. ED, 55 E. 11th St., New York 3, N.Y.
Booth 3513.

Amplifier 452

Range is 300 to 1000 mc

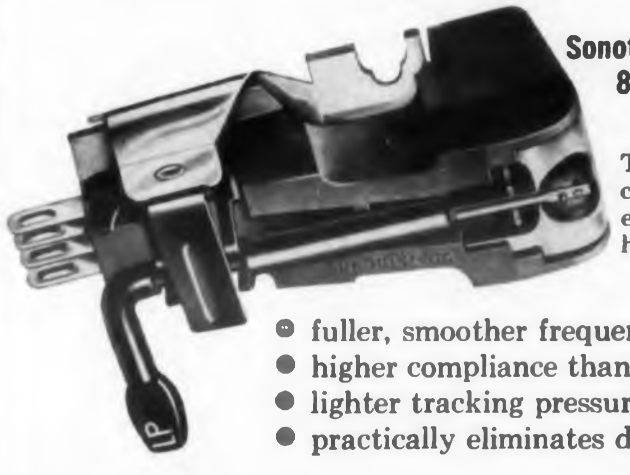
Model UH-2(A) amplifier, constructed to have a tunable center frequency, has an operating range of 300 to 1000 mc. The range of tuning is as much as ±10% of the center frequency. Broadband response is about 10 mc and the noise figure is from 5 db at 400 mc to 8.5 db at 1000 mc. The unit is furnished with a power supply which operates from 117 v ac, 60 cps, 25 w.

Applied Research, Inc., Dept. ED, Port Washington, N.Y.
Availability: The unit is made on order and can be delivered in 30 days.
Booth 1110.

Now . . . from Sonotone–

4 Big
Improvements

in the quality stereo cartridge



Sonotone 8TA cartridge replaces 8T as industry standard

The new Sonotone 8TA cartridge gives greater than ever stereo performance . . . has 4 big extras:

- fuller, smoother frequency response
- higher compliance than ever before
- lighter tracking pressure
- practically eliminates dust pile-up

ONLY
\$14.50*

Sonotone 10T unitized stereo at lowest price ever

New 10T cartridge sells at record low price of \$6.45.* And it covers the complete high fidelity range. 10T's unitized construction makes it easiest to install, easiest to replace. Low price means more sales—more profits.

SPECIFICATIONS

	8TA	10T
Frequency Response	Smooth 20 to 20,000 cycles. Flat to 15,000 with gradual rolloff beyond.	Flat from 20 to 15,000 cycles ± 2.5 db.
Channel Isolation	25 decibels	18 decibels
Compliance	3.0×10^{-6} cm/dyne	1.5×10^{-6} cm/dyne
Tracking Pressure	3-5 grams in professional arms 4-6 grams in changers	5-7 grams
Output Voltage	0.3 volt	0.5 volt
Cartridge Weight	7.5 grams	2.8 grams
Recommended Load	1-5 megohms	1-5 megohms
Stylus	Dual jewel tips, sapphire or diamond.	Dual jewel tips, sapphire or diamond.

*including mounting brackets

Sonotone makes only 6 basic ceramic cartridge models . . . yet has sold over 9 million units . . . used in over 662 different phonograph models. For finest performance, replace worn needles with genuine Sonotone needles.

Sonotone® CORP.
Electronic Applications Division, Dept. C23-30
ELMSFORD, NEW YORK

Leading makers of fine ceramic cartridges, speakers, tape heads, microphones, electronic tubes.
In Canada, contact Atlas Radio Corp., Ltd., Toronto

CIRCLE 206 ON READER-SERVICE CARD

Sweep Oscillators 510

Output is 2.5 v into 500 ohms

Operating from an input of 12 to 24 v, these transistorized, non-mechanical sweep oscillators have an output of 2.5 v into 500 ohms. An automatic leveling circuit keeps the output constant to within ±10%. Model TO-1 has a range of 950 to 3000 kc and model TO-2, 570 to 1600 kc. Control current requirements are about 0 to 35 ma across 450 ohms, 2 h, for full range. The unit will accept sweep frequencies from 0 to 1000 cps.

VARI-L Co., Inc., Dept. ED, 207 Greenwich Ave., Stamford, Conn.

Availability: *The units are furnished from stock.*
Booth 2209.

Microwave Power Levelers 495

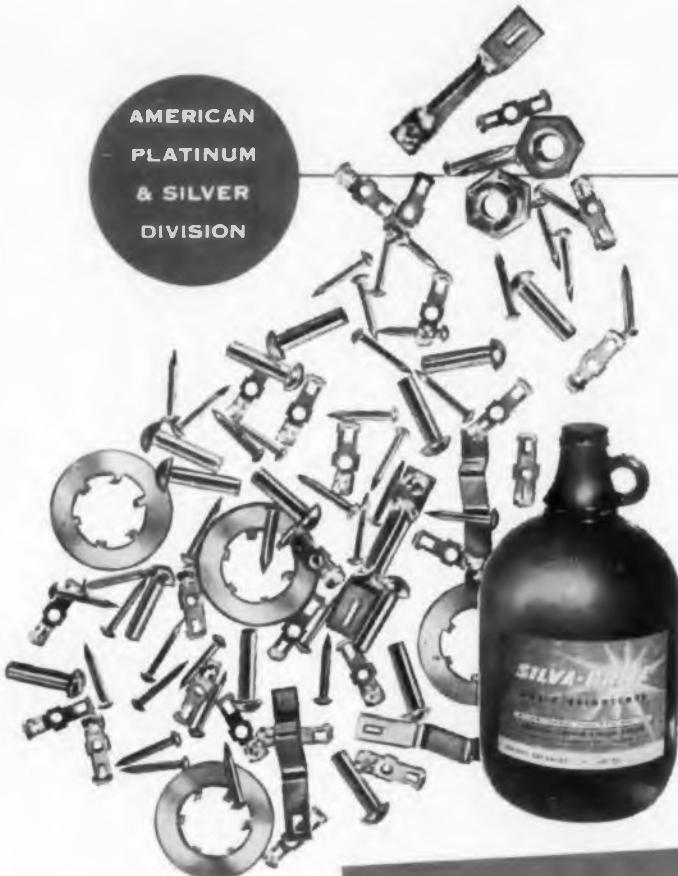
Ranges are 50 to 75 db

The 500 series of microwave, power levelers control output variations from a traveling-wave amplifier or backward-wave oscillator by a feedback process. Voltage gain is 80 db max; gain is adjustable over five overlapping ranges from 47 to 80 db. Ranges are 50, 60, 65, 70, and 75 db. Vernier control allows flexibility of adjustment. The dc amplifier bandwidth is flat within ±0.5 db from dc to 20 kc and —6 db at 100 kc. The units require 115 v ac at 60 cps and can be supplied for rack mounting or in cabinet models.

Menlo Park Engineering, Dept. ED, 711 Hamilton Ave., Menlo Park, Calif.
Booth 3836.

Have you sent us your subscription renewal form?

AMERICAN PLATINUM & SILVER DIVISION



a simplified mirror-bright silver plating process for electrical and electronic components

Here is the most efficient, simple procedure to protect electrical electronic and lamp components with a mirror-bright silver finish—through a complete range from flash to heavy deposit. The procedure is easy, economical and non-critical —with little or no polishing required. Silva-Brite is a clear, water-white solution, enabling the operator to observe work as it is being plated. Uniformly good results are attained with current densities ranging from 10 to 40 amperes per square foot. Normal room temperature operation minimizes fumes and tendency toward bath decomposition. Send for descriptive data together with detailed plating procedures.

AMERICAN PLATINUM & SILVER DIVISION
231 N. J. RAILROAD AVENUE, NEWARK, N. J.
CIRCLE 865 ON READER-SERVICE CARD

ENGELHARD
INDUSTRIES, INC.
EXECUTIVE OFFICES:
113 ASTOR STREET · NEWARK 2 NEW JERSEY

CHEMICAL DIVISION

for low cost purification and drying of hydrogen and other gases

The Deoxo Catalytic Purifier is combined with an extremely efficient automatically operated drying unit to provide oxygen-free hydrogen that is ideally pure and dry. The combined units are identified as the Deoxo Dual Puridryer. It supplies hydrogen with less than one part oxygen per million — dried to a dew point of —100°F. *No inert gas purging is needed.* The Deoxo Dual Puridryer can also be used with other gases such as: Nitrogen, Argon, Helium and saturated hydrocarbons, with equally fine performance. Write for descriptive literature.

CHEMICAL DIVISION • 113 ASTOR STREET
NEWARK, N. J.
CIRCLE 866 ON READER-SERVICE CARD

COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD. TORONTO • ENGELHARD INDUSTRIES OF QUEBEC, LTD. MONTREAL • ENGELHARD INDUSTRIES, LTD. LON • ENGELHARD INDUSTRIES A. G. ZURICH • ENGELHARD INDUSTRIES PTY., LTD. VICTORIA • SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S. A. BOGO INDUSTRIE ENGELHARD S. P. A. ROME • ENGELHARD INDUSTRIES OF SOUTHERN AFRICA, LTD. JOHANNESBURG. **ASSOCIATED COMPANIES:** ACME TI INDUSTRIES LTD. • SOUTH AFRICAN FOREST INVESTMENTS LTD., SOUTH AFRICA • AZOPLATE CORPORATION • NUCLEAR CORP. OF AMERICA,

100% OF ASSAYED PRECIOUS METAL CONTENT • IRVINGTON-BAKER REFINING DIVISION recognized leadership in the design and manufacture of slip ring assemblies.

The country's leading producers of electrical and electronic equipment look to Makepeace for the design and manufacture of slip ring assemblies.

Slip ring design for particular applications depends upon the various electrical and mechanical factors involved. Thus, Makepeace has developed many special alloys and combination of alloys to meet a wide range of requirements. Our engineers and metallurgists are thoroughly qualified in this specialized field and will be pleased to make recommendations on your particular problem.

Complete facilities are available for the manufacture of slip ring assemblies ranging in diameter from 1" to 48" and larger—for General Purpose, Radio Frequency and Video Ring Circuits, High Speed Instrumentation, High Voltage Ring Circuits and Power Pulse Slip Rings. A slip ring data file is available—write for your copy.

D. E. MAKEPEACE DIVISION • PINE & DUNHAM STREET
ATTLEBORO, MASS.
CIRCLE 867 ON READER-SERVICE CARD

fine wire, thin foils, ribbon and tubing in noble metals and their alloys, for all applications.

The unique combination of properties of the noble metals continually recommend them for industrial applications. Our modern melting, wire drawing, rolling and heat treating equipment coupled with long experience in the field is at your service for production of standard and special items.

WIRES: Bare drawn wire of ductile materials down to .004" —High temperature thermocouple wires—High temperature furnace windings—Potentiometer and Resistance wires—Platinum clad tungsten wire.

FOILS: In platinum, palladium and gold down to .0001"—In iridium and rhodium as thin as .001".

TUBING: Seamless in platinum, palladium, gold and their alloys. Sizes from .018" with .004" wall up to 1½" with .042" wall.

For complete information write for our leaflets, "Fine Wire, Foils, Ribbons" and "Noble Metal Thermocouple Wire".

BAKER PLATINUM DIVISION • 113 ASTOR STREET
NEWARK, N. J.
CIRCLE 868 ON READER-SERVICE CARD

C DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION • AMERSIL QUARTZ DIVISION • BAKER CONTACT DIVISION • BAKER DENTAL DIVISION
SETTING DIVISION • BAKER PLATINUM DIVISION • CHEMICAL DIVISION • EAST NEWARK INDUSTRIAL CENTER • HANOVIA LAMP DIVISION •
A LIQUID GOLD DIVISION • INDUSTRIAL DIAMOND DIVISION • INSTRUMENTS AND SYSTEMS DIVISION • IRVINGTON-BAKER REFINING DIVISION •
AKEPEACE DIVISION • NATIONAL ELECTRIC INSTRUMENT DIVISION • RESEARCH AND DEVELOPMENT DIVISION • H. A. WILSON DIVISION.

PROMPT PRECIOUS METAL SCRAP RECOVERY SERVICE • ENGELHARD PROCEDURES RECOVER

Silicon Glass Diodes 407

With tolerances of 20%, 10%, and 5%

Types 1/4M6.8Z through 1/4M200Z 1/4-w silicon Zener diodes come in sizes of 6.8 through 200 v, in tolerances of 20%, 10%, and 5%. They are also offered in series or parallel matched sets with tolerances as close as 1%. Diffused-junction devices, they are especially suitable for computer use and have many applications in oscillators, dc-coupled amplifiers, switching circuits, multivibrators, level-shifters, clamps, subtractors, and references.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.

Data Accumulator and Recording System 416

Rates are to 15,000 pps

Model 180 data accumulator and recording system accepts bi-directional input pulses at rates up to 15,000 per sec from measurements devices generating sequential pulses as a function of the parameter being measured. Each channel has a maximum storage of ±999,999 counts. A control unit supplies output programming and related readout control signals for the system. Nixie tube readout is used. The power requirement is 115 v ac.

Telecomputing Corp., Data Instrument Div., Dept. ED, 12838 Saticoy St., North Hollywood, Calif.

Storage at Less than 1½¢ per bit!

with the

BRYANT Model 7508 Magnetic Storage Drum

Bryant's new Model 7508 Magnetic Storage Drum offers you a convenient size memory at extremely low cost-per-bit. (Less than 1.5 cents per bit.)

This compact and efficient 7.5″ diameter by 8″-long drum is enclosed in its own dust-tight cabinet. Complete with connectors and isolator mounts. Overall dimensions are 14″ diameter by 16″ high.

Standard Operating Parameters include:

Bit Repetition Rate (Return to Bias): Over 300 KC • Bit Repetition Rate (Non-Return to Bias): Over 600 KC • RPM: 900 to 6,000 • Number of Tracks: 250 • Bit Capacity: 460, 800 • Bits-Per-Track: 3072 • Design Life (at 6,000 RPM): Over 3 years • Guaranteed Runout: Less than .0001″ TIR • Military Specifications: Compatible with MIL-E-4158A and MIL-E-16400B.

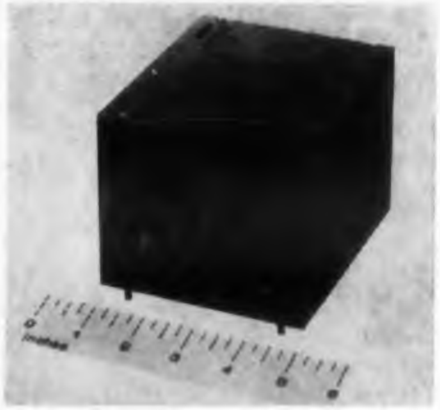
For more information about the Model 7508 and other Bryant Standard Magnetic Storage Devices, from 7500 to 75,000,000 Bits, write to Bryant Computer Products Division, P.O. Box 620, Springfield, Vermont.

CIRCLE 208 ON READER-SERVICE CARD

NEW PRODUCTS

Commutators 405

Provide up to 43 channels



Types 4000C and 4000D Dataplexers provide information capacities of up to 43 channels at a 20 frames per sec rate. The units comply with IRIG standards for PAM and PDM airborne telemetry. The PDM channels are linear within ±0.1% with pulse rise and decay times of 10 μsec. The PAM output duty cycle is adjustable between 40% and 100% with pulse rise and decay times of less than 5 μsec. Units operate in environments of —65 to +100 C, 100% relative humidity, 100 g shock, 100 g acceleration, and 30 g rms random vibration. Power requirement is 2.5 w.

Tele-Dynamics Inc., Dept. ED, 5000 Parkside Ave., Philadelphia 31, Pa.

Proximity Switch 402

For use in severe environments

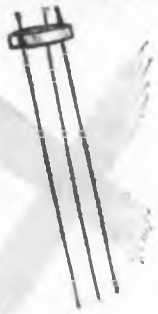
This proximity switch is designed for use as a limit, interlock, counter, or indicator sensor under unfavorable environments such as those caused by oil, grit, and extreme vibration, consists of a sensor and a separate amplifier with a plug-in relay. These components may be located up to 150 ft apart without the use of shielded wire. The sensitivity range is from 1/8 to 1/2 in. A centralized sensing pole increases the latitude of directional approach of the work-piece to the sensing face. It can be energized from 115 v, 60 cps power.

Micro Switch, Dept. ED, Freeport, Ill.

PROBLEM- HOW TO DRIVE COSTS DOWN?

HERCITE* TRANSISTOR MOUNTS

Save as much as 25%



Hercite, the latest in the line of new developments at Hercon, can save you up to 25% because of the newly developed and fully tested materials used in the manufacturing of Hercite bases. Engineering tests are conclusive proof of the excellent characteristics and quality available with the use of these bases which have high strength of compression combined with the oxide bond of matched seals.

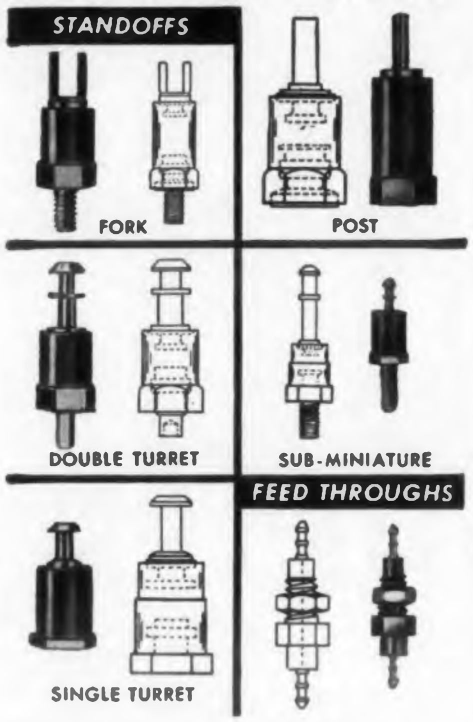
*Hercite (pronounced Her-kite) is a new material combination which makes it possible to produce superior quality transistor mounts at a great cost savings. Proof-test these mounts in your plant at no cost or obligation. Free samples on request. For this or any other glass-to-metal Seal Problem—

GET THE COMPLETE STORY BY WRITING TO:

HERCON ELECTRONICS CORPORATION
formerly
HERMETIC CONNECTOR CORP.
481 Washington Street, Newark 2, N. J.

CIRCLE 209 ON READER-SERVICE CARD

GET THE EXACT
TERMINAL YOU NEED
AT NEW LOW PRICES!



FROM THE LARGEST
STANDARD and CUSTOM
LINE AVAILABLE...

Over 100 varieties are furnished as standard. This includes a full range of types, sizes, body materials and plating combinations. Specials can be supplied to any specification. The Whitso line is complete to the fullest extent of every industrial, military and commercial requirement.

Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types—male, female or rivet mountings—molded or metal base. Feed through terminals are furnished standard or to specification.

Whitso terminals are molded from melamine thermosetting materials to provide optimum electrical properties.

Body Materials: Standard as follows—melamine, electrical grade (Mil-P-14, Type MME); melamine impact grade (Mil-P-14, Type MMI); and phenolic, electrical grade (Mil-P-14, Type MFE).

Plating Combinations: Twelve terminal and mounting combinations, depending on electrical conditions, furnished as standard.

Specials: Body materials and plating combinations, also dimensions, can be supplied to any custom specifications.

PROMPT DELIVERY IN ECONOMICAL QUANTITY RUNS

Get facts on the most complete, most dependable source for terminals and custom molded parts. Request catalog.

WHITSO, INC.

9326 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 210 ON READER-SERVICE CARD

Snap-Acting Switch 379

Provides dpdt control

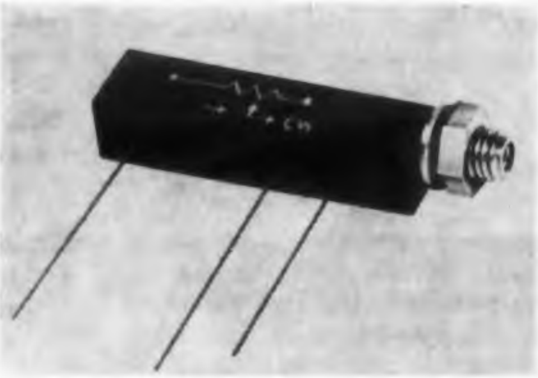
With two basic type A, snap-acting switch mechanisms in a single housing actuated by the same operating button, this switch, type DA, provides dpdt control of electrical circuits in automatic devices. The switch is listed at 15 amp, 125 to 250 v ac. Horsepower ratings are: 1/2 hp at 125 v ac, 1 hp at 250 v ac or 3/4 hp at 125 v ac, and 1-1/2 hp at 250 v ac. The molded phenolic body measures 1-1/8 x 1-13/16 x 41/64 in.; mounting is by two screws on 1-in. centers.

The W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Ives Road, Wallingford, Conn.

Price & Availability: Available from stock. Price is $2.40 when ordered in quantities of 1 to 99. Quantity discounts available.

Trimming Potentiometer 378

Has a 3.5 w power rating



Available with insulated leads or printed circuit plug-in pins, this trimming potentiometer has a power rating of 3.5 w at room temperature and 0.35 w at 175 C. Resistance values range from 50 to 100,000 ohms. This component withstands 30 g vibration at 30 to 2000 cps, and 100 g shock in any axis. It has a stability of 30 ppm nominal to 190 C reaching a zero power and total weight is 5 g.

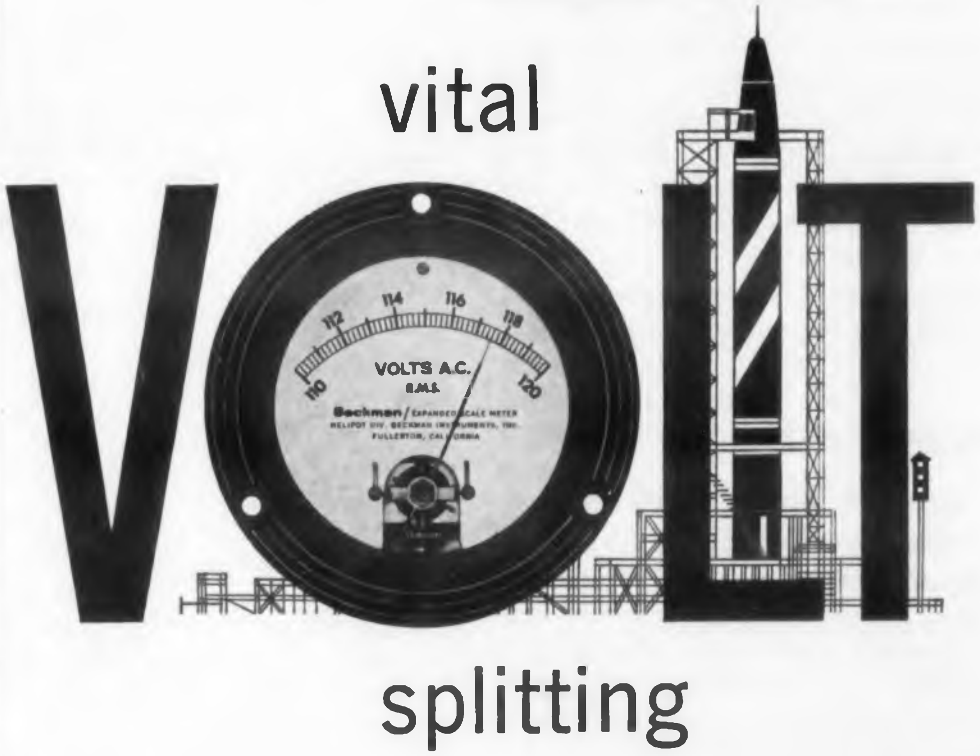
Aero Electronics Corp., Dept. ED, 1745 W. 134th St., Gardena, Calif.

Price & Availability: Delivery is from 2 to 3 weeks. Prices range from $9.50 to $12.15. Quantity discounts.

before the bird takes off During preflight checkout, ground power supplies must be meticulously monitored to avoid limping undervoltage, crippling overvoltage.

How?

BECKMAN Expanded Scale Voltmeters—with accuracy to a fraction... readability to hundredths! That's vital volt-splitting at the moment of "Go—No Go," when operation depends upon precise power input with no room for guesswork. (And no trifling with "average" readings: BECKMAN AC meters give honest, direct rms readings on all wave forms.)



Helipot offers you hundreds of models ...either AC or DC... in divers shapes, sizes and voltage ranges. (Not to mention voltage monitoring packages, which may include our expanded scale frequency meters and linear scale ammeters, too.) All have uncommon accuracy in common, plus resolution ten times that of conventional meters!

Incredible?

Make us prove it by asking for Data File **C124**

Beckman®/Helipot®

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California
Engineering representatives
in 29 cities

60016 ©1959 B.I.I.

potentiometers • dials • delay lines • expanded scale meters • servomotors • breadboard parts

CIRCLE 211 ON READER-SERVICE CARD

Vibration Equipment 486

Monitors and amplifies signals

Model 2702 Dyna-Monitor is a laboratory system that monitors and amplifies vibration, shock, pressure, and force signals. It provides vtvm readout or direct reading in g's or other parameters; a 10-mv input gives full-scale meter reading and 10-v output. A frequency response of ±5% with 20-ft of driven cable, is: 3 cps to 10 kc with 1000-μμf source capacitance or greater; 5 cps to 10 kc with 500- to 1000-μμf source capacitance; and 10 cps to 4 kc with 200- to 500-μμf source capacitance.

Endevco Corp., Dept. ED, 161 E. California Blvd., Pasadena, Calif.

Price & Availability: *Delivery is approximately 10 days. One channel is priced at $950, two channels at $1350, and three channels at $1750.*

Wire and Strip 489

Are coated with aluminum oxide

This flexible, aluminum-oxide-coated wire and strip can withstand temperatures up to 1100 F, and in certain forms, are good at temperatures as high as 1900 F. The insulating thickness can be controlled from 0.00008 to 0.001 in. Heat properties for aluminum-oxide insulation are: melting point, 3600 F; linear coefficient, 5 x 10^6.

Permaluster, Inc., Dept. ED, 2012 W. Burbank Blvd., Burbank, Calif.

Price & Availability: *Available from stock and made on order. Price is $50 per lb or 1000 ft, depending on gage and size. Quantity discounts available.*

Solderless Terminals 484

Come in all tongue types

These Avikrimp style solderless terminals come in all tongue types: ring, hook, spade, flanged spade, and rectangular. They are reinforced by a seamless tin-plated brass sleeve attached over the regular terminal barrel. In addition, they have a per-

NEW! LOW COST! 16
all-electronic, totally-transistorized
DIGITAL MULTIMETERS

NOW IN A SINGLE 5¼″ OR 8¾″ x 19″ PANEL Digital Multimeters for measuring any combination of AC/DC volts, AC/DC ratios, and resistance, with pre-amps for higher sensitivities, and optional electrical outputs and print control capabilities!

This new line of all-electronic, solid state instruments meets the growing requirement for precision, multi-purpose measuring instruments. Any combination of AC and DC voltages, AC and DC ratios, resistances . . . every electrical parameter which is of interest to the instrumentation designer . . . can now be measured quickly, accurately, with a single instrument.

Unmatched specifications! These Multimeters are the first to have a combination of high input impedance, 4 digit accuracy, automatic ranging, automatic polarity and high speed in a single instrument!

All electronic, solid state circuitry! Exclusive use of transistors and diodes provides a light, compact instrument possessing exceptionally high reliability and accuracy. The experience of more than 6,000 digital instruments has gone into their design.

Unique reference supply gives unequalled stability! For these new instruments, EI has developed a pre-regulated, twin Zener diode bridge with the Zener diodes in a temperature-stabilized oven. Temperature stability and drift characteristics of this reference are better than .005% and unequalled in the industry.

Easily integrated into semi- or completely automatic systems! These new instruments reflect EI's active participation in the building of small and medium size digital systems. All necessary control logic is available at rear panel connectors for external control. Every instrument is ideally suited for automatic input signal conditioning or scanning operation. Models with electrical outputs will operate directly in multi-point scanning and print-out data logging systems without any additional circuitry or auxiliary equipment.

Electrical outputs optional! Where "hard copy" of test results is not required, the addition of electrical outputs and print control capabilities is a costly, unnecessary luxury. EI provides these new instruments, in every measuring configuration, either with or without these features.

Sensitivity control eliminates effect of noisy readings! A front panel sensitivity control is provided on each of the instruments to overcome unusual noise conditions and give, as a by-product, a qualitative measurement of the noise present.

FLIP-TOP BOX CONSTRUCTION
FOR EASY MAINTENANCE.

Electro Instruments, Inc.
3540 AERO COURT • SAN DIEGO 11, CALIF.

S

any
for
ties!

ustry.
ımatic
ıctive-
edium
gic is
l con-
ımatic
ation.
rectly
gging
auxil-

y" of
trical
costly,
nstru-
r with

dings!
ı each
e con-
meas-

pick the instrument that exactly meets ir needs and order by model number!

MODEL 840
DC Volts/DC Ratios

MODEL 841
DC Volts/DC Ratios/Rosistanco

MODEL 842
DC Volts/DC Ratios/AC Volts

MODEL 843
DC Volts/DC Ratio/AC Volts/Resistance

MODEL 844
DC Volts/Ratio/DC Pre-Amplifier

MODEL 845
DC Volts/Ratio/Resistance/DC Pre-Amplifier

MODEL 846
DC Volts/Ratio/AC Volts/DC Pre-Amplifier

MODEL 847
Volts/Ratio/AC Volts/Resistance/Pre-Amplifier

MODEL 848
DC Volts/Ratio With Electrical Outputs

MODEL 849
DC Volts/DC Ratios/Resistance
With Electrical Outputs

MODEL 850
DC Volts/DC Ratios/AC Volts
With Electrical Outputs

MODEL 851
DC Volts/DC Ratio/AC Volts/Resistance
With Electrical Outputs

MODEL 852
DC Volts/Ratio/DC Pre-Amplifier
With Electrical Outputs

MODEL 853
DC Volts/Ratio/Resistance/DC Pre-Amplifier
With Electrical Output

MODEL 854
DC Volts/Ratio/AC Volts/DC Pre-Amplifier
With Electrical Outputs

MODEL 855
DC Volts/Ratio/AC Volts/Resistance
Pre-Amplifier With Electrical Outputs

variations of these basic models including AC ratiometers, millimeters, microvoltmeters and specialized measuring instruments red to individual systems requirements are available in the same ical configurations.

your **E I** *sales office or representative for complete information.*

Faster conversion times, higher
input impedance, greater accuracies,
plus all of the other specifications
you wanted in a digital multimeter!

DC VOLTAGE SPECIFICATIONS: Apply to all instruments incorporating the pre-amplifier

Range:	±.00001 to .09999; .0001 to .9999; 1.000 to 9.999; 10.00 to 99.99; 100.0 to 999.9 v
Accuracy:	0.02% ±1 digit for 10 microvolt range of .00001 to .09999 v; 0.01% ±1 digit from .0001 to 999.9 v
Input Impedance:	1000 megohms up to 9.999 v; 11 megohms up to 999.9 v
Average Reading Time:	50 milliseconds
Operating Ambient Temperature:	0-50°C
Maximum Source Impedance:	5 K ohms on 10 microvolt range only; noncritical all other
Automatic Features:	Ranging, polarity

DC VOLTAGE SPECIFICATIONS: Apply to all instruments except those incorporating the pre-amplifier

Range:	±.0001 to ±.9999; ±1.000 to ±9.999; ±10.00 to ±99.99; ±100.0 to ±999.9 v
Accuracy:	0.01% ±1 digit
Input Impedance:	1000 megohms to ±9.999 v; 11 megohms to ±999.9 v
Average Reading Time:	50 milliseconds
Max. Balance Time:	200 milliseconds
Operating Ambient Temperature:	0.50°C
Automatic Features:	Ranging, polarity

DC RATIO SPECIFICATIONS: Apply to all instruments measuring DC ratios

Range:	.0000 to .9999*
Accuracy:	±1 digit
Input Impedance:	1000 megohms
Average Reading Time:	50 milliseconds
Max. Balance Time:	100 milliseconds
Reference Voltage:	10 volts ±10% (nominal)
Reference Input Impedance:	1000 megohms
Operating Ambient Temperature:	0-50°C

*With properly chosen reference supply, ratios of up to 100 times unity may be measured.

AC VOLTAGE SPECIFICATIONS: Apply to all instruments measuring AC voltages

Range:	.0000 to .9999 VAC; 1.000 to 9.999 VAC; 10.00 to 99.99 VAC; 100.0 to 999.9 VAC
Accuracy:	0.1% and two digits
Frequency Response:	30 cps to 10,000 cps
Input Impedance:	1 megohm shunted by 30 mmfd up to 9.999 VAC; 10 megohms shunted by 30 mmfd up to 999.9 VAC
Average Reading Time:	2 secs. low freq.; ½ sec. high freq. (400 cps and up)
Operating Ambient Temperature:	0-50°C
Automatic Features:	Ranging

RESISTANCE SPECIFICATIONS: Apply to all instruments measuring resistances

Range:	000.1 ohms to 999.9 ohms; 1000. ohms to 9999. ohms; 10.00 K ohms to 99.99 K ohms; 100.00 K ohms to 999.9 K ohms
Accuracy:	0.01% ±1 digit to 99.99 K ohms; 0.03% ±1 digit to 999.9 K ohms
Average Balance Time:	200 milliseconds
Operating Ambient Temperature:	0-50°C
Automatic Features:	Ranging (decimal point placement)

ELECTRICAL OUTPUT SPECIFICATIONS: Apply to all instruments incorporating electrical outputs

- Both 2-4-2-1 Binary Coded Decimal and 10 Line Coded Decimal are provided

manently attached nylon insulating sleeve which extends beyond the metal support sleeve.

ETC Inc., Dept. ED, 990 E. 67th St., Cleveland 3, Ohio.

Price & Availability: *Available from stock. Can be delivered in 2 weeks. Prices are from $27.25 per thousand and up, depending on size and quantity.*

Laminates 487

Are copper clad

Called grade 320-R, with rolled copper foil, and grade 320-E, with electrolytically deposited copper foil, these materials are made with a paper-base phenolic laminate. Base stock is translucent and can be cold punched in thicknesses to 1/16 in. The copper foil is available on one or both sides and is 99.5% pure. Rolled copper thickness options are 0.0014, 0.0028, or 0.0042 in. Electrolytically deposited foil thicknesses are 0.0014 or 0.0028 in.

Taylor Fibre Co., Dept. ED, Norristown, Pa.

Price & Availability: *Can be delivered 10 to 14 days after order received.*

Chassis Slides 485

Have up to 200 lb capacity

These chassis slides come in eleven stock lengths from 10 to 30 in., in 2-in. increments. The Mark 10 series consists of units 1-3/4 in. in height, and a rated capacity of 100 lb; the Mark 20 series slides are 2-1/2-in. high, and have a 200-lb capacity. Models in both series may be flush mounted against the enclosure skin or air flow panel. There is no protruding hardware in operation. The available models include: shelf type, front rail type, standard, 1 position tilt up, or all position.

Markline Electronic Products Inc., Dept. ED, 7227 Whitsett Ave., N. Hollywood, Calif.

Price & Availability: *Can be delivered 5 days after receipt of order. Prices range from $11.50 per pair to $50 per pair, depending on size and model.*

◄ **CIRCLE 212 ON READER-SERVICE CARD**

Gertsch
Complex Ratio
Bridge

-measures both in-phase and quadrature voltage ratios - with high accuracy

This instrument cancels quadrature effects, giving a sharp, true null.

In eliminating quadrature voltage, this Gertsch bridge achieves an in-phase ratio accuracy as good as 0.001%. Quadrature voltage ratios are read as rectangular coordinates, tangent of phase-shift angle, or magnitude of phase-shift angle in degrees directly.

Write for complete data in Bulletin CRB.

- SELF-CONTAINED PHASE-SENSITIVE DETECTOR
- SIX-PLACE RESOLUTION
- TWO FREQUENCY RANGES
  - -30 TO 1000 CPS
  - -50 TO 3000 CPS

Gertsch

GERTSCH PRODUCTS, Inc.
3211 South La Cienega Boulevard, Los Angeles 16, California
UPton 0-2761 – VErmont 9-2201
Visit our exhibit at the I.R.E. Show, Booths 3701 and 3703

CIRCLE 213 ON READER-SERVICE CARD

CML

PRECISION
AC POWER SOURCE

WHERE DEPENDABILITY IS OF PRIME CONCERN

An Ultra Stable and Precise Supply of AC Voltage

OUTPUT: 6 V. A.
STABILITY: ± 0.2%
HARMONIC: 0.1%
REGULATION: 0.2%

Model 1301

Output frequency controlled by tuning fork. Loading and line voltage changes have negligible effect on output frequency, less than 1 PPM over the ambient temperature range of 0° to 50°C.

Harmonic content is 0.1% into a load unity power factor at rated output level. The noise and hum level is better than 60 db down.

Three output voltages available. Each adjustable from zero to maximum.

WRITE FOR COMPLETE SPECIFICATIONS AND PERFORMANCE DATA.

SIZE: 1301
5¼"x19"x10" d.

Available As Cabinet or Rack Mtd.

SPECIAL MODELS TO MEET UNUSUAL NEEDS

COMMUNICATION MEASUREMENTS LABORATORY, INC.
350 LELAND AVENUE, PLAINFIELD, NEW JERSEY

Tel. PL 4-5502

CIRCLE 214 ON READER-SERVICE CARD

NEW PRODUCTS

Cable Tester 406

Test voltages are 500, 1000, and 1500 v dc

Able to test up to 96 conductors for both hi-pot and continuity, this portable multi-conductor cable tester has hi-pot test voltages of 500, 1000, and 1500 v dc and insulation resistance settings of 1, 2, 3, 4, and 5 meg. Consisting of two separable halves, the instrument can be used for testing in-place cables when both ends of the cable are accessible. A 96-light indicator panel gives instantaneous indication of continuity. The instrument also indicates crossed wires. Operation is from a 115-v 60-cps line.

Leemath, Inc., Dept. ED, Oak Drive, Syosset, N.Y.

Metalized Ceramic Components 380

Come in tube, rod, and custom shapes

This line of metalized components includes both steatite and alumina ceramics in tubes, plate rods, and custom shapes. Conductive coatings of silver and platinum with electroplated coatings of copper, nickel, silver, and tin are applied to the components. Applications for the components include: metalized ceramic housings for hermetically sealed resistors, capacitors, transformers, diodes and rectifiers; metalized solder seal terminals, micromodule wafers, and printed circuits.

Duramic Products, Inc., Dept. ED, 426 Commercial Ave., Palisades Park, N.J.

Price & Availability: Made on order only. Delivered 30 days after order received.

RECHARGEABLE

ECONOMICAL

YARDNEY
SILCAD®
BATTERIES

You'll use and reuse your YARDNE SILCAD over 2,000 to 3,000 partial cy cles...300 to 500 complete discharges Here is true year-in, year-out economy

This, among other factors, explain why the long-life, maintenance-fre YARDNEY SILCAD is being used mor and more in military and commercial fields – as a compact, lightweight an rugged power source in portable TV an radio and tape recorders . . . in radi controlled models...in electric cars an trucks . . . in photographic equipmen such as lighting, photoflash and camer drives . . .

YARDNEY
ELECTRIC
CORP.

"Pioneers in Compact Power"®
40-50 LEONARD STREET, NEW YORK 13, NEW YOR

Patents granted and pending.
© 1960 by Yardney Electric Corp.
See You at the IRE Show—Booth #2127

CIRCLE 215 ON READER-SERVICE CARD

STOP the SPACE RACE! with

METRONIX

Panel Mounting Electronic Voltmeters ("PMEVs")

These miniaturized instruments provide sophisticated monitoring performance in small packages. Requiring only the panel space of a meter, they build reliability and versatility into systems and equipment. Always connected and ready for action, they pinpoint trouble much faster than cumbersome test lead devices.

Basic models can be easily adapted to special requirements, so there's no need to waste valuable engineering time and energy in building your own electronic voltmeters.

Styles include commercial, militarized, single and multiple range. Prompt delivery.

Model 320 Smallest d-c PMEV—Any sensitivity from .5 v a-c to 1 kv, f.s.d. Accuracy: ± 2% f.s.d.

Model 332 Smallest a-c PMEV—Meter: 2½-inch round. Basic range: 100 mv r.m.s. Other ranges to 300 v.

Model 311 High impedance a-c—Impedance: 5 megohms. Frequency range: 20 cps to 250 kc.

SPD-25 Sub-miniature militarized a-c—Per MIL-T-945; 2½-inch meter. Total area: 41.25 cubic inches.

For Quick Transistor Testing

Metronix Model 545-B presents directly on the meter the Beta parameter, the input impedance and the collector cut-off current of germanium and silicon transistors. For both production lines and laboratories. Test it yourself on special 10-day memo billing.

METRONIX, INC.
a subsidiary of Assembly Products, Inc.
Chesterland, Ohio
Telephone (Cleveland); HAmilton 3-4440
Booths 3916-18, IRE Show
CIRCLE 216 ON READER-SERVICE CARD

Jack Panel 412

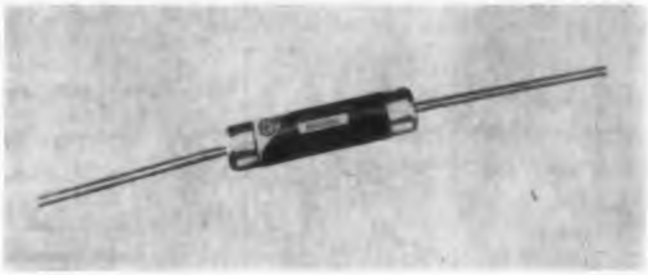
Made of aluminum

Series 2800 light-weight jack panel is made of anodized aluminum. It mounts 24 jacks per row, and 48 jacks per strip, on 5/8-in. centers. A narrow designated strip for each row, with a stop for each insert, is included. Both commercial and military types can be furnished.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Delay Line 413

Input-output impedance is 1 K



Model RM-1080 magnetostrictive delay line permits range markers to be generated for calibration purposes in the video section of radar. The first video pulse output is at 3.05 μsec and is followed by 6.1-μsec echos. The first marker output level is 25 mv. Pulse decay is 1 db and the input-output impedance is 1 K. The unit weighs 0.25 oz, has a diameter of 0.25 in. and is 1.5 in. long.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Sta., L.I., N.Y.

Hipot Tester 596

Provides from 0 to 10 kv, ac and dc

This unit is made up of a 0 to 10 kv ac and dc sensitive hipot tester, a testing sequence control panel, and a testing compartment. The electronic fault relay is adjustable in six steps from 5 to 5000 μamp. Dual scale panel meters show voltage and leakage current on each component being tested. Both a straight ground return and a guarded high voltage return are available. Input is standard 115 v, 60 cps.

Peschel Electronics, Inc., Dept. ED, RFD 1, Patterson, N.Y.

Price & Availability: Made on order only. Delivery is 45 days after order received. Price is $2000 per unit.

critical...

critical to many of the most complex military and industrial control systems are Diehl Servomotors and electromechanical components.

DIEHL AC Servomotors are made in output ratings ranging from 1 to 750 watts . . . in 60 cycle frequencies for land and shipboard operation . . . 400 cycle frequencies for airborne service. DC Servomotors produced by Diehl are available in ratings up to 2½ HP . . . and in combination with DC Tachometers.

Diehl produces an extensive line of high precision equipment: servomotors, resolvers, potentiometers, generators, servo amplifiers. In sum, the range of instrument servo components for automatic control. Major development work is in progress.

Whatever your critical need — development assistance or actual electromechanical hardware — you'll find that they'll best be filled at Diehl.

For complete details on this important source of service and supply, write for the Diehl facilities brochure.

Visit us at IRE Show Booths 1819-23

Diehl† SINGER*

DIEHL MANUFACTURING COMPANY
A SUBSIDIARY OF THE SINGER MANUFACTURING COMPANY
Somerville, New Jersey

†A Trademark of THE DIEHL MANUFACTURING COMPANY *A Trademark of THE SINGER MANUFACTURING COMPANY

CIRCLE 217 ON READER-SERVICE CARD

SYSTRON ANNOUNCES.....

LOWEST PRICED SOLID STATE 10 MC COUNTER-TIMER

ONLY $2900

MODEL 1039

• Fully Transistorized • Small Size-5¼" Panel Ht. • Nixie In-Line Readout

EXCLUSIVE:
- In-line readout • No time base adjustments
- 3 Amplifiers — 0.1 V RMS Sensitivity, 1 Megohm input impedance

Model 1039 is solid state . . .
- NO vacuum tubes • Greater reliability • Modular plug-in construction
- Low power — 50 watts • Ease of maintenance

IT'S UNIVERSAL
frequency — 0 to 10 MC
Intervals } .3 μsec 10⁸ sec.
Period }
Ratio of 2 frequencies — 1 to 10⁷
Phase Shift — Gated Counter
Compatible with all frequency extenders for measurements to 12,000 MC

SYSTRON CORPORATION

Write for complete specifications of Model 1039 and free copy of Short Form Catalog

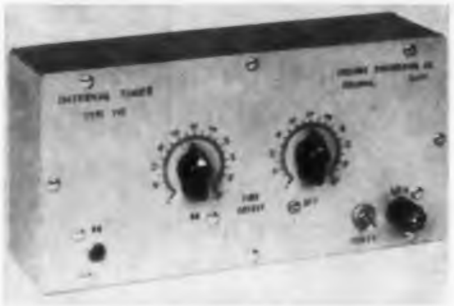
SYSTRON CORPORATION
950 Galindo Street • Concord, Calif.
Representatives in Principal Cities

CIRCLE 218 ON READER-SERVICE CARD

NEW PRODUCTS

Interval Timer 377

Comes in three types



Model 142 recycling interval timer comes in three types: bench type, rack panel mounted, and drop-in chassis type. The unit operates within the ranges of 50 msec to 1 sec, or 1 to 90 sec. It has independently adjustable on and off time intervals. The repeatability of the timing intervals is within 3%. Power requirements are 115 v, 60 cps; three terminals are provided for use in connecting the recycling load to the spdt relay contacts.

Fellow Engineering Co., Dept. ED, 1168 Meadowbrook Road, Altadena, Calif.

Price & Availability: *Delivery is from 2 to 4 weeks from receipt of order. Prices range from $69.50 to $84.50, fob Altadena, Calif.*

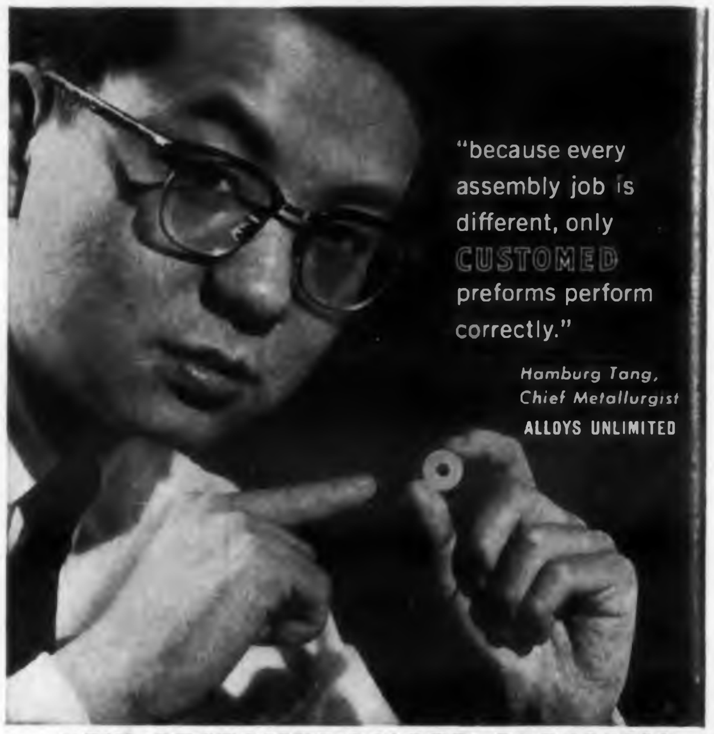
Lamp Holder 401

For neon and incandescent bulbs

Model 856 lamp holder, for both neon and incandescent bulbs, mounts in a 7/16-in. hole. A two-terminal type holder, it can be used in missile test stands, aircraft, computers, as well as laboratory, production, and quality control equipment. A lens which permits optimum light dispersion is used. The mounting space is 0.58 in.

The Sloan Co., Dept. ED, 4029 Burbank Blvd., Burbank, Calif.

Have you sent us your subscription renewal form?



NEW CUSTOMED SOLDER PREFORMS IMPROVE AUTOMATIC SOLDERING

New customed preforms consist of an accurately predetermined amount of a specific alloy. The proper melting temperature and correct volume of solder are assured. Labor costs are lowered. Production increases. Scrap is eliminated. Get the facts today! Write for 8 page Guide to Preform Soldering.

ALLOYS UNLIMITED INC

21-01 43rd Ave., Long Island City 1, N. Y.

CIRCLE 219 ON READER-SERVICE CARD

marion
advancement in instrument design

INDUCTION SOLDERING UNIT

FOR SMALL PARTS AND ASSEMBLIES

Simplifies, improves and speeds up component production. Provides local heat to otherwise inaccessible spots. Safe and simple. Max. power input 775 watts, 100 watts standby; 115 volts, 60 cycles. 15¾" x 21½" x 15". 150 lbs. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, N.H., U.S.A. *In Canada, Honeywell Controls Limited, Toronto 17, Ontario.*

Honeywell
First in Control
75th YEAR PIONEERING THE FUTURE H SINCE 1885

Visit us at Booth 2202 at IRE Show

CIRCLE 220 ON READER-SERVICE CARD

CIRCLE 221 ON READER-SERVICE CARD ➤

Chart Recorder 575

Has 5 full-scale voltage ranges

Model 80 chart recorder has 5 full-scale, calibrated voltage ranges of 10 and 100 mv, and 1, 10, and 100 v, and 5 full-scale calibrated current ranges of 1, 10, and 100 μa, and 1 and 10 ma. Its attenuator allows continuously variable full-scale deflections between calibrated ranges. The instrument can be operated as a zero left, zero center, or zero right recorder, and provides 4-times, full-chart width expansion on all ranges. It can be used grounded or floating up to 200 v from ground.

Yellow Springs Instrument Co., Inc., Dept. ED, Yellow Springs, Ohio.

Price: Model 80 is priced at $295.

Voltmeter 362

For measurement down to 10 mv ac or dc

Model SPD-35 voltmeter measures both ac and dc voltages down to 10 mw. It has 10 standard voltage ranges in ac and dc, up to 300 v. For ac measurement, it has an input impedance of 5 meg shunted by 25 μμf. Frequency range is 25 cps to 250 kc. The ac accuracy is ±3% full scale up to 100 kc and ±5% up to 250 kc. The dc circuit is stabilized by two feedback loops, one of which includes a chopper. The dc accuracy is ±3% on all ranges. Made for built-in half relay-rack mounting in systems and consoles, it permits continuous monitoring of critical parameters. Arc length of the meter is 5-1/8 in.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

***Price & Availability:** Price is $430; delivery is in one to four weeks.*

◄ CIRCLE 221 ON READER-SERVICE CARD

BASIC
BUILDING
BLOCKS
FROM KEARFOTT

DIRECTIONAL GYRO

This compact new gyro provides accurate heading information even under the severe conditions of environment frequently encountered in high performance aircraft and missile installations. Inner axis leveling loop, consisting of a liquid bubble type vertical sensor and A.C. torquer, continuously maintains the spin axis in a horizontal plane.

TYPICAL CHARACTERISTICS ≠A2215

Environmental Capabilities
Vibration:
5g, 20-1000 cps; 10g, 1000-2000 cps
Temperature Range (operative):
—54°C to +71°C
(non-operative):
—65°C to +85°C
Altitude: Unlimited

Azimuth Pickoff
Excitation:
26V, 400 cps, single phase
Output (sinusoidal):
11.8V ± 5% max.
Error from E.Z.: 10 min. max.

Motor
Excitation:
115V, 400 cps, three phase
Speed: 23,500 RPM
Power: Starting: 35 watts
Running: 7.5 watts

Performance Characteristics
Drift: 4°/hr. max.
Leveling Rate:
Between 2° and 4°/min.
Azimuth Torquing Rate:
360°/min. (intermittent)
40°/min. (continuous)

Physical Features
Dimensions: 4" dia. x 5³⁄₁₆" long
Weight: 5.5 lbs. (approx.)

Write for complete data.

BASIC
BUILDING
BLOCKS
FROM KEARFOTT

VERTICAL GYRO

Kearfott's rugged new vertical gyro, designed for missile application, is a two-degree-of-freedom instrument with 360° of freedom about outer gimbal axis. Self-contained vertical erection system incorporates liquid bubble-type vertical sensing device.

TYPICAL CHARACTERISTICS #B2115

Environmental Capabilities
Vibration:
5 g, 20-1000 cps;
10 g, 1000-2000 cps
Temperature Range (operative):
—54°C to +71°C
(non-operative):
—65°C to +85°C
Altitude: Unlimited

Pickoffs
Excitation:
26V, 400 cps, single phase
Error from E.Z.: 10 min. max.
Output Voltage (line to line):
11.8V ± 5% max.

Motor
Excitation:
115V, 400 cps, three phase
Power: Starting: 35 watts
Running: 7.5 watts

Performance Characteristics
Repeatability of Established Vertical:
To within a cone of half angle equal to 12 minutes of arc
Scorsby Drift Rate in 5 Min. Time:
0.3°/min. (average)
Erection Rate:
Normal: Between 2° and 4°/min.
Fast: 80°/min. intermittent,
40°/min. continuous

Physical Features
Dimensions: 4" dia. x 5³⁄₁₆" long
Weight: 5.5 lbs. (approx.)

Write for complete data.

BASIC
BUILDING
BLOCKS
FROM KEARFOTT

FREE GYRO

A highly reliable, two-degree-of-freedom instrument utilizing AC synchros at each gimbal axis. Designed to operate under the most severe missile conditions, this gyro has AC torquers mounted at each gimbal axis to permit command positioning or slaving of spin axis to desired reference position; each torquer capable of producing a precession rate of 360°/minute with 12.5 watts/phase power input.

TYPICAL CHARACTERISTICS ≠Q2315

Environmental Capabilities
Temperature Range
(operative): – 54°C to +71°C
(non-operative): —65 C to +85°C
Altitude: Unlimited
Vibration: 10g, 10-2000cps

Pickoffs
Excitation:
26V, 400 cps, single phase
Output (sinusoidal):
11.8V ± 5% max.
Error from E.Z.: 10 min. max.

Motor
Excitation:
115V, 400 cps, three phase
Speed: 23,500 RPM
Momentum:
2.25 x 10⁶ gm cm²/sec.

Caging and Preset Provision
(Electrically energized torquer type)
Excitation: 115V max./phase
Torquer Constant:
22.8 dyne cm/Volt²

Performance Characteristics
Free Drift:
0.5°/minute each axis
Runup Time:
1 minute max.
Torquing Rate:
360°/min. (intermittent)
40°/min. (continuous)

Physical Features
Dimensions: 4" dia. x 5³⁄₁₆" long
Weight: 5.5 lbs. (approx.)

Write for complete data.

Synchronous Motor

Ferrites

Rotary Switch

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

KEARFOTT DIVISION

GENERAL PRECISION INC.

LITTLE FALLS, NEW JERSEY

Midwest Office: 23 W. Calendar Ave., La Grange, Ill.
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

CIRCLE 222 ON READER-SERVICE CARD

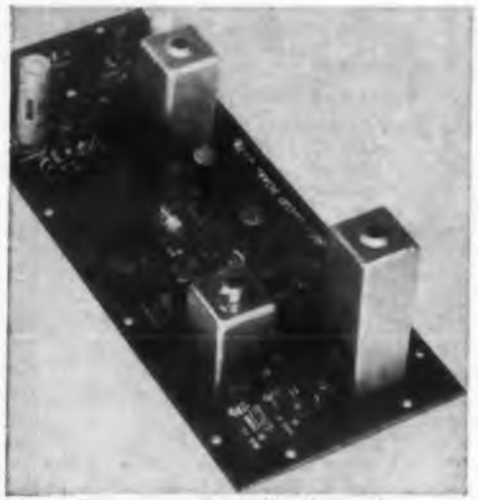
the CLEVITE reporter

News and Technical Data on Piezoelectric and Magnetic Components

TRANSFILTERS® AID SELECTIVITY IN HEATHKIT® "MOHICAN"

Heathkit's new "Mohican" portable communications receiver uses Clevite "Transfilters" to improve i.f. selectivity. The radio covers 550KC to 30 mc—quite a range for an all-transistor unit.

Two "Transfilter" interstage couplers (TO-01A) pass 455KC and couple the 1st and 2nd and 2nd and 3rd i.f. stages. Two emitter bypass "Transfilters" (TF-01A) are used instead of conventional capacitors. The TO-TF combinations help give the "Mohican" excellent selectivity among remote stations broadcasting over the wide band covered.



"Mohican" Printed Circuit Chassis

Heathkit® "Mohican"

Clevite "Transfilters" have pared up to 50 cents in parts cost from transistor receivers. They are small, rugged units with real performance advantages over conventional LC components. Clevite's factory or field sales engineers can fill you in on specifications and circuit application data. The TF-01A and TO-01A are standard items, and sell for 30 and 35 cents in 10,000 lots. Samples are one dollar. You can buy a "Mohican" Kit from Heath Co. for $99.95 or from its distributors at a slightly higher price.

Transducer Element is Critical in Ultrasonics

In ultrasonics or sonar nothing helps like starting with the right transducer element. Should it be crystal or ceramic? Do you require a high ac drive element (like "PZT-4") or a highly sensitive pickup device (such as ADP)? Do you want a disc or tube? Will special electrodes simplify your device?

Start asking yourself these questions while your transducer design is on paper. Then ask Clevite to supply you some experimental transducer elements and engineering data. Our engineers may not have *all* the answers, but some that they have you can't get anywhere else. Send today for the bible of the ultrasonic industry—"Piezotronic Technical Data" and our new bulletin "Modern Ceramic Shapes".

VISIT BOOTH 2622, IRE, MARCH 21-24, N. Y. C.

Clevite Products Include Magnetic Heads • Ceramic Filters • "Transfilters"
Piezoelectric Tranducer Elements • Accelerometers

CLEVITE ELECTRONIC COMPONENTS division of CLEVITE
3405 Perkins Avenue • Cleveland 14, Ohio
East Orange, N. J. • Chicago, Ill. • Inglewood, Calif.

CIRCLE 223 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Frequency Doubler Sets 635

Models 938A and 940A cover 18 to 26.5 kmc and 26.5 to 40 kmc, respectively. They can be driven by types 626A and 628A signal generators or electronic sweep oscillators.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palo Alto, Calif.

Booth 3302-3304-3306, 3401-3403-3405.

Attenuators 680

These fixed coaxial units have ranges of 1 to 12.4 kmc at 3, 6, and 10 db and 2 to 12.4 kmc at 20 db.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Booth 3713-3717.

Recording and Plotting System 671

Designed for aircraft, missile and industrial applications, model 96-451CV has digital readout. The polarity and magnitude of the strain is presented digitally at the same time the analog value is plotted.

B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St, Philadelphia 40, Pa.

Booth 3123.

Vacuum Oven 668

This vacuum baking-oven is a self-contained, package unit for outgassing and sealing semiconductor components. A high vacuum is provided. Heat, in a non-oxidizing environment, is provided for fusing and sealing.

F. J. Stokes Corp., Dept. ED, 5500 Tabor Rd., Philadelphia 20, Pa.

Booth 4126.

Booster Amplifiers 667

These compact, chassis-mounted boosters accept up to seven independent parallel inputs. The input resistor package is independent of the amplifier and connects to it by a mating plug. Overall feedback gain is more than 60 DB.

Reeves Instrument Corp., Dept. ED, Garden City, N.Y.

Booth 1305-1307.

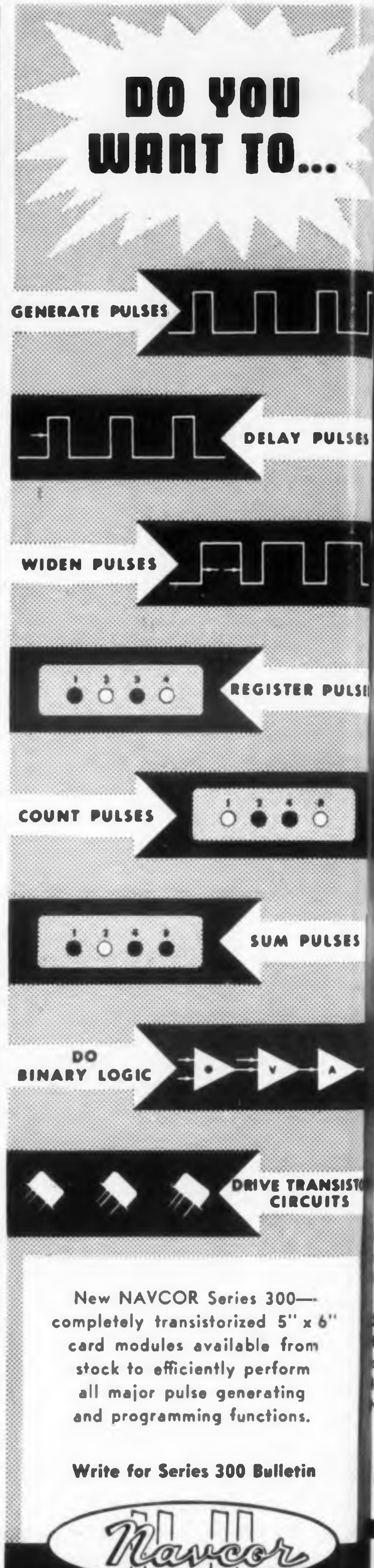
Universal Slotted Section 677

This single-body unit accommodates, interchangeably, slotted transmission lines covering the H and Y-bands. It can be adapted for dial indicator readings and uses a standard probe.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Booth 3713-3717.

Have you sent us your subscription renewal form?



New NAVCOR Series 300—completely transistorized 5" x 6" card modules available from stock to efficiently perform all major pulse generating and programming functions.

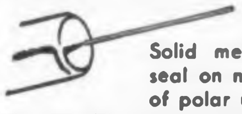
Write for Series 300 Bulletin

Navcor
NAVIGATION COMPUTER CORP
1621 SNYDER AVE., PHILADELPHIA 45, PA.
PHONE: HOward 5-7700

CIRCLE 224 ON READER-SERVICE CARD

iei
tantalum
foil
electrolytic
capacitors

for
HIGH
RELIABILITY



Solid metal hermetic seal on negative end of polar units reduces chances of electrolyte leakage by 50%.

Only one external butt weld on polar units minimizes possibility of lead wire breakage. (No weld on the negative end.) Leads on capacitors of 3/16" O.D. and larger withstand 3 lb. stress in any direction for 30 min. Welds withstand at least four "round trip" bends.

Internal Features. All electrical connections welded, for low resistance, low power factors. Capacitor section fits snugly into metal case, resulting in good vibration resistance. Plugged end of case is double-sealed with compressed bushing and tough resin.

iei also supplies a full line of aluminum foil miniature and sub-miniature electrolytic capacitors. Write for bulletins 41858 and 81558. International Electronic Industries, Inc., Box 9036-E, Nashville, Tennessee.

iei
AN sps COMPANY
where reliability replaces probability

CIRCLE 225 ON READER-SERVICE CARD

Traveling Wave Tube 544

Bandwidth is 800 mc

Model VA-128 traveling-wave, medium-power, pulse-amplifier tube has a bandwidth of 800 mc. Peak power output is 5 kw as the driver stage for advanced coherent and frequency agile radar systems. It offers rigid control of driver tube characteristics from 2.7 to 3.5 kmc.

Varian Assoc., Dept. ED, 611 Hansen Way, Palo Alto, Calif.

Availability: *Delivery time is 90 to 120 days.*
Booth 2714-2720.

Vhf Admittance Bridge 549

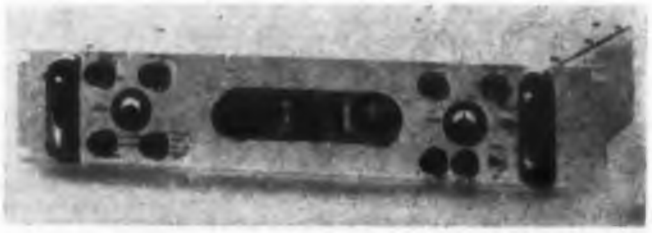
Accuracy is 2%

Model 978 vhf admittance bridge has an accuracy of 2% from 30 to 300 mc. Capacitance is ±40 μμf and conductance is 0 to 50 millimhos. A miniature thermistor element employed in a servo feedback system is used as a conductance standard. Two-terminal measurements can be made on rf components, semiconductors, transmission lines, and other devices. The test voltage is rarely more than 50 mv.

Marconi Instruments, Inc., Dept. ED, 111 Cedar Lane, Englewood, N.J.
Booth 3301-3303-3305.

Receiver 547

For fm, am and cw signals

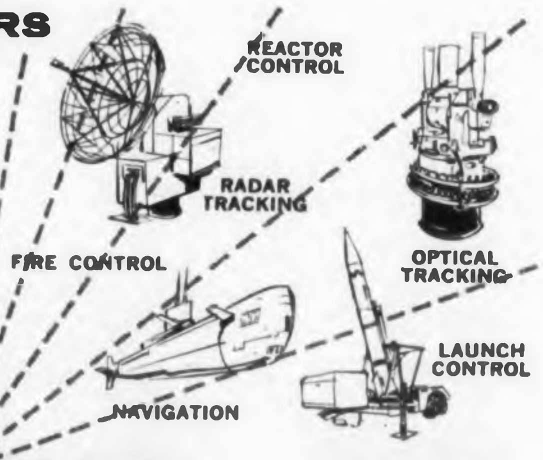


Type 1906 receiver is designed for fm, am and cw signals. The if is 21.4 mc with bandwidths of 300 kc and 20 kc. The automatic gain control for am is 40 db for a 7-db change of output. The fm output stability varies less than 2 db above 1 μv. The following outputs are provided: spectrum display output, 600 ohms unbalanced for external use; and 600 ohms phone output. The unit weighs about 25 lb and measures 19 x 3.5 x 15 in.

Nems-Clark Co., Dept. ED, 919 Jesup Blair Drive, Silver Spring, Md.

Price: *$2250.*
Booth 3826-3828.

DIGISYN® ENCODERS
for precision in:
Radar and Optical Tracking
Navigation and Guidance Systems
Missile Launch Control
Nuclear Reactor Control



NEW RD-17

Photoelectric
Shaft
Position
Encoder

DIGISYN® RD-17
The Ultra-Precise Encoder

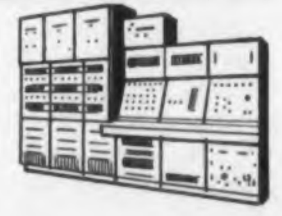
- 17-digit accuracy in 10" diameter — 10-second resolution without gearing
- Self-contained amplifiers and control electronics
- Self-contained power supplies — 115 Volts, 60 cps or 400 cps input power
- Solid or Hollow Shaft Input
- Serial or Parallel Digital Readout
- Modular construction — easy maintenance

When you need the ultimate in accuracy, the utmost in reliability, the maximum in performance, the minimum in maintenance — specify DIGISYN® Shaft Position Encoders. They provide a direct, single-step method of digitizing the angular position of a shaft, meet military specifications, and function in environmental extremes.

For full information on the new, ultra-precise RD-17 or other DIGISYN® encoders and accessories, write today, or call (Boston) COpley 7-8425.

Standard & Custom Encoders

Data Processing Equipment



WAYNE-GEORGE
CORPORATION
(ADCON DIVISION)
588 COMMONWEALTH AVENUE • BOSTON 15, MASS.
"SEE US AT I.R.E. BOOTH # 3232"
CIRCLE 226 ON READER-SERVICE CARD

DECISION MAKER

for simplified monitoring, controlling, high-precision switching

Normal/abnormal . . . high/low . . . go/no-go: these are important decisions being made by A.P.I. Very High Sensitivity Measuring Relays.

Direct from sensory elements or circuits, the A.P.I. measuring relay makes a decisive "yes or no" decision on the basis of very close-tolerance voltage or current changes. In typical, critical applications, this measuring relay is saying "yes or no" on a change of ±1 microamp; or in a 400- to 500-volt circuit, on a variation of only a few percent.

Moreover, the relay is capable of actuating on very tiny currents: for example, total inputs as small as 0.2 microampere or 0.1 DC millivolt. It does so without signal amplification, amplifier costs or the signal distortion problems that often go along.

Performance stability is inherent; reliability is exceptional due to the A.P.I. locking-coil design. On "make", contact is firm with substantial contact pressure; contact resistance is low. On "break", separation is clean and quick without contact teasing.

10,000,000 perfect operations is not an all-time record; it's a reasonable expectation of service life.

Widely used for precision switching in computer, control and alarm circuits, VHS measuring relays are practically unlimited in scope of application.

For more information, send for Bulletin 104-D.

api ASSEMBLY PRODUCTS, INC.
Chesterland 17, Ohio

CIRCLE 227 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Swept Oscillator 676

This unit operates from 8.2 to 12.4 kmc. It has automatic gain control. The sweep frequency is linear with respect to time

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Booth 3713-3717.

Waveguide Components 634

For measurements in the communications band WR75, these waveguide components are for precise work between 10 and 15 kmc.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palo Alto, Calif.

Booth 3302-3304-3306, 3401-3403-3405.

Direct-Reading Frequency Meters 679

Three terminals allow this instrument to operate as an absorption or transmission type meter. It has the same specifications as the firm's series 410 meters.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Booth 3713-3717.

Control Meter 674

This switching device, having no physical contacts, sends out continuous signals after the pointer reaches a set point or until the pointer returns to the set point.

International Instruents, Inc., Dept. ED, P.O. Box 2954, New Haven, Conn.

Booth 2813.

Power Meter 678

This temperature-compensated unit is fully transistorized. It is more stable than uncompensated units, even at 10 μw.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Booth 3713-3717.

Projection Video Monitor 673

For military and commercial requirements, model PVM remotely-controlled, high resolution projection unit can project both closed circuit and on-the-air TV pictures to a size of 9 x 12 ft.

Blonder-Tongue Laboratories, Inc., Dept. ED, 9 Alling St., Newark 2, N.J.

Booth 3225.

Coaxial Frequency Meter 675

This direct-reading instrument operates over the range of 4 to 11 kmc.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

Booth 3712-3717.

TOUGH

...AS A TURTLE'S BACK

ARMAG*-PROTECTED DYNACOR® BOBBIN CORES AT NO EXTRA COST!

Tough-as-tortoise-shell Armag armor is an exclusive Dynacor development. It is a thin, non-metallic laminated jacket for bobbin cores that replaces the defects of nylon materials and polyester tape *with very definite advantages*—and, you pay no premium for Armag extra protection.

Tough Armag is suitable for use with normal encapsulation techniques on both ceramic and stainless steel bobbins. It withstands 180°C without deterioration—is completely compatible with poured potted compounds—has no abrasive effect on copper wire during winding—fabricates easily to close-tolerance dimensions—inner layer is compressible to assure tight fit on bobbin—does not shrink, age or discolor.

Write for Engineering Bulletins DN 1500, DN 1000A, DN 1003 for complete performance and specification data covering the wide range of Dynacor low cost Standard, Special and Custom Bobbin Cores—all available with Armag non-metallic armor.

*TRADEMARK

DYNACOR

DYNACOR, INC
A SUBSIDIARY OF SPRAGUE ELECTRIC
1012 WESTMORE AVE., ROCKVILLE, MARYLAND
CIRCLE 228 ON READER-SERVICE CARD

ONLY $18,000

FOR A COMPUTER

!!!

...that possesses the mathematical logic of giant computers, yet is easy to operate and program...requires no site preparation or technical personnel...performs engineering, scientific and business computations automatically and with electronic speed. Iterates, compares, branches and handles sequences of complex operations. If you use as few as 4 desk calculators for the same job, the new Clary DE-60 can save you thousands of dollars every year!

To find out more about this versatile computer, simply mail in this coupon. No obligation, of course.

Clary

Clary Corporation
Computer Division
Dept. ED-1
San Gabriel, Calif.

Please send me complete information on your new electronic computer, the DE-60.

Name

Company Position

Address

City Zone State

Franchises available to qualified principals.

CIRCLE 229 ON READER-SERVICE CARD

DC Power Supply 467

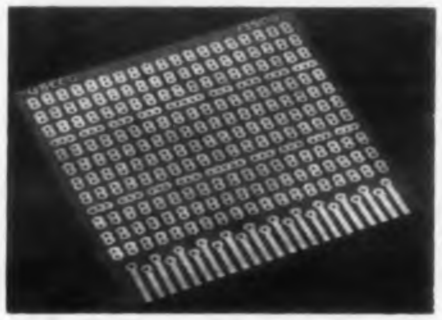
Adjustable from 0 to 15 v

Model 850, transistorized power supply is adjustable from 0 to 15 v at any input current from 0 to 1 amp. An octal plug is used for all input and output connectors, including remote programming and remote sensing. Regulation on the unit is better than 3 mv; ripple is less than 500 µv for any combination of line or load. The unit measures 6-1/2 x 3-7/16 x 6 in.; 3-1/2 in. rack mounting panels are available.

Harrison Laboratories, Inc., Dept. ED, 45 Industrial Road, Berkeley Heights, N.J.
Price: $197.

Plated Circuit Cards 434

Have standard grid pattern and hole spacing



These plated circuit cards, called the Carte Blanche series, use standard grid pattern and hole spacing. They have circuit contact extensions and a land pattern compatible with standard 0.1-in. grid design. They can also be supplied with terminals. The universal card contains 22 fingers to fit standard plug-in, right-angle, or swage-type connectors with 0.156-in. spacing, and may be sheared or sawed to any size.

Litton Industries, U. S. Engineering Co. Div., Dept. ED, 13536 Saticoy St., Van Nuys, Calif.
Price & Availability: Prices vary with design and quantity. For small quantity orders, prices begin at $7.75 ea. Delivery is from stock.

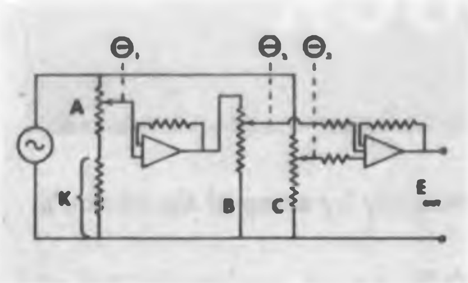
Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN

DESIGN IDEAS FOR ELECTRONIC ENGINEERS:

How to design better analog computing circuits with Vernistat* a. c. potentiometers

Analog computers typically use such components as potentiometers, resolvers, and linear synchros to relate shaft position to voltage. In most applications, to reduce the effect of loading error, high impedance circuits, and phase shift, a substantial amount of additional equipment, such as isolation amplifiers and auxiliary power supplies, is required. Size, weight, heat dissipation, and possibility of failure are thus greater than if loading error, phase shift, and high output impedance problems did not exist.

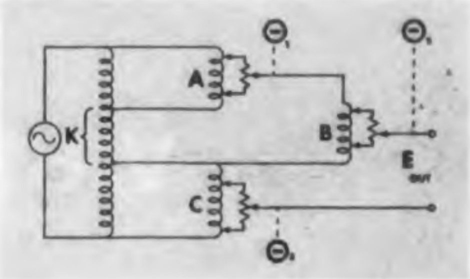
Typical of a class of equations which are incorporated into much analog computer circuitry is the relation
$E_{out} = [K + A(\Theta_1)] B(\Theta_2) + C(\Theta_3)$.



ONE WAY TO SOLVE this relation is shown in this diagram of a conventional resistance potentiometer computing circuit. Such circuits, however, suffer from excessive phase shift, particularly at high frequencies.

Due to high potentiometer output impedances, the circuit requires an isolation amplifier in the multiplying channel, while summing resistors and a feedback amplifier are required in the addition section. Both of these amplifiers, as additional components, add a factor of unreliability and use more power, increasing the problem of heat dissipation.

A MORE EFFICIENT WAY TO SOLVE this equation is with Vernistat a.c. Potentiometers. The Vernistat is an ideal component for analog computer systems. Its combination of a tapped autotransformer and an interpolating potentiometer uniquely provide characteristics unobtainable with other types of shaft position-voltage devices. The Vernistat provides precise voltage division, high input impedance, low output impedance, and low phase shift. These characteristics directly relate to the design of improved computer circuits.



FOR EXAMPLE, in the computer circuit shown here, multiplication may be performed without the aid of an isolation amplifier, because of the Vernistat's high ratio of input to output impedance. Addition is accomplished by utilizing voltages of opposite phase in the two computing channels obtained by a tapped input transformer. By eliminating the amplifiers of the preceding circuit, a reduction of size, weight, heat rise, and power requirements is obtained. With fewer components required, there is an over-all increase in reliability.

IN SOLVING DESIGN PROBLEMS like these, Vernistat a.c. Potentiometers offer such major advantages as: low output impedance (as low as 40 ohms) with high input impedance (as high as 200,-000 ohms) — high resolution (to 0.002%) — low phase shift (as low as 0.2 minutes) — and high terminal linearity (to 0.01%). Vernistats meet the requirements of MIL E 005272-B. and operate at 125°C without derating.

WRITE TODAY for full description and specifications on Vernistat a.c. Potentiometers, Adjustable Function Generators, and Variable Ratio Transformers.

AT THE IRE SHOW, VISIT US IN BOOTH 2828

*vernistat® — *a design concept that unites in one compact device the best features of the precision autotransformer and the multiturn potentiometer*

vernistat

765 Main Avenue, Norwalk, Conn.

Perkin-Elmer Corporation

CIRCLE 230 ON READER-SERVICE CARD

atlee
clips
increase
their
grip
under

VIBRATION

and

SHOCK

TESTS PROVE IT . . . tests conducted independently by some of the nation's most critical users of component holders.*

the **TESTS:**
- vibration at 500 cps with 90 g peak acceleration, and at 2,000 cps with 65 g peak acceleration, for one minute
- 1,750 impact shocks at 200 g, at right angles to and also along the axis of the holder
- 100 complete cycles of component insertion and withdrawal
- all tests repeated after 15 minutes exposure to 500° F.

the **RESULTS:**
- no visible shifting of the component in the holder
- no resonant frequencies developing under vibration
- dynamic holding power unchanged by heat
- dynamic holding power unchanged by use
- force needed to dislodge component *increased* during tests

the **REASONS:**
- severe vibration and shock cause the material of the holder to flex slightly, producing a closer "set" of the holder surfaces to the actual contours of the held component

atlee component holders *start out* with a tighter-than-usual grip, because of proper contours, construction and materials. As environmental stresses increase, this holding power automatically increases to meet the greater demand . . . because the holders actually mold themselves to the components. Here is an equipment designer's dream come true: the greater the stress, the *greater* the security.

DESIGN FOR RELIABILITY WITH **atlee** *— a complete line of superior heat-dissipating holders and shields of all types, plus the experience and skill to help you solve unusual problems of holding and cooling electronic components.*

*Names on request

atlee corporation
(Formerly Atlas E-E Corporation)
47 PROSPECT STREET, WOBURN, MASSACHUSETTS

CIRCLE 231 ON READER-SERVICE CARD

Battery 462

Has a 7 amp-hr capacity

Designed for missile APU systems, model P58A silver-zinc primary battery has a capacity of 7 amp-hr, and produces 14 amp at 28 v. Maximum current for the 20-cell unit is 50 amp. Discharge time is 30 min at 14 amp. Operating temperature range is from 50 to 150 F; special models have wider ranges. The battery withstands 50 g shock, 20 g acceleration, and 10 g vibration, along all three axes.

Cook Batteries, Dept. ED, 3850 Olive St., Denver 7, Colo.

Circuit Tester 403

Semi-automatic

Type A64 semi-automatic continuity, hi-pot, and resistance tester checks 64 or 128 contacts at a time. Using the same displays, it can be modified to incorporate any multiple of 16. The use of relays is avoided in the device. It can be used by untrained personnel. Dimensions of the standard model are 13-7/8 x 7-3/8 x 9-1/4 in.

Intercontinental Dynamics Corp., Dept. ED, 170 Coolidge Ave., Englewood, N.J.

High-Vacuum Electronic Pumps 591

Handles 40 liters per sec

Series 240 general purpose electronic pump handles 40 liters per sec and produces a vacuum below 1 x 10^{-9} mm Hg when combined with a power supply. Operating on a cold-cathode discharge within a magnetic field, the pump has no

CAN YOU

MEASURE JUNCTION THERMAL IMPEDANCE REPRODUCIBLY

TEST CONTROLLED RECTIFIERS DYNAMICALLY

GENERATE ONE 5000 AMP. SINUSOIDAL PULSE

EVALUATE A 500 AMP. RECTIFIER AT 1500 VOLTS

...We Can!

BRING YOUR
DIODES AND
HEAT SINKS TO
BOOTH #3006

WALLSON
ASSOCIATES, INC.
912-914 Westfield Ave., Elizabeth, N. J.

CIRCLE 232 ON READER-SERVICE CARD

AiResearch Minifan* is an extremely high performance 400-cycle AC motor-driven fan used for cooling airborne or ground electronic and electrical equipment. Model shown has a flow capacity of 53.5 cfm at a pressure rise of 3.44 H_2O, and requires only 69 watts.

Minifan operates up to 125°C. ambient. Its size and weight make it ideal for spot cooling, cold plates or as a cooling package component. The fan can also be repaired, greatly increasing its service life.

Range of Specifications

- **Volume flow: 21.5 to 53.5 cfm**
- **Pressure rise: .6 to 3.44 H_2O**
- **Speed: 10,500 to 22,500 rpm**
- **Single, two or three phase power**
- **Power: 16 to 69 watts**
- **Standard or high slip motors**
- **Weight: .36 to .48 lb.**

A world leader in the design and manufacture of heat exchangers, fans and controls, AiResearch can assume complete cooling system responsibility. Your inquiries are invited.

*Minifan is an AiResearch trademark.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

CIRCLE 233 ON READER-SERVICE CARD

moving parts and the modular internal structure is easily removed for maintenance. It weighs 54 lb and has over-all dimensions of 15.25 in. in diam and 7.375 in. in height.

Ultek Corp., Dept. ED, 920 Commercial St., Palo Alto, Calif.

***Price & Availability:** Price is $1175 fob Palo Alto. Units are made on order only at the present time and can be delivered in 30 days. They will be available from stock in September, 1960.*

Commutators 399

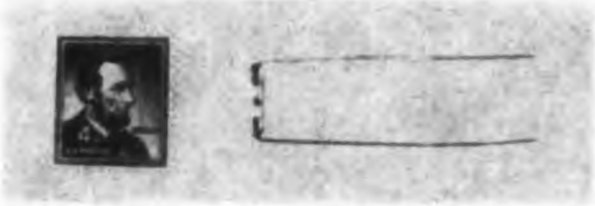
Have 30 channels

These dual-pole 30-channel commutators, in the GDI series have sampling rates of 1 frame per sec and 10 frames per sec. Units with other sampling rates can be furnished. Each pole is designed to operate into a standard sub-carrier oscillator having an input impedance of 500,000 ohms. The input signal range is 0 to +4 v. The units are completely solid state, operate over a wide environmental range of temperature and pressure, and are consistent with the requirements of missile applications.

General Devices, Inc., Dept. ED, Box 253, Princeton, N.J.

Thermistor 574

Is sealed in a glass rod



Suited for printed-circuit applications, the model 21A7 thermistor is sealed in a glass rod. It has a temperature coefficient of —3.1% C; cold resistance at 25 C is 100 ohms and drops to about 25 ohms at 50 C. The time constant is 25 sec when suspended by its lead in still air at 25 C. This unit is adaptable to temperature measurement, control and compensation.

Victory Engineering Corp., Dept. ED, 519 Springfield Road, Union, N.J.

***Price & Availability:** Available from stock and can be delivered 21 days after order is received. Price is $5.20 per unit.*

BREAKTHROUGH IN
THE SCIENCE OF
PRESSURE CONTROL

digital-servo
reliability
crystal-determined
accuracy

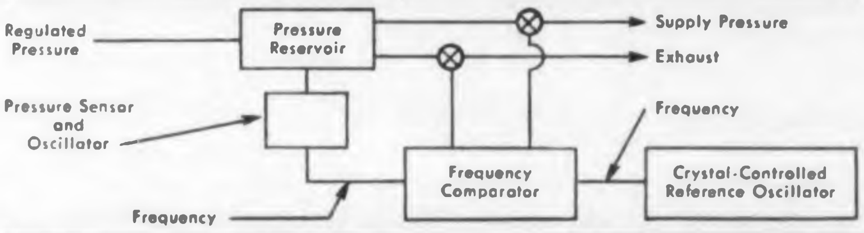
WIANCKO'S Q3700 SERIES
DIGITAL PRESSURE GENERATOR

This system, employing unique digital-servo concepts, provides instant selection of a pneumatic pressure accurate to ±**0.05 PERCENT.**

Pressure in a reservoir is measured and converted to a precision frequency. This frequency is compared with a selected reference frequency. If the frequency from the pressure sensor is high with respect to the reference frequency, the comparator produces a difference frequency in the form of pulses. These pulses then drive momentary exhaust valves until the pressure drops to the pre-selected value. When the frequency is low, error signals are produced which operate momentary pressurizing valves. The Q3700 is the best answer yet to pressure control and calibration problems.

Ideal for:

- ***Programming precision pressure/time functions***
- ***Automatic end-to-end calibration of data and telemetering systems***
- ***Rapid calibration of pressure devices***
- ***Ground checkout of instrument and control systems***



For complete information please request Product Bulletin 111

WIANCKO
ENGINEERING COMPANY

Precision with lasting reliability

255 North Halstead Avenue • Pasadena, California

CIRCLE 234 ON READER-SERVICE CARD

an
electronic
engineer
becomes an
editor...

George Rostky tells "Why I Became an Editor of **ELECTRONIC DESIGN**"

George Rostky, BEE, member of IRE and AIEE, spent 5 years as an electronic engineer before joining Hayden Publishing Company, Inc. Now Associate Editor of Electronic Design, Mr. Rostky tells why he switched from engineer, to engineer-editor.

"**as an editor** *you have the opportunity to gain a first hand, comprehensive view of the entire industry; avoiding narrow, specialized activities.*

"**as an editor** *you can achieve the satisfaction that comes with creating clear. precise, understandable material . . . of witnessing the news at it breaks . . . of meeting the challenge of each new article.*

"**as an editor** *you can avoid 'sitting on a job for a month', or depth probing, in favor of fast-moving, timely projects.*

"**as an editor** *you can enjoy meeting and getting along with people, spread your interest over many engineering problems, talk the language of engineers, attend conferences, and visit many electronic plants."*

ELECTRONIC DESIGN OFFERS YOU A CAREER IN EDITORIAL WORK

For further details and description of editorial positions open, write to Edward E. Grazda, Editor, ELECTRONIC DESIGN, 830 Third Ave., New York 22, N. Y. Or begin at once, by sending us the Resume Form in the Career Opportunities Section of this issue and circling the Reader Service Number listed below. Each application will receive careful attention.

CIRCLE 929 ON CAREER INQUIRY FORM, P. 317

NEW PRODUCTS

Double-Turret Terminal 410

Made of Teflon

Type 2610 Teflon double-turret terminal is designed to press fit into a 0.136-in. hole in panels from 1/32 to 1/8 in. thick. Two over-all lengths are offered: one, having the greatest spacing between the top and middle turrets, is 0.325 in. long; the other, with turrets spaced equidistantly, is 0.365 in. long. The finish is 0.003-in. silver plate plus water dip lacquer or 0.003-in. tin-lead solder plate. Units are especially suited for use in conditions of extreme humidity and low capacity to ground.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Computer Power Supply 404

Has five outputs

This computer power supply has five outputs: ±15 v at 10 amp, ±6 v at 5 amp, and 48 v at 1 amp. Line and load regulation is 0.2% and ripple is less than 3 mv. All outputs are cut off when the current at any output exceeds a predetermined value. A transistorized unit, the supply measures 7.25 x 17 x 13 in.

Invar Electronics Corp., Dept. ED, 323 W. Washington Blvd., Pasadena, Calif.

Gold Preforms 589

For the manufacture of semiconductors

These miniature gold preforms are for use in the manufacture of semiconductor devices such as diodes and transistors. They can be used as a high temperature solder for attaching the wafer to the base tab or for making electrical contact between leads and studs. The gold approaches

UNIFORM TUBING

ALLOYS

ALUMINUM

1100, 3003, High Purity, 2024, 5052, 6061, 6951 and the New High Strength Alloy UT-58.

COPPER

OFHC Copper, Phosphor Copper, 70-30 Brass, Yellow Brass, Red Brass, 18% Nickel Silver, 'A" Phosphor Bronze, #25 Beryllium Copper, 30% Cupro Nickel.

NICKEL

"A" Nickel, Monel and Inconel.

STAINLESS STEEL

304, 310, 316, 321, 347, 410.

GLASS-TO-METAL SEALING

#52 Nickel-Iron and "Rodar".

PRECIOUS METALS

Gold and Silver Alloys.

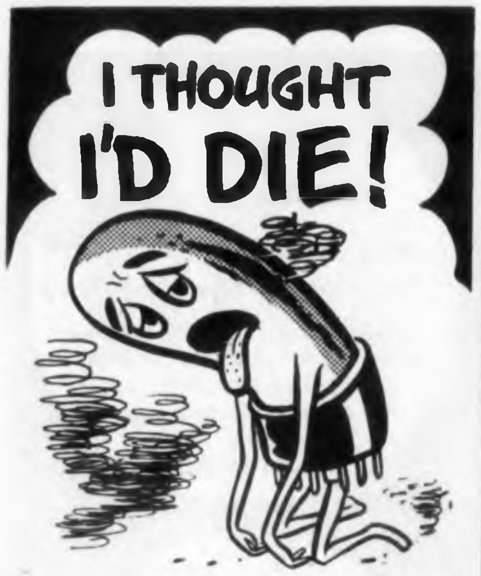
SIZES: O.D. from .005" to .625". Wall Thicknesses down to .001". Tolerances commercial or precision down to ± .00025", on smaller sizes.

•

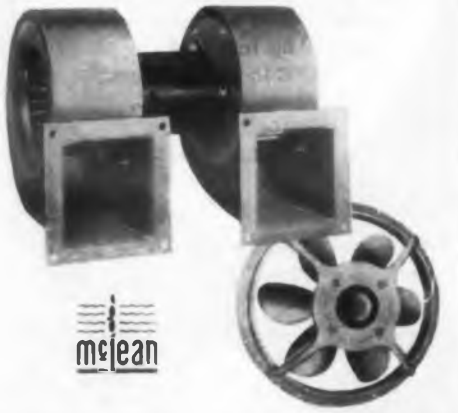
See Our Exhibit
Booth 4047
I.R.E. Show

UNIFORM TUBES, INC. COLLEGEVILLE 2, PA.
HUxley 9-7276 TWX-CGVL 1044

CIRCLE 236 ON READER-SERVICE CARD



The life of any electronic component is a hard one, and added to the work, the heat was just too much! I was down for the count when a McLean blower saved my life. Now my work is a breeze!



McLEAN RING FANS & BLOWERS
Sturdy units for a variety of uses.

Extend the life of sensitive tubes, transistors and other components with McLean packaged cooling units. Prevent system failure . . . maintain calibration and accuracy. Find out how in McLean's 1960 catalog . . . 44 pages of helpful information on cooling electronic equipment. McLean's rack-mounted fans and blowers are smart, compact, easy-to-install and have a multitude of mounting possibilities. Over 100 models in various panel heights and CFM's. Mil.Spec.equipment for packaged cooling also available.

WRITE TODAY
44 Page Packaged Cooling Catalog

McLEAN ENGINEERING LABORATORIES
World Leader in Packaged Cooling
Princeton, N. J. • WAlnut 4-4440
TWX Princeton, New Jersey 636
See us at the I.R.E. Show—booth 1624
CIRCLE 237 ON READER-SERVICE CARD

99.999% purity. Shapes such as discs, cups, small washers with large holes, spheres, and small cubes are offered. Except for the spheres, all are stamped from foil. The gold is alloyed with antimony, germanium, silicon, gallium, and other elements.

Alpha Metals, Inc., Dept. ED, 56 Water St., Jersey City 4, N.J.

Price & Availability: *The products are made to customer specifications and can be delivered in about 14 days. Price is furnished on request.*

Modules for Digital Systems 408

Size is 3-1/16 x 3-3/8 in.

For the assembly of digital systems, these transistorized modules measure 3-1/6 x 3-3/8 in. and weigh about 1.5 oz each. Flip-flops, shift registers, multivibrators, one-shots, dc logic, and other types are available. Uses are in digital systems, automation, timing and control, data processing, test equipment, instrumentation, and digital servos.

Control Equipment Corp., Dept. ED, 19 Kearney Rd., Needham Heights 94, Mass.

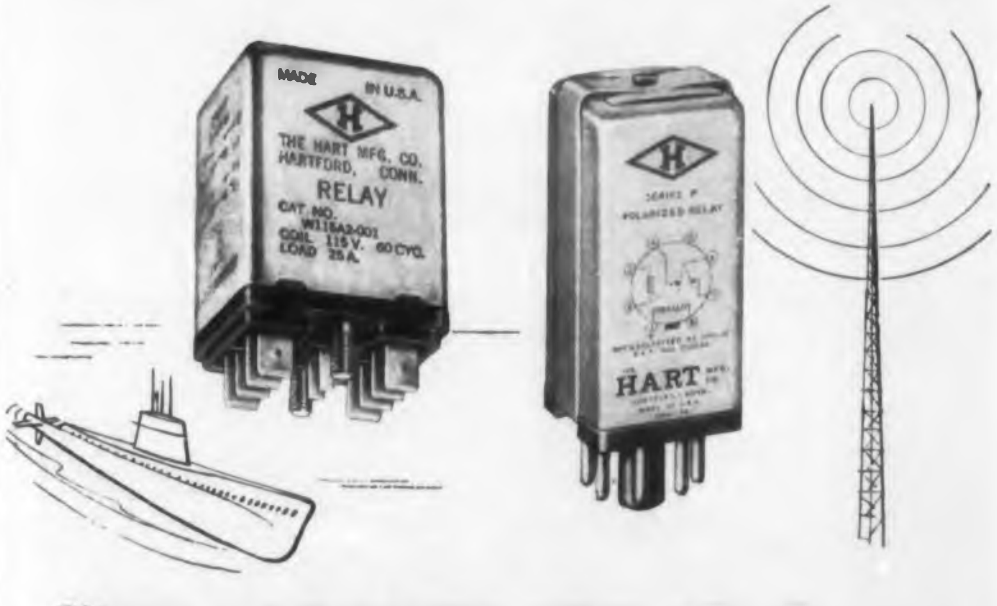
Power Dividers 411

For airborne applications

Made for airborne applications, these power dividers feature an impedance of 50 ohms and a vswr of less than 1.3:1. For two-way or three-way power division, the following bands are available: L, C, S, and X. Different connector and flange types can be supplied. The units weigh from 2.5 to 4 oz.

Transco Products, Inc., Dept. ED, 12210 Nebraska Ave., W. Los Angeles 25, Calif.

Heart of the Control System



"DIAMOND H" Relays

Look into the heart of the control system for a missile, a computer, a nuclear submarine, or a great many other critical applications. You might be surprised how often you'll find "Diamond H" relays.

Unless, of course, you're one of the increasing number of engineers who've already selected "Diamond H" relays for a spot where they just have to work despite all sorts of adverse conditions.

Hart makes relays of three basic types: miniature, hermetically sealed, aircraft-missile relays (Series R/S); high speed, sensitive, polarized relays (Series P), and general purpose AC, DC relays (Series W).

Technical literature outlining the wide range of characteristics available with each type relay is yours for the asking. You'll find "Diamond H" engineers uncommonly adept at working out a variation of the basic designs to meet your set of specific requirements.

Tell us your needs . . . by phone, wire or letter.

THE HART MANUFACTURING COMPANY
210 Bartholomew Ave., Hartford 1, Conn.
CIRCLE 238 ON READER-SERVICE CARD

Since 1942 the Bird Electronic Corporation has met the challenge of a constantly growing electronic industry. Today, enlarged engineering facilities demonstrate our intention to maintain leadership in our field. A wide range of coaxial line instruments and accessories are being designed to meet a variety of specifications; and new applications are continuously being sought.

In addition to experience and established leadership, Bird has the physical facilities to produce and dependably deliver coaxial line instruments and accessories meeting your highly exacting requirements.

See us at the IRE Show, Booths 3215 and 3217

BIRD ELECTRONIC CORP.
CHurchill 8-1200 (Cleveland)
30303 Aurora Road, Solon, Ohio
Western Representative:
VAN GROOS COMPANY, Woodland Hills, Calif.

CIRCLE 239 ON READER-SERVICE CARD

NEW PRODUCTS

Coaxial Attenuators 465

Operate from dc to 4000 mc

The AD series of coaxial microwave attenuators operates from dc to 4000 mc and has an input power rating of 15 w. The units consist of two or more tee section pads cascaded to distribute the power dissipation. Cooling fins are provided to minimize temperature rise. Maximum vswr is 1.20. All attenuators are constructed to meet the environmental requirements of MIL-E-5272B.

Microlab, Dept. ED, 570 W. Mount Pleasant Ave., Livingston, N.J.

Price & Availability: *Available for immediate delivery from stock. Prices range from $45 to $65 depending on the attenuation and connectors.*

Switching Transistor 631

Average turn-on time is 4 mμsec

Type 2N1468 silicon npn transistor has an average turn-on time of 4 mμsec while switching 40 w peak power with an average power dissipation of 250 mw. For operation to 125 C, it has applications in computers, sampling oscilloscopes, klystron pulsing, and other advanced equipment. Parameters include emitter cut-off current varying from 0.01 ma avg to 1 ma max. Avalanche and collector-to-emitter voltage vary from 40 v min to 70 v avg. The unit employs a JEDEC TO-5 case and a JEDEC E3-44 base.

Raytheon Co., Semiconductor Div., Dept. ED, 215 First Ave., Needham Heights, Mass.

Molybdenum Sheet Metal 594

For use in semiconductor products

This molybdenum sheet metal, available in both nickel-clad and copper-clad types, is particularly suitable for use in semiconductor products, such as silicon power rectifiers. For these rectifiers, discs punched from the sheet provide high electrical conductivity and a temperature coefficient of expansion approaching that of silicon.

FIRST AGAIN!

New Babcock 10 amp Magnetic Latching Relay

New subminiature Model BR-9, meets Mil R 5757C, 25018, with vibration to 30g @10 – 2000 cps, 50g shock @11 millisec over −65°C to 125°C range. Bulletin BR-594.

BABCOCK BR-1S RELAY

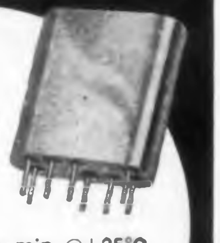
Miniature, hermetically sealed BR-1SZ requires only 5 mw power, features very critical pull-in to drop-out ratios, 100,000 op. min. and −65°C to 125°C ranges. Meets Mil R 5757C, 6106C, 25018. Bulletin BR-593.

BABCOCK RELAYS

BABCOCK BR-7 RELAY

Subminiature 10 amp, DPDT relay with 0.2" grid spaced header accepts 30g vibration @10 – 2000 cps, 50g shock @11 millisec. over range of −65°C to 125°C. 100,000 op. min. @+125°C. Meets Mil R 5757C, 25018. Bulletin BR-592.

BABCOCK BR-8 RELAY



Subminiature A. C. or D. C. crystal can relay, 250,000 op. min. @+25°C. Vibration, 30g, 40 – 2000 cps. at −65°C to +125°C. Available with adjustments for repeatability over millions of operations. Meets Mil R 5757C, 25018. Bulletin BR-591.

BABCOCK RELAYS, INC.
1640 Monrovia Ave., Costa Mesa, Calif.

IRE SHOW BOOTH M-15
CIRCLE 240 ON READER-SERVICE CARD

YOKE
DISTORTION
your problem?

Uniform magnetic fields
Produced in Celco
Precision
Deflection
Yokes
Minimize
SPOT
DISTORTION

Exclusive **Celco** core materials make it possible to achieve faster recovery times, minimum hysteresis, high linearities and maximum sensitivities.

Contact **Celco** Engineering Department for a fast solution to all your yoke problems.

Celco produces a complete line of standard or special commercial and military precision deflection yokes.

Celco
Constantine Engineering
Laboratories Co.

Main Plant: MAHWAH, N. J. DAvis 7-1123
- Pacific Division - Cucamonga, Calif. - YUkon 2-2688
- Central Division, Lanesboro, Pa. ULysses 3-3500
- Southern Division, Miami, Fla; - Wilson 5-2164

CIRCLE 241 ON READER-SERVICE CARD

The product also has many uses in electronic tube applications. It is available in thicknesses of 0.01 to 0.08 in. and in widths to 4 in. Standard thickness of the cladding is 0.0005 to 0.001 in. It is suitable for both military and industrial applications.

General Electric Co., Lamp Metals and Components Dept., Dept. ED, Cleveland 12, Ohio.

Price & Availability: *The product is currently available on order only. Price is quoted on request.*

Instrument Knobs 592

More than 50 variations available

These aluminum instrument knobs are precision engraved to customer requirements. Six basic sizes with over 50 variations are offered. They have shaft sizes from 1/8 to 1/4 in. and are supplied with two Allen type setscrews. Mil specs are met.

Vemaline Products Co., Dept. ED, P.O. Box 222, Hawthorne, N.J.

Price & Availability: *Price is $0.65 per unit. $0.60 when ordered in quantities of 51 to 250, and $0.35 for 251 to 500. Delivery time is 10 days.*

Power Supply 466

Gives 300 to 500 v dc output

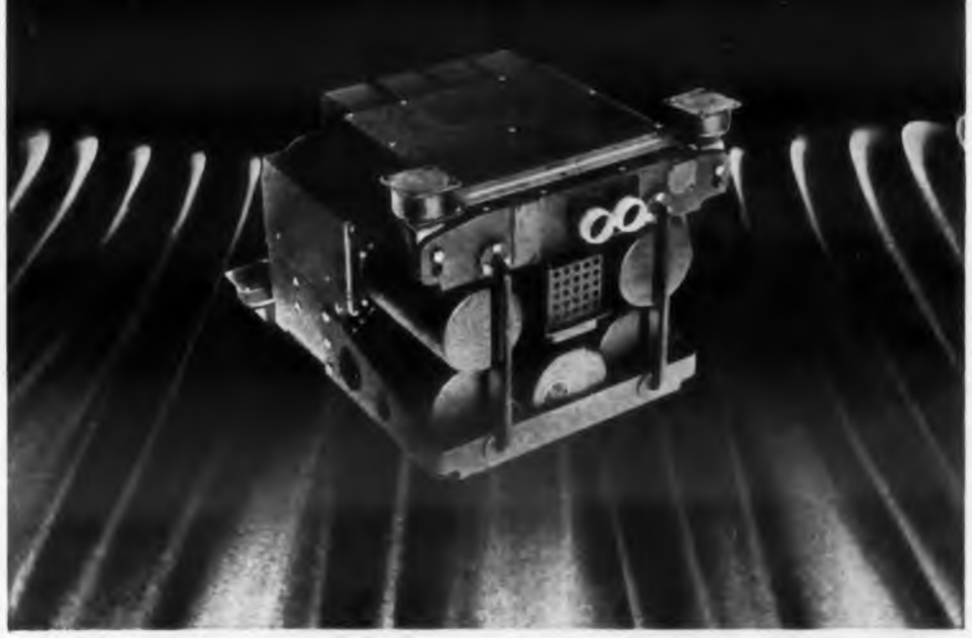
Designed for chassis or sub-chassis use, model RS-505 power supply provides an output of 300 to 500 v dc at 0 to 50 ma continuous duty. Input is 105 to 125 v ac, 55 to 400 cps; line and load regulation are 0.02%. Ripple and noise is less than 7 mv peak-to-peak, and recovery time is less than 25 μsec. The unit measures 5 x 4-1/8 x 6-1/2 in.

Trans Electronics, Inc., Dept. ED, 7349 Canoga Ave., Canoga Park, Calif.

Price & Availability: *Chassis units purchased from stock at $94; $118 for unit rack mounted without meters; $151.25 per unit rack mounted with meters.*

Have you sent us your subscription renewal form?

GROW WITH AIRESEARCH
IN ELECTRONICS



• AiResearch Central Air Data Computer for North American's A3J, Navy's first weapon system, provides information dealing with bombing, navigation, engine inlet control, radar, automatic flight control and cockpit instrumentation.

Expansion in electronics and electromechanical activity is creating excellent openings at all levels for qualified engineers. Diversified programs include Central Air Data systems on the North American A3J, McDonnell F-4H and the Lockheed F-104 as well as other commercial and military aircraft and missile projects.

Openings in the following areas:

- **FLIGHT SYSTEMS RESEARCH** General problems in motivation and navigation in air and space; required background in astronomy, physics, engineering.
- **DATA SYSTEMS RESEARCH** Experience with physical measuring devices using electromagnetic, atomic, thermionic and mechanical approaches.
- **CONTROLS ANALYSIS** Work in preliminary design stage involves servomechanisms analysis and analog computer techniques.
- **FLIGHT DATA COMPONENTS** Analysis proposal, design and development work in the following specialties: circuit analysis, servo theory, transducers, transistors, airborne instrument and analog development of high and low temperature problems.
- **ELECTROMAGNETIC DEVELOPMENT** Work with magnetic amplifiers requires knowledge of electromagnetic theory, materials and design methods.
- **INSTRUMENT DESIGN** Electromechanical design of force-balance instruments, pressure measuring devices, precision gear trains and servo-driven positioning devices. Experience in electrical and electromagnetic transducers desirable.
- **AIRBORNE INSTRUMENTATION ANALYSIS AND DESIGN** Work involves solving problems in accuracy, response and environmental effects.

Send resume to:
Mr. R. K. Richardson

THE GARRETT CORPORATION
AiResearch Manufacturing Division

9851 SO. SEPULVEDA BLVD., LOS ANGELES 45, CALIFORNIA

CIRCLE 927 ON CAREER INQUIRY FORM, P. 317

the fastest oscilloscope

(900 MC BANDPASS)

fastest rise time of all sampling oscilloscopes – 0.4 mμs rise time
fastest sweep speeds – 0.05 mμs/cm
fastest rep rates – to 300 mc w. model 603 trigger unit

and

highest sensitivity – up to 2.5 mv/cm (30:1 SNR at full scale deflection)
easiest to use – no critical adjustments
most versatile – complete line of options and accessories

LUMATRON AT WORK – There are more Lumatron Millimicrosecond Sampling Oscilloscopes in use than any other type . . . at Raytheon, NRL, Bureau of Standards, Texas Instruments, Transitron, Hughes, General Transistor and many others.

LUMATRON – FIRST IN MILLIMICROSECOND INSTRUMENTS
See the complete line of instruments for all fast rise time applications AT IRE – BOOTH 3059 or write for complete information and new Millimicrosecond Engineering Data Chart ED-3.

Lumatron electronics

Lumatron Electronics, Inc., 116 County Courthouse Rd., New Hyde Park, L. I., N. Y.

CIRCLE 243 ON READER-SERVICE CARD

NEW PRODUCTS

Delay Line for Computers 415

Rise time is 7% of time delay

Developed to meet the needs of computer applications, type 7C delay line features a rise time of 7% of time delay. The frequency response is over a 10-mc bandwidth with attenuation less than 1.2 db per μsec delay at low frequencies. Temperature range is –35 to +125 C and temperature coefficient is 0.005% per deg C. The vswr is 500 v peak. For units having a delay of 1 μsec or less, the size is 0.5 x 0.5 x 3.75 in. There are more than 36 types available with time delays of 0.1 to 1.5 μsec and impedance from 150 to 1000 ohms.

AD-YU Electronics Laboratory, Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N.J.

Precision Dials 639

Used for turns counting

Model RBC, which has two set screws, and model RBD, designed for applications where black-matte finish and white-filled numerals are preferred, have been added to the RB series of turns-counting dials. Mechanically, both models are identical. Working parts consist of two coaxial dials; the inner is calibrated in hundredths of a turn, the outer in full turns. The number of completed turns is visible in a window directly opposite the index. Capacity of the dials is 15 full turns.

Beckman Instruments, Inc., Helipot Div., Dept. ED, 2500 Fullerton Road, Fullerton, Calif.

Drift Field Transistors 637

For am battery receivers

These drift field transistors are for front-end applications in am battery receivers. Type 2N1425 if amplifier type provides a useful power gain of 30.4 db in a common-emitter circuit without a neutralizing network. In circuits where maximum power gain is needed with neutralization, it provides 34 db. Type 2N1426 converter type provides a useful conversion power gain of 37.6 db in a common-emitter circuit with a dc collector-to-emitter voltage of –11 v and an emitter current of 0.65 ma.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

Now you can try the famous 960*

Transistor and Crystal Diode Tester

in your own plant–without obligation–

and convince yourself that you won't find a unit comparable to this PRECISION instrument for your electronic maintenance requirements

The Model 960 is a comprehensive tes set designed for practical, reliabl checking of transistors and crysta diodes. Specialized circuitry and operating parameters have been engineere in cooperation with leading semi-con ductor manufacturers. Self-containe AC power supply completely eliminate the necessity for batteries. **ONLY $99.9**

*One of 25 ***PRECISION*** Instrument listed in the new 1960 Catalog of Industrial Electronic Test Equipment an Panel Meters. Write today, for you copy, to Department ED-3.

PRECISION

PRECISION APPARATUS COMPANY, Dept. ED-3.
70-31 84th Street, Glendale 27, L. I., N. Y.

☐ We would like to evaluate the Model 960 in our own plant—with no obligation, of course.
☐ Send us the New Catalog of Industrial Electronic Test Equipment and Panel Meters.

Name of Company________________
Street Address________________
City________Zone_____State_______
Signed____________Title_______
Our Local Electronic Parts Distributor Is______
____
(please print)

CIRCLE 244 ON READER-SERVICE CARD

High-Gain Twin Triode 593

Has frame-grid construction

Type ECC88/6DJ8 high-gain twin triode with true frame-grid construction offers high reliability in such applications as industrial controls, instrumentation, and communications. Characteristics, for each section, are: plate voltage, 90 v; grid voltage, —1.3 v; plate current, 15 ma; transconductance, 12,500 μmhos; amplification factor, 33; and equivalent noise resistance, 300 ohms. Having a 9-pin design, the triode is particularly suited for cascode amplifier service.

CBS Electronics, Dept. ED, 100 Endicott St., Danvers, Mass.

Price & Availability: *Units are available from stock at a price of $1.20 ea in quantities of 50 or more.*

Miniature Delay Lines 595

Delay to rise time ratio is 4:1

The miniature delay lines offered in Kit 123 have a delay to rise time ratio of 4:1. Five lumped constant delay lines are available with delays of 0.1, 0.25, 0.5, 1 and 1.1 μsec. Designed for transistor and printed circuit applications, the units have attenuations ranging from 1% to 3%. Low insertion loss is obtained by the use of miniature toroidal inductors. The units are molded in hermetically sealed brass tubes measuring 0.4 x 1.5 in. and having a fused tin plate finish.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

Price & Availability: *Available from stock, units are priced at $97.50 ea.*

Germanium PNP Transistors 638

Designed for specific uses

These germanium pnp transistors are specifically designed for application in industrial and military hf communications, instrumentation, control, navigation, and mobile equipment. Types are designated: 2N274, 2N384, 2N1023, 2N1066, 2N1224, 2N1225, 2N1226, 2N1395, 2N1396, and 2N1397. Characteristics include: maximum junction temperature rating, 100 C; maximum transistor-dissipation rating in free air at 25 C, 120 mw, transistor-dissipation rating with heat sink, 240 mw, and maximum collector-to-base rating, —40 v, except for the 2N1226 which is rated at —60 v. The units operate to 50 mc and above in rf amplifier service, and 125 mc and above in oscillator service.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

Logic Modules 499

For 100-kc operation

This line of encapsulated logic modules is designed for 100-kc operation. Applications include portable, mobile, and airborne equipment as well as missile systems. They operate over the temperature range of 0 to 55 C; units having a wider temperature range can also be furnished.

C & K Components, Inc., Dept. ED, 101-103 Morse St., Newton 58, Mass.
Booth 1627.

Molding Press 669

For production of miniature components

Model 725 automatic transfer, plastics molding press is suited for the production of miniature and subminiature components, punches and dies for precision parts, TV-tube aluminizing equipment, impregnation systems for capacitors and filters, silicon rectifiers, and other devices.

F. J. Stokes Corp., Dept. ED, 5500 Tabor Road, Philadelphia 20, Pa.
Booth 4126.

Speed Sensor 517

For use with rotating equipment

Model 9353B transistorized, overspeed sensor protects rotating equipment against destructive acceleration and damaging rotational speeds. When the input speed signal reaches 12.8 kc ±1%, an internal relay is tripped and 28 v dc is applied through the relay contacts. The trip point frequency is specified by the customer. In addition to overspeed prevention, the output of the unit may be used for other control functions such as limit cycle control, off-on control, and sequencing. The device is suitable for use in aircraft and ground support equipment.

Varo Manufacturing Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.
Booth 1731.

TV Camera 655

Has 600-line resolution

Model TTVC camera provides a 600-line resolution. It has crystal-controlled rf-modulated channels, a maximum output of 50 mv, and a video output of 1.4 v, peak-to-peak. Weight is 14.5 lb.

Blonder - Tongue Laboratories, Inc., Dept. ED, 9 Alling St., Newark 2, N.J.
Booth 3225.

Oscillator Klystron 620

Is liquid-cooled

Type VA-64G two-resonator oscillator klystron, having a frequency of 13.3 kmc, is liquid-cooled. It delivers a minimum of 15 w cw into a matched load. Suitable for fixed-frequency, doppler-radar navigation applications, the tube measures 3.275 x 1.4 x 2 in. and weighs about 5 oz.

Varian Assoc., Dept. ED, 611 Hansen Way, Palo Alto, Calif.
***Availability:** Delivery time is 90 to 120 days.*
Booth 2710-2720.

Silicon Transistor 652

High speed, general purpose

Type 2N717 npn silicon transistor is a high-speed, general-purpose unit having saturated switching times of less than 1 µsec at 0.5 amp. The typical gain-bandwidth product is 100 mc. In low-level amplifier use, the unit provides a 15-db neutralized gain at 30 mc. Current gain is essentially flat over a two-decade range of current. The JEDEC TO-18 package permits 1.5-w dissipation at room temperature. Environmental requirements of MIL-S-19500B are met.

Fairchild Semiconductor Corp., Dept. ED, 545 Whisman Road, Mountain View, Calif.

***Availability:** Units are available from distributors.*

Booth 2701-2707.

Strain Gage Power Supplies 650

Temperature coefficient is 0.005% per deg F

Model 10-150 strain-gage, floating power supplies have a temperature coefficient of better than 0.005% per deg F. The units are designed to furnish bridge excitation to resistant strain gages and transducers in multichannel data-acquisition systems. The shielded-line transformer and high impedance-to-ground permits the transmission of signals through single-ended amplifiers with little or no cross-talk through 20,000 cps. The units can be rack-mounted in a panel measuring 10 x 3.5 in.

B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St., Philadelphia 40, Pa.

Booth 3123.

Rate Table 531

Uses a synchronous motor

Model 82A rate table consists of a turn-platform driven by a synchronous motor. The table can be remotely operated by applying or removing the rated voltage. A clutch-brake disengages the motor and engages the brake. Platform travel is controlled by limit switches. The table has a platform 6 in. in diameter and can handle a 2-lb load.

Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., Culver City, Calif.

***Price & Availability:** Price is $2100. The unit can be delivered in 30 days.*

Booth 3846.

Traveling Wave Tube Amplifier 630

Frequency range is 4 to 8 kmc

Model 5-542 traveling wave tube amplifier is for operation with the Raytheon traveling wave-tube QK-542. Frequency range is 4 to 8 kmc, output is 1 w min into a 50-ohm load, and response is 10 cps to 10 mc. Small-signal gain is 30 db min and gain at maximum power output is 25 db. Spurious modulation in at least 35 db below the output signal level. Input voltage is 105 to 125 v, 60 cps, at about 960 va. Dimensions are 10.5 x 19 x 16 in.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

***Price & Availability:** Price is $3190 and delivery is from stock.*

Booth 1633.

Silver-Zinc Battery 516

Delivers 80 w-hr per lb

Model 61700 silver-zinc battery, designed for missile applications, is capable of delivering 80-w-hr per lb. The unit is made up of 19 cells of 200 amp-hr nominal capacity and is housed in a pressurized stainless-steel case. It weighs 140 lb and measures 11-3/16 x 14-7/8 x 11-1/2 in. In typical application, it offers five cycles supplying 65 amp at a 6-1/2-hr discharge rate with three pulses of 90 amp for 1 min each. Operating temperature range is 20 to 80 F.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York, N.Y.

Booth 2127.

NEW PRODUCTS AT THE IRE SHOW

Digital Modules 498

For military use

The MIL-T series of dynamic, 1-mc digital modules conform to MIL-E-4159, MIL-E-5400, and MIL-E-16400. All unit delay lines and pulse transformers are encapsulated. Boards and fingers are double-etched. Each module is held directly within a stainless steel frame, which bolts directly to the standard 19-in. block. The units are logically and functionally equivalent to the T-PAC series, but differ in physical format.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Framingham, Mass.

Booth 3308-3310.

Vibration Equipment 518

Calibrates velocity-type pick-ups

This system calibrates velocity-type pick-ups and accelerometers used in measuring vibration. It accommodates high acceleration levels over a wide-frequency span.

MB Electronics, Dept. ED, 781 Whalley Ave., New Haven 8, Conn.

Booth 3107-3108.

Power Supplies 642

Outputs are 30 to 330 v dc

These high-voltage, transistor-regulated, power supplies are available in four models. Model PS4221 has an output of 30 to 210 v and a current range of 0 to 0.8 amp. Model PS4231 provides 120 to 330 v at 0 to 0.8 amp. Model PS4232 provides 120 to 330 v at 0 to 1.5 amp and Model PS4222 provides 30 to 210 v at 0 to 0.5 amp. All models have an output regulation of within 0.1% against 10% change in line and load from zero to full load. Ripple and noise level for models PS4231 and PS4232 is 3 mv rms and for models PS4221 and 4222, 2 mv rms. The output impedance is less than 0.4 ohms from dc to 100 kc for the 0.8-amp units and 0.2 ohms for the 1.5-amp models. Short circuit protection is provided.

Power Sources, Inc., Dept. ED, Burlington, Mass.

Booth 1914.

Compacting Press 649

Processes 34 to 50 pieces per min

Model F-4 compacting press, for use in the production of hermetic seals, tantalum capacitor anodes, barium titanate shapes, ferrite cores, and other electronic components, processes 34 to 50 pieces per min. It can make parts with diameters up to 1-1/4 in. and depths to 1-1/4 in. The press is a 4-ton single-punch unit.

F. J. Stokes Corp., Dept. ED, 5500 Tabor Road, Philadelphia 20, Pa.

Booth 4126.

Shaft-Driven Ratio Transformers 371

Range is 30 to 1000 cps

These heavy-duty shaft-driven ratio transformers are recommended for use in the frequency range of 30 to 1000 cps. Input voltage can be as high as 1000 v above 400 cps; a frequency of 2.5 cps is possible. Models RT-14 and RT-14A have a resolution in 0.001% steps; models RT-15 and RT-15R have continuous resolution. Terminal linearity is 0.001% for all models.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

***Price & Availability:** The product will be available by October, 1960. Price has not yet been determined.*

Booth 3701-3703.

Digital Deviation Ohmmeter 519

Balance time is 1 sec

Model DVM-300 digital deviation ohmmeter measures the resistance around a selected nominal value and presents the information in digital form as a percentage. The instrument uses three digits and has an average balance time of 1 sec. It reads ±5% of the total resistance to an absolute accuracy of 0.01%. It is suited for automatic measurement of temperature coefficients. Contact closures are available for Go/No-Go testing and tolerance sorting operations.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.
Booth 3811.

Ball Bearing Chassis Slides 648

Precision made

Series 140 and 150 ball-bearing, chassis slides are precision made and designed for use in the ground instrumentation of missile programs. The slide mechanisms are made of extruded 7075 T6, a hard aluminum alloy. Other parts are made of stainless steel. Slide widths are 5/16 to 1/2 in. Load ratings are up to 200 lb per pair. Positive locking of the slide assembly in fully extended position is provided. Shock-block mounting is available for use in environments of heavy shock and vibration. All slides incorporate a pushbutton levering device.

Jonathan Manufacturing Co., Dept. ED, 720 E. Walnut St., Fullerton, Calif.
Booth 4514.

Transistors 646

Come in three types

These transistors are offered in three different types. Type XN102 medium-power, mesa transistor is rated at 0.5 w, 160 mc. Type XN102 germanium, diffused-junction pnp device is for hf amplifier applications where medium-power outputs are needed. Type 2N705 germanium pnp, diffused-junction device is for very high-speed switching applications and will attain speeds of less than 10 mμsec. This unit can be used in a wide variety of computer pulse and switching circuits, both saturating and non-saturating.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.
Booth 1114-1115.

Resistance Wire 366

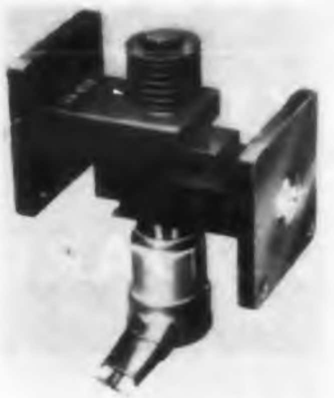
For use to 300 C

Able to stand 300 C for short periods of time, this electrical resistance wire can be used continuously at 250 C. The insulation material is Ceron ST; an overlay of Teflon is also used. Sizes as fine as 0.001 in. in diameter are available.

Kanthal Corp., Dept. ED, Amelia Place, Stamford, Conn.
Booth 4002.

Amplifier Klystron 619

Power gains are 25 to 35 db



Type VA-832 amplifier klystron has a three-cavity construction that provides power gains of 25 to 35 db. It operates in the range of 9.7 to 9.9 kmc, cw or pulse, delivering a minimum of 6 w cw or up to 1 kw of peak-pulsed output power. Focusing is electrostatic. The tube weighs 1 lb and measures 2-1/2 x 3-1/2 x 1-5/8 in. It can be used in high altitudes without pressurization.

Varian Assoc., Dept. ED, 611 Hansen Way, Palo Alto, Calif.
Availability: The tube is in limited production.
Booth 2710-2720.

IMPULSE

A DIGEST OF NEW DEVELOPMENTS
IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE DIV. OF ALCOA, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

OPERATION SIMPLIFICATION. A high priority request from the Pentagon points to the big need for simplification in missile control and guidance systems. Fewer components and mechanical parts are what the Defense men are looking for in the hope of cutting down the numerous failures and malfunctions in missile performance. Along the same line, an Army Colonel has called for "deprovement" as a technique for design in military equipment. What he's looking for is stuff that's "smaller and worser" rather than "bigger and better." It's a wide open invitation and everyone is welcome to suggest possible solutions!

ELECTRIC CAR REVIVAL. Fuel cells that generate electricity when hydrogen and oxygen gases are fed into special carbon electrodes may spark a revival of the electric car. Resembling in some respects a big battery, the fuel cell might offer these advantages: silent operation; no smog-producing exhaust; economy because of the high (65% to 80%) efficiency. Some 20 companies are reported working on fuel cells for everything from satellites to outboard motors.

BIG VOICE FOR THE NAVY. By the end of this year the Navy hopes to have the world's most powerful radio station in operation at Cutler, Maine. The antenna system will have two arrays, each having a center tower 980 ft. high; an inner ring of six towers 875 ft. tall; and an outer ring of six towers 800 ft. high. Some 2200 miles of copper will be used in the ground system under the antenna arrays. With transmission output up to two megawatts, radio contact will be possible even with subs lying deep in the Arctic Ocean.

GUIDE TO TESTING. A detailed breakdown of what the Department of Defense demands in the way of environmental testing for electronic component parts is still available. Components fall into one of eight distinct groups and evaluation is done in terms of 12 test areas. Write to the Office of Technical Services, Dept. of Commerce, Washington 25, D.C. and ask for "Environmental Requirements Guide for Electronic Component Parts."

DUGOUT DATA. So far it's been man against man when rival baseball team managers try to outsmart each other. But soon baseball strategy will be decided by a computer. At least that is what's going on at the University of California, where a big computer is being "given its innings." The machine weighs the desirability of thirteen possible plays against the composite batting averages of the typical big league team.

CABLEMAN'S CORNER. The subject of cable testing is an important one. This is the phase of production that determines whether or not the cable you are purchasing is in accordance with your standards and requirements. In the field of electronics and automation, cables are required to suit various stringent electrical, mechanical, and/or chemical environments. Many years of study and testing have gone into the design of test equipment to be used for these critical tests. It is not enough to know that a cable has been tested in a manner that is "essentially" the same as the required standard. Slight variations in equipment design or methods of tests can mean the difference between conformance and non-conformance. Make sure the test data you receive gives a true picture of the performance of your cable. When you need cable, call on a cable specialist. Phone Rome 3000, or write to Rome Cable Division of Alcoa, Dept. 1130, Rome, N. Y.

These news items represent a digest of information found in many of the publications and periodicals of the electronics industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request.

CIRCLE 253 ON READER-SERVICE CARD

Airborne Time Code Generator illustrates high-density packing obtainable with T-Series circuits.

Hinged arrangement of mounting panel facilitates accessibility.

The finished package weighs only 20 lbs.; measures 5" x 8" x 20⅜". Unit generates 14-digit Point Mugu code, modulating a 1 kc carrier plus a dc time code. Three sine wave and four pulse outputs are also provided, all with only 96 T-Series circuits and 77 watts of input power.

FROM SYSTEM SPECS TO BREADBOARD TO FINISHED PRODUCT IN 75 DAYS!

That's the record set by the manufacturer of this complex airborne Time Code Generator — thanks to the compatibility of proven EECO T-Series Circuit Modules and the flexibility of the EECO Breadboard Kit.

Designed and developed for testing the fire control of manned supersonic aircraft under actual flight conditions at altitudes up to 80,000 feet, this Time Code Generator employs T-Series circuits throughout. Required accuracy of 1 part in 10⁵ was easily obtained.

HIGH DENSITY, LIGHT WEIGHT

The total package contains 96 T-Series Circuits, 14 filament-type EECO Minisig Indicators, and power converters (the beginning of our line of compact 12-volt EECO Power supplies for use with T-Series circuits) — all within a volume of ½ cubic foot. In spite of this terrific packing density, the equipment still retains extreme ease of accessibility and weighs only 20 lbs. No cooling is required.

T-SERIES VS. VACUUM TUBE CIRCUITS

The use of T-Series transistorized Germanium circuits throughout resulted in great savings as against equivalent equipment designed around vacuum tube circuits. Here are some startling comparisons:

	T-SERIES	VACUUM TUBE
SIZE	800 cu in.	8,000 cu. in.
WEIGHT	20 lbs (including power converters)	160 lbs. (plus fan and power supply)
POWER	77 watts	650 watts (plus power for fan)

SAVE TIME AND MONEY

You, too, can develop the most complex equipment in record time with these proven EECO circuits and systems development aids. They'll save you time and money in four major areas:

1 **DESIGN** — You can devote full time to system design problems or unusual circuit requirements, knowing that routine circuit detail has been compatibly pre-engineered and packaged for you.

2 **BREADBOARD** — The unique EECO Breadboard Kit and plastic circuit cards enable you to set up, change, or take down experimental arrangements quickly — without waste of time or materials. Unit contains all necessary permanent wiring to accommodate any regular T-Series circuit. All other circuit inter-connections are made by patch cords or plugs, with prepunched circuit cards to guide you.

3 **PRODUCTION** — Your production problem is reduced to one of mounting sockets on panels or chassis and providing simple socket-to-socket wiring. Plug in the appropriate circuits and the system is complete.

4 **CHECKOUT**—The extreme reliability of T-Series circuits eliminates the need for circuit "debugging." Checkout time is reduced to a bare minimum.

Why not let proven EECO T-Series circuits and systems development aids help you solve your equipment design problems?

If you have not already requested your copy of our new Catalog No. 859, write us today on your company letterhead.

EECO Breadboard Kit.

ENGINEERED ELECTRONICS Company

ENGINEERED ELECTRONICS COMPANY
(a subsidiary of Electronic Engineering Company of California)
506 East First Street • Santa Ana, California

Look for us at the IRE National Convention, New York, March 21-24

CIRCLE 255 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Bushings 647

For capacitors and transformers

These hermetic, high voltage, porcelain-to-metal sealed bushings are for use in high reliability capacitors, and electronic and distribution transformers. The bonding process makes possible direct bonding of parts made of stainless-steel, cold-rolled steel, or nickel-iron alloy to unglazed porcelain.

Ceramaseal, Inc., Dept. ED, New Lebanon Center, N.Y.

Price & Availability: Units are made on order and have a delivery time of 8 to 10 weeks. Price varies from $1 to $7 ea.

Booth 1724.

Input Conditioning Module 651

For strain gages and transducers

Model 1-200AM miniature plug-in strain gage and transducer input conditioning module combines the basic features of the firm's model 12-202A bridge-balance and calibrating unit. Up to 24 of the channels can be housed in a rack adapter measuring 19 x 7 in.

B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St., Philadelphia 40, Pa.

Booth 3123.

Transistorized Chopper 375

Meets Mil specs

This transistorized chopper is designed to meet MIL-5272C and MIL-E-5400. Type 2422 has a maximum drive voltage of 10 v, a maximum signal input of ±5 v, and operates over the temperature range of +130 to −55 C. Type 2441 has a maximum drive voltage of 22 v, a maximum signal input of ±10 v, and a temperature range of +80 to −40 C. Type 2451 has a maximum drive voltage of 36 v, a maximum signal input of ±15 v, and a

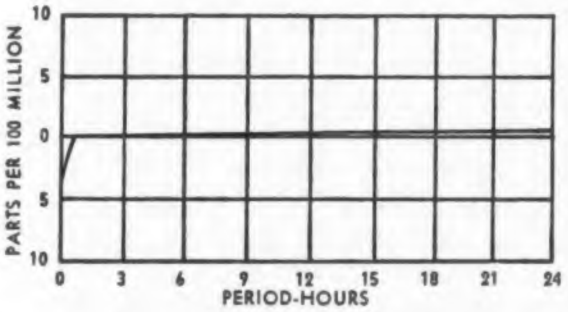
1x10-8

with compact, transistorized series

JKTO-PIP FREQUENCY STANDARDS

(Standard Models Stocked For Quick Delivery)

This series brings together a combination of ultra-stable glass sealed crystals, matched-design silicon transistor-oscillator circuitry, and transistorized proportional control oven performance. The result of this advanced engineering is frequency stability of 1 part in 100,000,000 per day, under normal conditions.



For information, write stating your requirements.
THE JAMES KNIGHTS COMPANY
SANDWICH, ILLINOIS

SPECIFICATIONS

FREQUENCY: 1 to 5 mc. is standard. Other frequencies available on special order.
OVEN: Transistorized, proportional control.
OUTPUT: One V into 5000 ohms.
POWER: Operates from 24 to 28V D.C.
DIMENSIONS: 2" x 1.84" x 2⅞" H.
WEIGHT: 10 Oz. Maximum.
ENVIRONMENTAL: Hermetically sealed, shock and vibration resistant.
TEMPERATURE RANGE: From −55°C to +75°C. Also from −55°C to 100+°C.

PRODUCTS

CIRCLE 256 ON READER-SERVICE CARD

temperature range of +80 to −40 C. For all units, the null balance at 25 C is 200 mv.

Victory Engineering Corp., Dept. ED, P.O. Box 373, Union, N.J.

Price & Availability: Units will be available in May 1960. Price is quoted on request.

Booth 1423.

HF Microwave Diodes 534

Have low-loss figure

These low-noise, hf microwave diodes may be used as up-converters, amplifiers, limiters, harmonic generators and switches. They are particularly suitable for use as low-noise parametric amplifiers.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.

Booth 2322-2332, 2415-2425.

Silicon Transistor 654

Collector-to-base rating is 120 v

Type 2N698 diffused silicon transistor has a collector-to-base rating 120 v which allows wider voltage swings in amplifier and oscillator circuits as well as more protection in inductive switching circuits.

Fairchild Semiconductor Corp., Dept. ED, 545 Whisman Road, Mountain View, Calif.

Availability: The unit is available through distributors.

Booth 2701-2707.

Frequency-Time Standard 628

Consists of four instruments

This system, providing an easily operated primary frequency and time standard, consists of four instruments. Model 113AR frequency divider and clock makes time comparisons between model 103AR oscillator and standard transmitted time signals.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palo Alto, Calif.

Booth 3302-3304-3306, 3401-3403-3405.

NEW... ...small... compact...light... STRANDED-WIRE FLAT CABLE for the ultimate in FLEXIBILITY

CICOIL **Super-Flex** multi-conductor cable is ideal for use where extremes of temperature, movement and vibration preclude the use of other materials in missile packages, computers, gyro and radar systems. They provide light, reliable and compact harnessing of even the most complex electronic circuitry. **Super-Flex** cables are made of **stranded conductors**, precisely spaced in CICOIL's specially processed silicone rubber base compound. Cables are made in lengths up to 9 feet, and widths determined by the size and number of conductors. Cable termination can be supplied bare or with commercial or military grade connectors. Special connectors can be molded by CICOIL to meet your requirements.

Write for new brochure and complete technical data.

CICOIL CORPORATION

13833 SATICOY ST.
VAN NUYS
CALIFORNIA

CIRCLE 257 ON READER-SERVICE CARD

a complete, compact system for shaft rotation digitizing...

PULSE GENERATOR ROTATING ELEMENT IS A LOW INERTIA DISC, DESIGNED FOR A MAXIMUM OF 2000 DISCRETE, EVENLY SPACED ELECTRICAL PULSES.

TELEPAK

TELEPAK is a reliable, compact system for shaft rotation digitizing in a variety of scientific and mechanical applications.
The TELEPAK System consists of two basic elements:

A pulse generator which divides 360° angular rotation into as many as 2000 discrete, evenly spaced electrical pulses. Pulse formation is completely passive—no switches, light beams or magnetic impulse generators. Rotating element (illustrated above), is a simple, low inertia disc, mounted in precision ball bearings. Generated pulses are inductively coupled to the output and amplitude is independent of rotational velocity from zero to maximum rpm.

An electronic counter/accumulator in miniaturized solid-state form provides excitation for the angle pulse generator, receives the generator pulse out-put, and continuously accumulates displacement position in decimal digital form. Directional sensing and bi-directional counting enables the system to follow both clockwise and counterclockwise motion.

The digital position conversion is displayed visually by in-line (Nixie) readouts and is also stored in a load driving memory for electrical readout.

- Write for Bulletin No. DI. 09 for complete Technical Data.

*See TELEPAK at the **IRE SHOW** in New York, Booth No. 2128.*

DI
DATA INSTRUMENTS
Division of Telecomputing Corporation
12838 Saticoy Street, North Hollywood, Calif. • TRiangle 7-8181
DATA INSTRUMENTS: *"Pioneers in Data Instrumentation"*

CIRCLE 258 ON READER-SERVICE CARD

NEW ALUMINUM-CASE HIPERMAG CORE DEFIES ABUSE, PROTECTS PERFORMANCE

All-new Westinghouse aluminum-case Hipermag cores bring you three exclusive advantages:

- *Minimum height, maximum seal, excellent winding contour* are provided by the new overlap flange closing of case.
- *Ample insulation* of wire wound directly on the case is assured by its hard, tough, black anodized coating.
- *Full protection against continuous vibration, shock and temperature cycling* is made possible by a new silicone damping medium developed by Westinghouse Research Laboratories. Moreover, protection of core magnetic characteristics is effective at all operating temperature ranges.

Aluminum-case Hipermag cores are tested in accordance with EIA standards and are available in EIA standard sizes. Special tests and sizes can be secured. These cores, as well as polyclad hermetically sealed Hipermag cores, are available in Hipernik®V (50% oriented nickel-iron) and 4-79 Permalloy (square loop) in a variety of thicknesses.

For complete information, call your Westinghouse representative or write Specialty Transformer Department, Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pennsylvania.

J-70935

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV ALTERNATE FRIDAYS

CIRCLE 260 ON READER-SERVICE CARD

NEW PRODUCTS

Welding Equipment 624

Capable of 500 welds per minute, this Weldex spike welder may be used for critical welding of small parts where too much heat would damage the enclosure or delicate electronic components. The unit produces 100,000 amp pulses of about 1 msec duration.

Metal Craft Co., Weldex Div., Dept. ED, 3300 Doris, Detroit, Mich.

Availability: Can be delivered in 14 days.

Adapter Panel 625

This adapter panel is designed for mounting the firm's 2-channel Mark II recorder in a standard 19 in. rack. The instrument may be removed from the adapter panel at any time and returned to its standard portable case.

Clevite Corp., Brush Instruments Div., Dept. ED, 37th and Perkins, Cleveland 14, Ohio.

Price: Price of the panel is $100, fob Cleveland.

Current Transformers 623

These Donut current transformers are used to extend the range of ammeters and to provide operating current for relays. The series 700 units are available in ratios from 10:5 to 5000:5, with burden rating of 2.5 to 12.5 kv.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Price & Availability: Some models available from stock; other models delivered in 21 days. When ordered in quantities of 1 to 10, price is between $9 and $17.

Connector Test Adapter 626

This hand-tool is used for making voltage, signal, continuity and performance tests on black boxes, components, harnesses, systems, aircraft, and missiles using AN-MS miniature, subminiature, and similar type connectors. The tool has heavy silver or gold contact plating, a bendable shaft, and four-way lead connection.

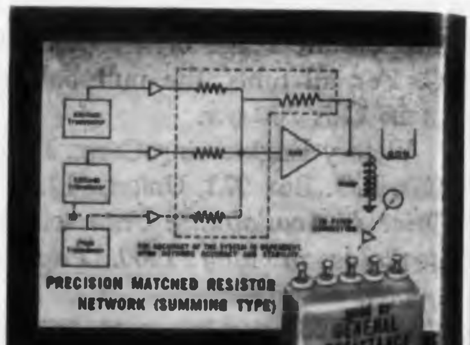
Air-O-Tronics Engineering Co., Dept. ED, Box 31, Lancaster, Calif.

Price & Availability: Available from stock. Large quantities delivered 10 days after receipt of order. Price is between $0.90 and $1.15 each for quantities 1 to 9.

Glass-To-Copper Seals 530

The use of Copseal preforms in copper-to-glass seals permits a true oxide bond. Specific electrical resistance at 100 C is about $\log_{10}$ 11.1 ohms per cm, and increases as temperature is decreased. The coefficient of expansion is 155 x 10^{-7}.

Mansol Ceramics Co., Dept. ED, 140 Little St., Belleville, N.J.



No Muss! No Fuss! with GenRes PRECISION RESISTOR NETWORKS...

If it can be made GenRes will make it! Custom-engineered, mass-produced GenRes Resistor Networks can be supplied in any shape or form in strict conformance with your most stringent requirements.

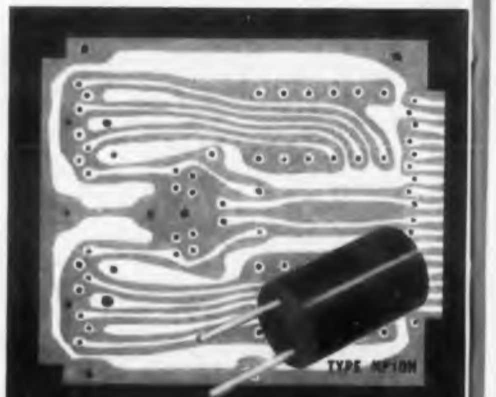
AVAILABLE FEATURES —

- ★ ACCURACIES TO .005%!
- ★ 400-cycle or higher frequencies.
- ★ Extremely low quadrature voltages to as low as 1/10 mv per volts.
- ★ Sizes to customer specifications.

TYPICAL APPLICATIONS —

GenRes Precision Resistor Networks are components in such critical applications as Summing Circuits, Voltage Dividers and Binary Networks. SEND US YOUR SPECIFICATIONS.

GENERAL RESISTANCE INC.
430 Southern Blvd. • N. Y. 55 • CY 2-1500



Tight Tolerance Applications call for GenRes PRECISION RESISTORS...

GenRes application-engineered, ultra-high reliability Precision Wirewound Resistors are tested accurate to .01% over a temperature range from −55° to 125°C! Offering axial, lug, printed circuit and radial lead, hermetically sealed standard, ceramic and temperature compensating types to meet any requirement, rugged GenRes WW Resistors have temperature coefficients as low as 1 ppm/°C. For such critical applications as Analog Computers, Telemetering Equipment, Power Supplies or Precision Instruments see GENERAL RESISTANCE first.

ALSO AVAILABLE: Temperature-sensitive GenRes resistors having temperature coefficients of from 0 to .6%/°C. and high temperature types for space applications.

BOOTH 3026 I.R.E. CONVENTION

GENERAL RESISTANCE INC.
430 Southern Blvd. • N.Y. 55, N.Y. • CY 2-1500

CIRCLE 261 ON READER-SERVICE CARD

Feedthrough Terminals 424

Designed for use in plug-in components, types 1030 and 1031 fit into 7- or 9-pin miniature sockets, have pin diameters of 0.04 in., and come in six mounting shank lengths. Type 1032 has a pin diameter of 0.032 in.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Ceramic Insulators 425

Used where high frequencies or sealing to metals or glasses is involved, AlSiMag 243 ceramic insulation material is said to have low loss. Uses of the material are mainly in vacuum tube applications.

American Lava Corp., Dept. ED, Manufacturers Road, Chattanooga 5, Tenn.

Price & Availability: *Custom made only.*

Silicon Diodes 437

Among these silicon glass diodes are included general purpose JAN types 1N457, 1N458, and 1N459. Also included are fast switching Signal Corps types 1N662, 1N663, 1N643 MID, and 1N658.

Silicon Transistor Corp., Dept. ED, Carle Place, Long Island, N.Y.

Type Bar 436

Enables a typist to quickly snap in special symbols which may be needed for typing work in various fields of science and business. Among the symbols available are degree signs, numerical subscripts, the millimeter symbol, and the Greek alphabet. Specially designed symbols can be ordered, including many company trademarks.

Sperry Rand Corp., Remington Rand Div., Dept. ED, 315 Park Ave. South, New York 10, N.Y.

Price & Availability: *Made to order only and delivered 30 days after order received. Price is $9.75 per unit.*

Sequence Timer 492

This sequence timer is electronically timed, has instant reset, and is push-button started. Each of twelve time positions is separately adjustable to 30 minutes or more. Model B 705-12 can be supplied for rack mounting on the standard 3-1/2 x 19 in. panel.

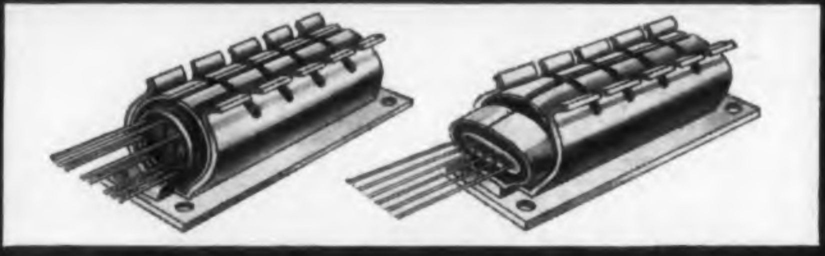
Research Industrial, Dept. ED, Roslyn, Pa.

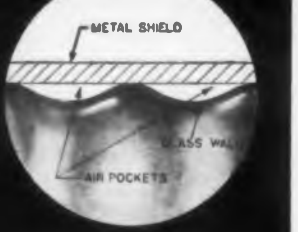
Price & Availability: *Can be delivered 15 days after order received. Price is $89.60 per unit.*

Correction Notice

The magnetic splicing tape described on page 89 of the January 20th issue is not made by Post Designs, Inc., as stated. The manufacturer is Robins Industries Corp., 37-27 Prince St., Flushing 54, N.Y.

This is the time of our annual subscription renewal.





Handle for Electronic Cabinets 527

The handle is completely recessed in a cup 9/16-in. deep and 2-3/4-in. in diameter for spot-welding or riveting; it is made of stainless steel. Over-all depth of assembly from front of panel is 1-1/8 in.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

Silicone Rubber 526

Room temperature vulcanizing silicone rubber, for potting and encapsulation, is improved through the use of RTV-992, 993, and 994 paste curing agents. The agents are easy to handle and are used in larger quantities than liquids, making for quicker and more accurate measurement.

General Electric Co., Silicone Products Dept., Dept. ED, Waterford, N.Y.

Teflon Terminal 525

Type ST-250L4, dual-turret type, stands high associated wiring and component pull. Designed for a chassis 0.11 in. thick, it requires a mounting hole 0.158 ±0.002 in. in diam. Height above the chassis is 0.406 in.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

Rectifier Power Supplies 528

A complete line of semiconductor rectifier power supplies for the production and testing of tantalum and other electrolytic capacitors uses silicon or selenium elements, and vernier controlled automatic programming for adjustment of automatic formation process cycles. The units also include motor operated transformers, servo controlled and operated; filtered output; and positive-acting, dc overload protection.

Meaker Co., Sel-Rex Rectifier Div., Dept. ED, Nutley 10, N.J.

Availability: Made on order only.

Stroboscopes 529

TapeStrobes are devices that determine tape-speed accuracy for speeds ranging from 1-7/8 to 60 ips. Model A measures 7-1/2, 15, and 30 ips speeds; model B measures 3-3/4, 7-1/2, and 15 ips speeds. With a step-down adapter, model A measures 3-3/4 ips, and model B measures 1-7/8 ips.

Scott Instrument Labs, Inc., Dept. ED, 17 E. 48th St., New York 17, N.Y.

Price & Availability: 60-cps units immediately available. Two-week delivery for 50-cps unit and model W adapter. Other speeds made to specific requirements. Prices: Models A & B 60-cps units, $22.50 each; models A & B 50-cps units, $24.50 each; model W adapter, $2.00 each. Quantity discounts available.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

ADVANCED IDEAS
IN MEASUREMENT
See them at the
IRE Show
BOOTHS
3927-29

WAYNE KERR
Absolute Standard of Low Capacitance
Available only from Wayne Kerr. A 3-Terminal capacitor constructed to value of 10 μμf, accurate to 0.01%. Obsoletes substitution methods of measurement.
Transformer Ratio Arm Bridges:

WAYNE KERR
Precision Low Impedance Comparator Type B-821
A 3-Terminal bridge to compare impedances in the order of 1000 ohms against a known standard with accuracy of 0.001%... ratios between standard and unknown of 0.8:1 to 1.2:1.

WAYNE KERR
Precision High Impedance Comparator Type B-921
A 3-Terminal bridge to compare impedances of the order of megohms against a known standard. Accurate to 0.001%. Voltage ratio adjustable between 0.333:1 and 3:1.

Other Wayne Kerr Measuring Equipment You' Want to See
Audio to VHF Bridges; Oscillators; Attenuators; Microwave Equipment; Vibration and Distance Meters; Waveform Analyzer.

Send for catalog W-K-02.

●

Don't forget—Booths 3927-29
If you don't see us at the IRE show, or can't attend, we'll be at the WESCON show, too. If you can't wait, phone us in Phila., LOcust 8-68201

WAYNE KERR
CORPORATION
1633 Race St., Philadelphia 3, Pa.

Representatives in major U.S. cities and Canada

CIRCLE 268 ON READER-SERVICE CARD

Word Indicator Light 435

The Roto-Tellite word-indicator lights can now be operated on 115 v ac. Any 115 v rms can be used. Only solid state components are used in this unit. They rebulb from the front without using any tools, mount flush, and are in conformance with MIL-E-5272B.

Master Specialties Co., Dept. ED, 956 E. 108th St., Los Angeles 59, Calif.

Availability: Can be delivered 30 days after order is received.

Magnetic Shield 607

This NeticCo-Netic shield is nonshock sensitive, nonretentive, and does not require periodic annealing. Interfering magnetic fields are eliminated by the shield permitting potted tubes to be located close to other black box gear.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

Price & Availability: Delivery is 6 to 8 weeks. Price varies with quantity from $85 to $120.

Plug-in Enclosed Relays 610

Four types are: GMP, 1 to 3 poles, ac or dc, 5-amp contacts; GMSP, 1 to 3 poles, ac or dc, 8-amp contacts; PGP, 1 to 3 poles, dc, with coil resistance to 10,000 ohms, sensitivity of 130 mw per pole; and PVP, 1 pole, with coil resistance to 10,000 ohms and sensitivity of 70 mw. All types have polystyrene enclosures and a 9 or 11-pin base.

Hillburn Electronics Products Co., Dept. 9D, 55 Nassau Ave., Brooklyn 22, N.Y.

Price & Availability: Some units are supplied from stock; others require from four to six weeks for delivery. Price varies with models and is furnished on request.

Bar Knobs 609

Have sloping pointers to eliminate parallax. Two styles of series 70 bar knobs are offered in black or gray, with or without dial skirts, and in either mirror or nonreflective matte finish. Colors are available on special order.

Raytheon Co., Commercial Apparatus & Systems Div., Dept. ED, Waltham 54, Mass.

Price & Availability: Immediately available in black. Allow 8 to 10 weeks for special color orders. Prices are between $0.75 and $1.02 when ordered in quantities of 1 to 99. Quantity discounts on orders of 100 or more.

Microwave On-Off Switch 438

Model V-FSW 1 is a low-power switch with high isolation when off, low loss when on. Switching time is 1 to 2 μsec.

T. R. G. Inc., Microwave Component and Antenna Dept., Dept. ED, 9 Union Square, Somerville 43, Mass.

Price & Availability: Price is $1500 ea. The unit is made on order and can be delivered in 60 to 90 days.

CAPITOL SWITCHES are adapted to many variations of switching requirements and mechanical arrangements. They are manually operated units, featuring selective control of one or more groups of circuit combinations.

CAPITOL SWITCHES are a finely finished product, offering maximum reliability, with smooth mechanical action. All parts are non-corrosive. Paladium contacts are rated at 3 AMP.

CAPITOL SWITCHES INCLUDE:
Illuminated single and multiple position switches, interlocking push button switches, push-lock, push-release switches and telephone lever switches.

TYPICAL APPLICATIONS
Test equipment control panels, intercommunication systems, computer systems, TV and Radio Control systems, missile control systems.

WRITE FOR COMPLETE SWITCH CATALOG NO. 102

THE CAPITOL MACHINE CO.
SWITCH DIVISION
36 BALMFORTH AVE., DANBURY, CONN.
Visit booth 2736, I.R.E. Show

CIRCLE 269 ON READER-SERVICE CARD

You'll be in good company...
Pressure-Sensitive, Anodized Aluminum Foil
NAMEPLATES

Certified to meet all MIL Specs.
IMMEDIATE DELIVERIES
Contact your nearest GESCO (General Electric Supply Co.) man, or airmail your sketches to...

North Shore NAMEPLATE
(A Division of Anodyne, Inc.)
214-27 Northern Blvd., Bayside 61, N. Y.
BAyside 4-4000 • Teletype: NY 4-1975 • Cable: Norplate • TWX: LPT
NAMEPLATES • PIPE & ELECTRICAL MARKERS • ACCIDENT & IDENTIFICATION SIGNS

CIRCLE 270 ON READER-SERVICE CARD

expansion

IS A CONSTANT AT RHEEM

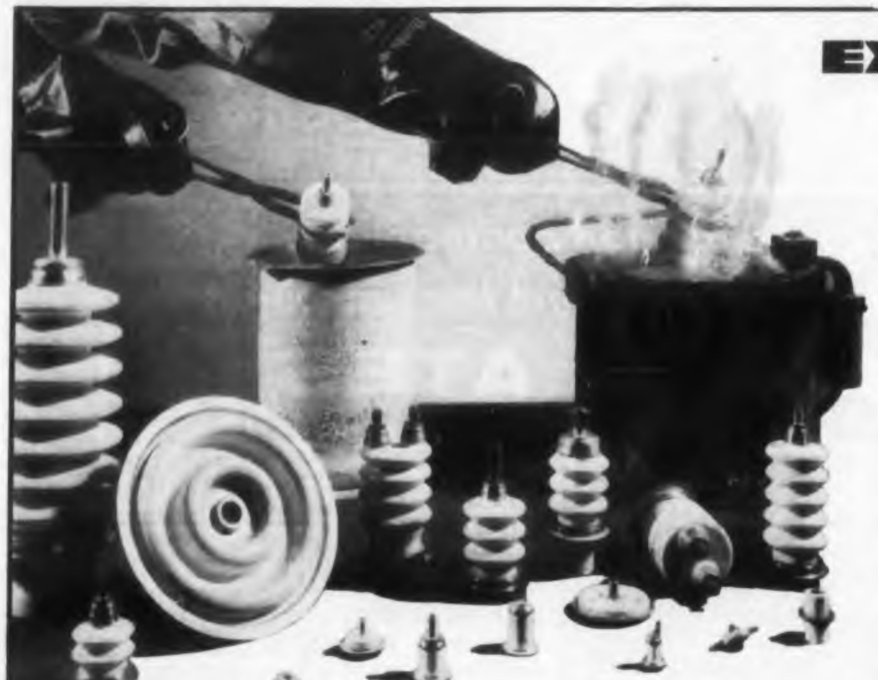
Scientists & Engineers—Physicists, Metallurgists, Physical Chemists, Electronic Engineers, Process Engineers, Application Engineers, District Sales Managers, Sales Engineers, Jr. Sales Engineers

A growth curve that sparks the imagination of any progressive individual. Right now, the scope and diversity of activities at Rheem Semiconductor Corporation are assuming impressive proportions. Some of the country's best scientists and engineers are in charge of our spacious new facilities where the research, development and manufacture of semiconductor devices are constantly being expanded. Everything at Rheem points to a future filled with material success and professional satisfaction. It may be possible for you to share this future. We suggest that you inquire, now, into the specific openings available.

We look forward to seeing you at the IRE Convention in New York, March 21 thru 24th. We will be at the Barbizon-Plaza Hotel, 106 Central Park South, New York City, and our telephone number will be PLaza 7-9572. If you do not plan to attend, your resume will receive our most serious and confidential consideration.

RHEEM SEMICONDUCTOR CORPORATION
327 Moffett Boulevard, Mountain View, California

CIRCLE 928 ON CAREER INQUIRY FORM, P. 317



EXTREME THERMAL SHOCK

won't damage these

CERAMASEAL HERMETIC TERMINALS

SOME HAVE EVEN WITHSTOOD A SUDDEN 460°C CHANGE

With an alumina content up to 99%, CERAMASEAL terminals are not only mechanically strong, but some have even been transferred directly from liquid nitrogen into hot solder without cracking!

The CERAMASEAL molecular bond between the ceramic and metal flanges, caps or tubes is stronger than the high alumina ceramic.

Easy to install too, by conventional brazing, heli-arc welding or soldering techniques.

FOR COMPLETE INFORMATION, catalog and spec sheets, write Ceramaseal, Inc., New Lebanon Center, N. Y. or phone: West Lebanon 3-5851.

Hermetic Ceramic Terminals, Magnetron Wells, Sapphire-to-Metal Seals

CERAMASEAL, inc.

CIRCLE 271 ON READER-SERVICE CARD

Modular Computer Components 659

Subminiature

This line of subminiature components is suitable for a variety of applications in computers and control systems. Designed especially for missile use, the modules weigh from 2 to 6 oz and occupy 2 to 4 cu in. They operate continuously in a temperature range of —55 to +80 C and withstand up to 10 g vibration from 0 to 2000 cps. All applicable requirements of MIL-E-8189 and MIL-E-5400, Class I and II, are met. The units available include: ac summing amplifiers, ac isolation amplifiers, servo preamplifiers, power amplifiers, electronic differentials, and other devices.

Reeves Instrument Corp., Dept. ED, Garden City, N.Y.

Booth 1305-1307.

Data Transmission Resolvers 662

Size 11

This line of size 11 data transmission resolvers includes transmitters, differentials, and receivers for radar systems. The transmitter and receiver units have a maximum angular voltage error of 20 sec and a maximum total null voltage of 20 mv. The differential unit has a maximum angular error of 20 sec and a maximum total null voltage of 115 mv. Weight of the units is 4 oz. They are interchangeable.

Reeves Instrument Corp., Dept. ED, Garden City, N.Y.

Booth 1305-1307.

CIRCLE 273 ON READER-SERVICE CARD ➤

Servo Indicator 557

Provides direct readings

Model SBI 201/111 miniature servo indicator provides direct readings proportional to the ratio of two dc signals It can indicate the ratio of any two variables or of a single variable and its excitation source. In typical applications, excitation voltage is 5 to 50 v and maximum-to-minimum signal ratios are 4:1 or up to 10:1 on special order. Accuracy is ±0.5% and resolution is ±0.25% of full scale. At 28 v full-scale, response time is 0.25 sec and sensitivity is 10 mv. Originally designed for missile check-out applications, the unit measures 3 in. in diameter and 7 in. in length.

North Atlantic Industries, Inc., Instrumentation Div., Dept. ED, Terminal Drive, Plainview, L.I., N.Y.

Booth 3012.

Signal Generators 552

Frequency range is 8.5 to 9.6 kmc

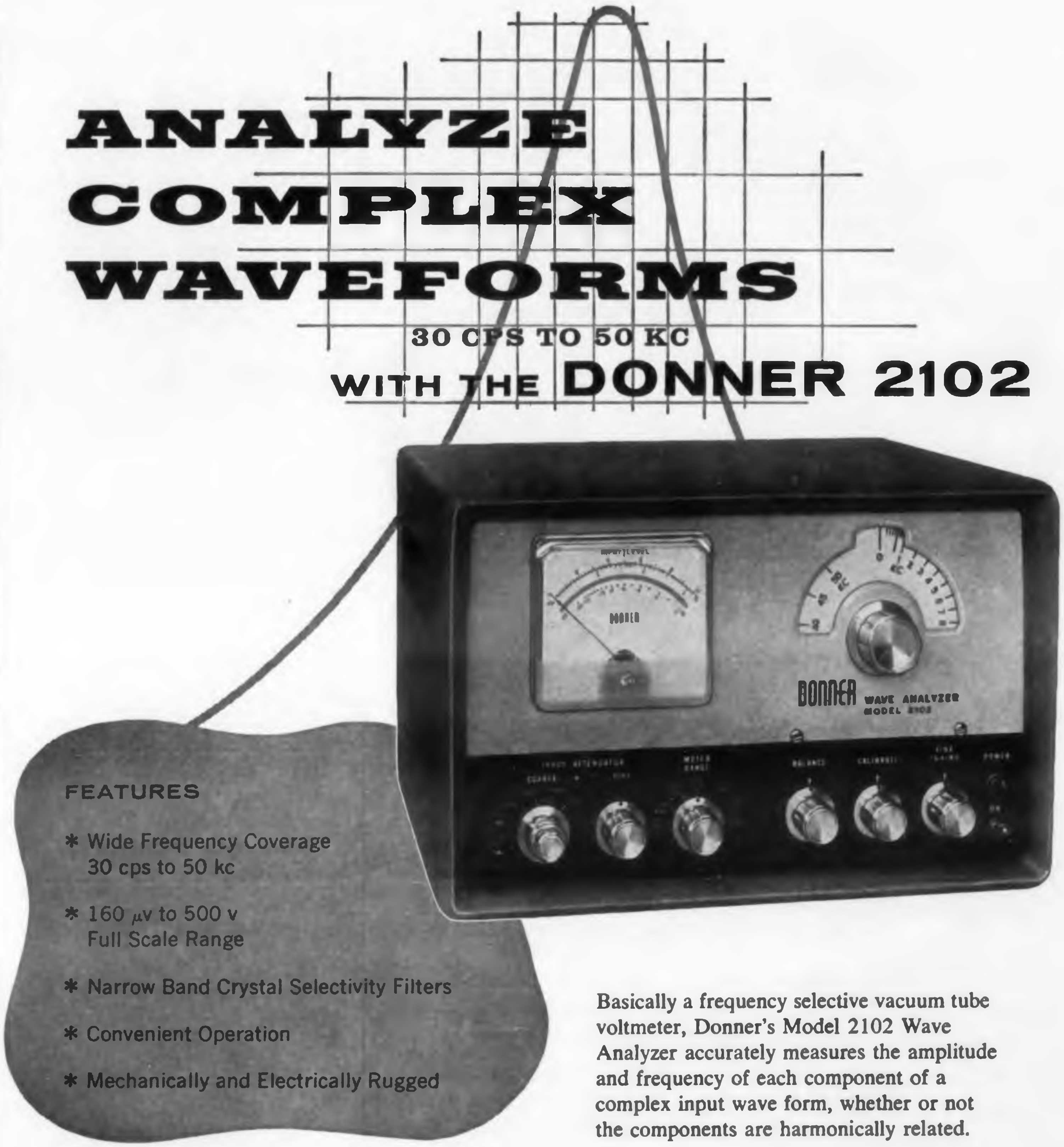
These signal generators are for use in the frequency range of 8.5 to 9.6 kmc. Variable frequency, cw microwave sources, they are frequency stabilized to a tunable reference cavity. Model 300, designed for low-power applications, has an output of 10 mw avg and a short-term frequency stability of 1 part in 10^8. It weighs 20 lb. Model 500 has a power output of 500 mw, a short-term stability of 1 part in 10^8, and a long-term stability of 1 part in 10^6. The units are suitable for laboratory research, inspection, and testing. Other units can be furnished for K, C, and S-band operation.

Strand Labs, Inc., Dept. ED, 294 Centre St., Newton Centre 58, Mass.

Availability:* *From stock.

Booth 3007.

← CIRCLE 273 ON READER-SERVICE CARD



ANALYZE COMPLEX WAVEFORMS

30 CPS TO 50 KC

WITH THE DONNER 2102

FEATURES

- ✱ Wide Frequency Coverage 30 cps to 50 kc
- ✱ 160 μv to 500 v Full Scale Range
- ✱ Narrow Band Crystal Selectivity Filters
- ✱ Convenient Operation
- ✱ Mechanically and Electrically Rugged

Basically a frequency selective vacuum tube voltmeter, Donner's Model 2102 Wave Analyzer accurately measures the amplitude and frequency of each component of a complex input wave form, whether or not the components are harmonically related.

APPLICATIONS

The Model 2102 is used to analyze fundamentals and harmonics in vibrating systems and to analyze intermodulation products in sub-audio, audio, and carrier systems. It speeds analysis of hum, noise and distortion in recorders, amplifiers and filter networks.

CONVENIENT OPERATION

The fundamental frequency component is tuned with the large calibrated dial, and the amplitude of the fundamental is adjusted to a 0 db, or reference level. Tuning the dial to the frequency of each component of interest gives the relative amplitude of that component on the panel meter. The mirror-scale panel meter reads the relative amplitude directly in percentage of the fundamental, or in db below the reference level.

BRIEF SPECIFICATIONS

FREQUENCY RANGE	30 cps to 50 kc
FREQUENCY CALIBRATION	±3 percent plus 10 cps
VOLTAGE RANGE	Full scale deflection from 160 μv to 500 v
VOLTAGE ACCURACY	±5 percent
INPUT IMPEDANCE	200,000 ohms
SELECTIVITY	3 db down at ±9 cps, 40 db at ±40 cps
DOMESTIC PRICE	$645 f.o.b. factory

Write for complete technical specifications. Address Dept. 19-3

DONNER SCIENTIFIC COMPANY
CONCORD, CALIFORNIA

CIRCLE 274 ON READER-SERVICE CARD

MINIATURE AND
SUB-MINIATURE
CONNECTORS

ESCON
INC.

A new
high standard
of connector quality
and performance for
Missiles, Aircraft,
Computer and other
Electronic Systems.

ESCON connectors meet all MIL-5015 and MIL-C-8384 (USAF) specifications and are available in all standard sizes and contact arrangements.

ESCON has the production capacity to assure fast delivery on both standard and special applications.

ESCON is an outstanding specialist in hermetic as well as standard connectors.

ESCON is unusually well prepared to create custom connectors, maintaining complete research and development facilities for engineering and testing special applications.

ESCON is able to ensure exacting quality control because all components are produced and assembled under one roof.

Look to ESCON for the solution of your connector design and delivery problems. Write for specifications literature.

SEE US AT BOOTH 1109 THE I.R.E. SHOW.

ESCON INC.
A Subsidiary of
GLASS-TITE Industries, Inc.

571-9

723 BRANCH AVENUE • PROVIDENCE, R. I.

CIRCLE 275 ON READER-SERVICE CARD

NEW PRODUCTS AT THE IRE SHOW

Servo Table 555

Voltage-to-angular position platform

Model 18A servo table is a voltage-to-angular position platform in two axes for subjecting vertical gyros to angular positions and rate. Operation of the table around one axis tilts the load up to 90 deg in either direction. The load may be oriented remotely through 90 deg around a vertical axis allowing the second axis of the gyro to be subjected to the same tests. The table has a platform 6 in. in diameter and can handle a 4-lb load. It can be remotely controlled. The unit is suitable for missile and aircraft checkout.

Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., Culver City, Calif.

Price & Availability: *The unit can be delivered in 30 days and is priced at $3300.*

Booth 3846.

Rack Adaptor 359

For subdividing circuitry into modular units

This picture frame rack adaptor makes it possible to subdivide circuitry into modular plug-in units within a single, rack-mounted assembly. Combinations of 2, 4, and 8-in., or one 17-in. chassis can be used. The adaptor mounts in any standard relay rack. Of rugged steel construction, it provides rigid support. Two heights and depths are available.

Alden Products Co., Dept. ED, 117 N. Main St., Brockton 64, Mass.

Booth 1508-1510.

North Atlantic
Series RB500
Ratio Boxes

Model RB-501
Rack mount

Measure A.C. Ratios
From −0.011111
To +1.11111...with
accuracy to 1 ppm

With any of North Atlantic's RB500 Ratio Boxes you can now measure voltage ratios about zero and unity—without disrupting test set-ups.

And—a complete range of models from low cost high-precision types to ultra-accurate ratio standards—in portable, bench, rack mount, binary and automatic stepping designs—lets you match the model to the job.

For example, characteristics covered by the RB500 Series include:

Frequency: 25 cps to 10 kc.
Accuracy: 10 ppm to 1.0 ppm
Input voltage: 0.35f to 1.0f
Input impedance: 60 k to 1 megohm
Effective series impedance: 9 ohms to 0.5 ohms
Long life, heavy duty switches

Name your ratio measurement and its probable there's a North Atlantic Ratio Box to meet them — precisely. Write for complete data in Bulletin 11F

Also from North Atlantic ...a complete line of complex voltage ratio-meters...ratio test sets... phase angle voltmeters

NORTH ATLANTIC
industries, inc.
603 Main Street, Westbury, N.Y.
EDgewood 4-1122

See us at I.R.E.—Booth 3833
CIRCLE 276 ON READER-SERVICE CARD

See our
Booth #4204-6
IRE SHOW
NEW YORK

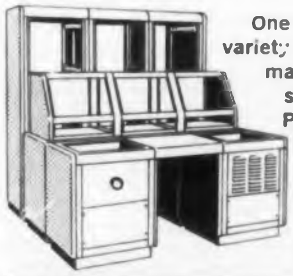
PREM-O-RAK

BALL-CORNERED
MODULAR
TRANSMITTER
RACKS

22" and 25½" DEEP FOR STANDARD 19" RACK PANELS

Designed for MULTIPLE INSTALLATIONS and for use with PREM-O-RAK CONSOLE SYSTEMS.

RIGIDLY CONSTRUCTED • Frame made of 14 gauge steel • Panel Mounting Angles 3/16" thick • End Panels and Doors made of 16 gauge steel.



One of the unlimited variety of arrangements made possible with standard, flexible Prem-O-Rak units

CONTACT YOUR DISTRIBUTOR or SEND FOR FOLDER S-160A

PREMIER
METAL PRODUCTS CO.
337 MANIDA ST., NEW YORK 59, N. Y.

WESTERN SALES OFFICE:
1485 Bayshore Blvd., San Francisco, Cal.
EXPORT DEPARTMENT: EMEC
127 Grace Street, Plainview, N. Y.
IN CANADA: PREMIER METAL HOUSINGS, Ltd.,
5810 Smart Avenue, Montreal

CIRCLE 277 ON READER-SERVICE CARD

Drive Module 548

For indicator tube

This transistor drive module is designed for the Nixie indicator tube. The transistor driver and the indicator tube, called Trixie, have a readout comprising 10 medium-voltage npn transistors in a common emitter configuration. Each transistor drives one of the indicator tube's cathodes. The modules can be triggered by 3 v at 300 μa. Temperature range is —30 to +55 C.

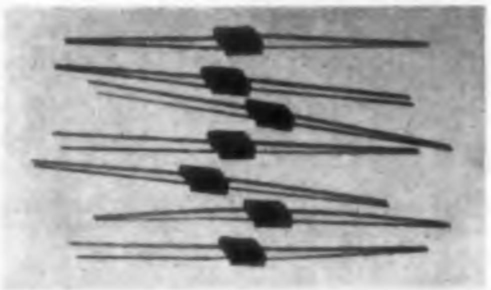
Burroughs Corp., Electron Tube Div., Dept. ED, P.O. Box 1266, Plainfield, N.J

Price & Availability: Price ranges from $20 to $30, without the indicator tube, depending on quantity. Delivery is from stock.

Booth 1211-1213-1215.

Silicon Switching Diode 558

Total dissipation is 200 mw



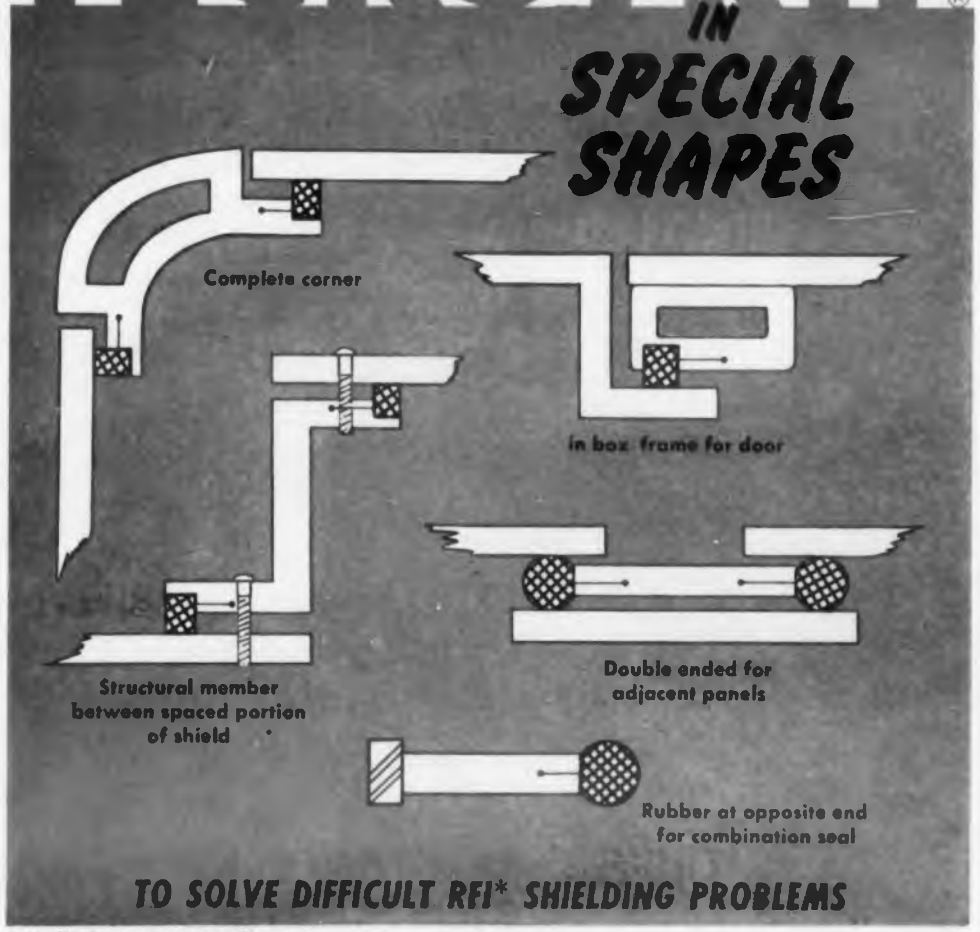
Model FD100 diffused silicon switching diode has the following characteristics at 25 C: capacitance of 2 μμf at 0 v dc, reverse recovery time of 4 mμsec, forward voltage of 1 v max at 10 ma dc, breakdown voltage of —40 v dc min, and total dissipation of 200 mw The diode is housed in a miniature glass, axial-lead package. It is intended for use in computer circuitry.

Fairchild Semiconductor Corp., Dept. ED, 545 Whisman Road, Mountain View, Calif.

Price & Availability: Units are available from stock. Production quantities have a delivery time of 30 days. Price is $6.50 ea for orders of 1 to 99 units and $5 for 100 or more units.

Booth 2701-2707.

TECKSTRIP®



*Radio Frequency Interference

Basic Teckstrip, which combines a resilient RFI gasket and a rigid, easy-to-install aluminum mounting strip, can be made in special cross-sections to solve difficult shielding problems. These special shapes make possible savings in fabricating costs and greatly simplify gasket installation.

Now, *only from Tecknit* comes a complete RFI gasket engineering service to aid you in the solution of the "impossible" problems. Staffed by outstanding authorities in the field, Tecknit Design Service stands ready to develop cost reducing special Teckstrip for you.

Write today for a Problem Outline Sheet and a copy of the new Teckstrip Bulletin RF-9.

TECKNIT®

Technical Wire Products, Inc.
48 Brown Avenue, Springfield, N. J.
Phone: DRexel 6-3010.
TWX: MLBN, 40

PS-803
Technical Wire Products, Inc.
48 Brown Avenue, Springfield, N. J.

Gentlemen:

Send me complete information on Standard and Special-Shape Teckstrips.

Company____________________
Name____________________
Address____________________
City__________ Zone____ State________

See our exhibit in Booth #4129 at IRE Show

CIRCLE 278 ON READER-SERVICE CARD

Built-in Damping Cuts Vibration of Structural Members. 280

Structural members and assemblies can now be designed and produced to solve specific problems of extreme shock and vibration. This is accomplished by building high damping characteristics right into the structural fabrications. The amplification of resonant vibration is reduced by using this built-in design technique.

Called Rigidamp, these structural members are said to have a usual resonant response ranging from only 5 to 10 times the excitation vibration throughout the frequency range met in modern dynamic environments. They have an extremely flat vibration response up to 2000 cps and this frequency can be exceeded in most cases. This is in sharp contrast to the high vibration amplification of conventional structures.

Damping Achieved by Laminated or Cellular Construction

The materials attain their high damping action by either special laminated or cellular construction. The laminated process is used with sheets and thin rectangular section beams. Laminates are made of conventional materials, either metal or plastic, and separated by a viscoelastic damping medium (Fig. 1).

In flexing under impressed vibrations, the laminations slide relative to each other. This sliding is impeded by the specially formulated viscoelastic material, and most of the energy of resonance is absorbed in straining the viscoelastic layer in shear.

Other structural shapes such as I-beams, channels, and angles are of cellular construction (Fig. 2). Longitudinal cells are formed throughout the length of the member. Each cell contains an insert separated from the cell walls by the viscoelastic damping material.

For equipment and systems already designed, where vibration is causing problems, strip dampers of cell-insert construction are used (Fig. 3). These "fixes" reduce the resonant response of conventionally fabricated equipment, and are ideal for damping longitudinal structures.

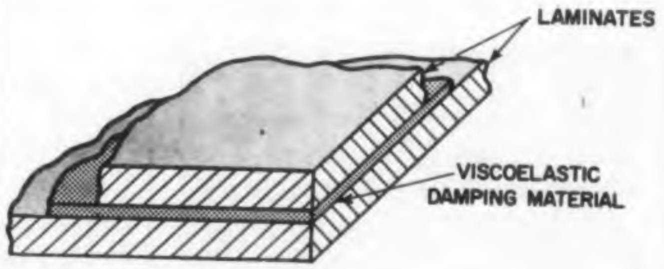


Fig. 1. Viscoelastic damped laminated sheet. Laminates are of conventional materials, either metal or plastic.

Fig. 2. Rigidamp structural members. Viscoelastic medium between cell and insert absorbs dynamic energy when beams flex under impressed vibration.

According to the company, Rigidamp construction is the first practical development of the theory in which:

- All portions of the structural fabrication act as load carrying members.
- Materials and structures can be designed in all frequencies normally encountered in modern dynamic environments.

Rigidamp Structures Have Electronic Applications

Possible applications of Rigidamp structures are electronic circuit boards, electronic chassis, shelves, dust covers, text fixtures, relays, and other parts. Mounting shelves for electronic equipment in a high performance Navy aircraft have been built by the company. Manufactured in production quantities these pioneer assemblies have proved in service to be capable of satisfactory operation in dynamic environments where conventional design techniques were unable to meet specifications, the company claims.

However, high damping gains are compensated by losses in other areas. A viscoelastic damped member or structure has less load carrying capacity than conventional members of the same mate-

(continued on page 248)

Fig. 3. Strip dampers on beams on left offer means of "fixing" the resonant response of conventionally designed structures.

INDIANA GENERAL CORPORATION

a new symbol of magnetic progress

Two established leaders — Indiana Steel Products and General Ceramics — Combine to Serve You Better

This trademark is the calling card of a new leader in science-age materials — Indiana General Corporation. It is born of a union between two established leaders — The Indiana Steel Products Company in permanent magnets . . . the General Ceramics Company in ferrites and memory systems. Together, as Indiana General Corporation, they serve you better by placing at your disposal the brains and resources of two scientifically oriented concerns. Research and development have been the backbone of both of the original companies; both have records of significant achievement in their particular fields.

Indiana General can help you "design-engineer" your products with the latest magnetic innovations. If you have a design problem, the Indiana General sales engineer in your area will be most happy to advise you. And, behind him, our experienced scientists and design engineers are available for consultations — at no cost or obligation. Write us outlining your problems.

LOUD-SPEAKER INDOX V ceramic permanent magnet provides high energy level . . . reduces speaker length and weight.

MEMORY SYSTEM New microstack unit for coincident current memory systems saves 90% of space required by conventional stack, yet is more reliable.

MAGNETRON Powerful Hyflux ALNICO V magnets improve performance in many types of microwave equipment.

AUTOMATIC DIRECTION FINDER Ferramic "E" magnetic core material helped engineers create a new concept in aircraft antenna design.

This is Indiana General Corporation

INDIANA STEEL PRODUCTS DIVISION Valparaiso, Indiana • Metallic and Ceramic Permanent Magnets
GENERAL CERAMICS DIVISION Keasbey, New Jersey • Ferrites, Memory Products, Technical Ceramics and Chemical Stoneware
ADVANCED VACUUM PRODUCTS (Subsidiary) Stamford, Connecticut • Alumina Ceramic-to-metal Hermetic Terminals
STEARNS MAGNETIC PRODUCTS DIVISION Milwaukee, Wisconsin • Magnetic Materials Handling and Separation Equipment
THE INDIANA STEEL PRODUCTS COMPANY OF CANADA LIMITED Kitchener, Ontario • Permanent Magnets and Stainless Steel Castings

If your product involves magnets or ferrites, Indiana General can help you make it better.
Visit us at the IRE Radio Engineering Show, *booths:* 1310-12-14-16

INDIANA GENERAL
CORPORATION
VALPARAISO, INDIANA
CIRCLE 282 ON READER-SERVICE CARD

rial and cross section. Also, structural damping imposes a slight increase in weight. But because many designs are based on dynamic stress level, Rigidamp designs may not require increases in weight or cross section.

Special techniques and application knowledge are required in order to achieve optimum results. For these reasons, the company does not plan to market the damped structural members as materials, but will provide design and fabrication services to solve specific problems.

Barry Controls, Inc., Dept. ED, 700 Pleasant St., Watertown 72, Mass.

Printed Circuits 283

Members of trade associations, professional societies, and other interested organizations can now obtain speakers to discuss the design, applications, and utilization of printed circuits. W. J. McGinley, President of the Institute of Printed Circuits, has announced that such speakers are available from a new speakers bureau developed by the IPC. Members of the IPC are available as speakers in most major cities.

Institute of Printed Circuits, Dept. ED, 27 E. Monroe, Chicago 3, Ill.

Wire and Cable Design 284

Times Wire & Cable Co., Inc., announces an expansion of wire and cable engineering services that embraces all mechanical and electrical phases of the design and manufacture of electronic conductors. The company is now equipped and manned to handle design problems from dc to X-band, and through voltage and current handling encompassing virtually all requirements of the electronics industry.

Times Wire & Cable Co., Dept. ED, 358 Hall Ave., Wallingford, Conn.

Computing Service 285

Establishment of the Douglas Computing Service to sell excess computing machine time outside the company has been announced by the Douglas Aircraft Co. The available computing equipment includes: IBM 709, 704, 701, and 650 computers as well as IBM 722 tape-to-card, IBM 720 card-to-printer, IBM 717 card-to-printer, IBM 714 card-to-tape, the Univac file computer, and the Univac tape printer. A scale of hourly rates has been established for each type of machine.

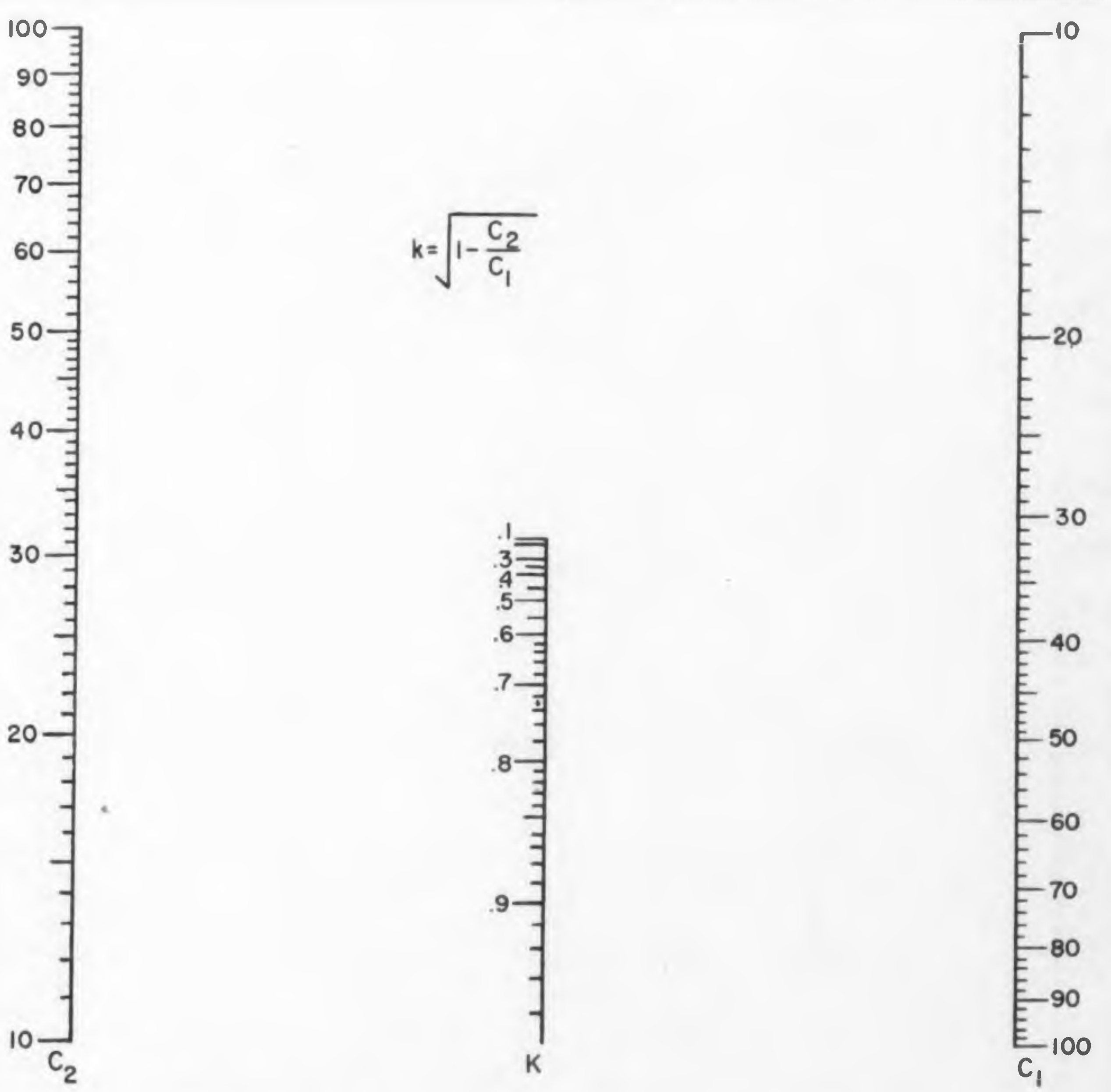
Douglas Computing Service, Douglas Aircraft Co., Inc., Dept. ED. General Offices, Santa Monica, Calif.

Computing Coefficient of Coupling

Donald Moffat
Motorola, Inc.
Western Military Electronics Center
Phoenix, Arizona

Coefficient of coupling of an rf transformer can be calculated from Q-meter measurements. As a convenience for the designer, the method is reviewed here by Mr. Moffat, and nomograms are provided for solving the equations. To use the Mutual Inductance method, an additional nomogram is given.

(text begins on page 250)



Nomogram 1. Coefficient of coupling, given two resonant capacitances.

Computing Coefficient of Coupling (cont.)

THERE ARE two ways to calculate the coefficient of coupling of an rf transformer from Q-meter measurements, and both start the same way. Leave one winding (call it the secondary) open and find a frequency f_1 to resonate the primary with external capacity C_1. Then short the secondary.

First Method

To use the first method, leave the frequency unchanged and find a new capacity C_2 to resonate the primary. Coefficient of coupling is given by

$$k = \sqrt{1 - C_1/C_2}\,.$$

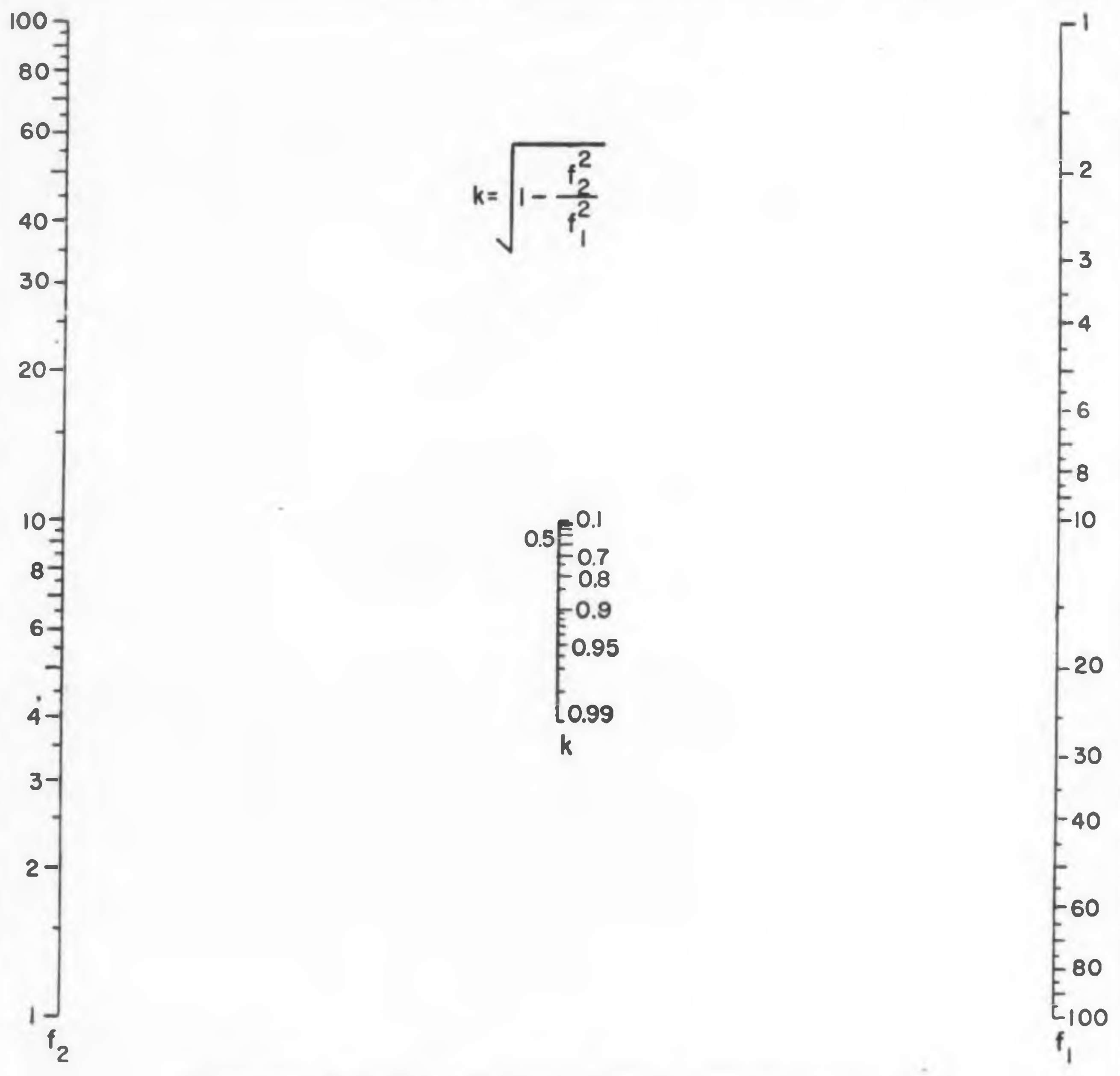
To solve this equation on Nomogram 1, simply join C_1 and C_2 with a straight line and read k where the line crosses the center scale. The range of values of the capacitors can be extended by multiplying both C scales by the same number.

Second Method

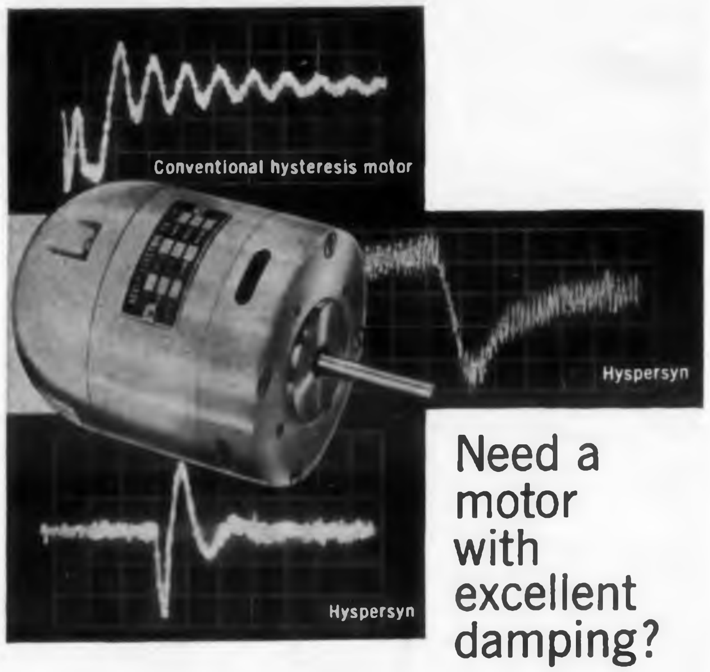
In the second method the capacity, C_1, is left unchanged and the primary is reresonated with a new frequency, f_2. Coefficient of coupling is given by.

$$k = \sqrt{1 - f_1^2/f_2^2}\,.$$

On Nomogram 2, a straight line be-



Nomogram 2. Coefficient of coupling, given two resonant frequencies.



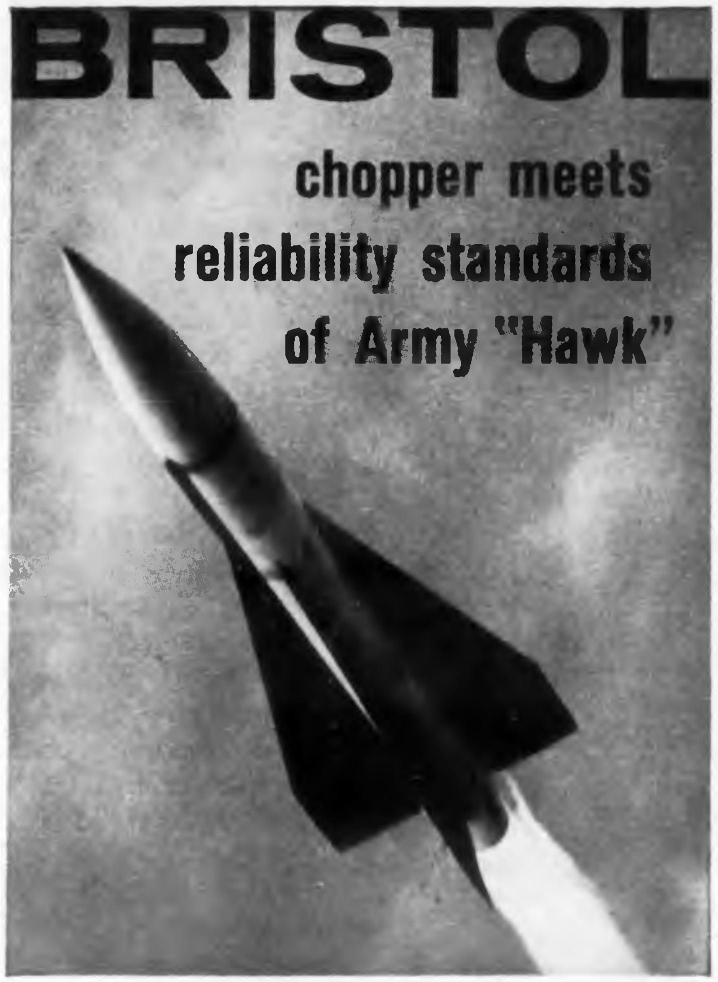


PHOTO COURTESY OF RAYTHEON COMPANY WALTHAM, MASS.

Every part that goes into a modern-day missile system must pass a rigid battery of tests and a thorough statistical screening to insure highest possible reliability in action.

That's why we're pleased to announce that Bristol Syncroverter choppers play an important role in guidance of the U.S. Army HAWK missile, produced by Raytheon Company, Waltham, Mass., prime contractor for the complete HAWK weapons system.

Billions of operations. Bristol Syncroverter* choppers are ideal for applications requiring the utmost in statistical reliability. The Bristol life-test lab has now had miniature Syncroverter choppers running for years without failure – both with and without contact load. Just one sample: five choppers with 400-cycle drive and 12v, 1ma, resistive contact load have completed 26,000 hours (2.96 years) continuous operation–over 37-billion operations!

An extremely wide variety of standard models is available–including external coil low-noise types. For complete data, write: Aeronautical Components Division, The Bristol Company, 151 Bristol Road, Waterbury 20, Conn.

actual size

*T. M. REG. U. S. PAT. OFF. 9.26

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS

See us in Booth 1817 at the I.R.E. Show

CIRCLE 289 ON READER-SERVICE CARD

Computing Coefficient of Coupling (cont.)

tween f_1 and f_2 crosses the center scale at the correct value of k.

Although measurements for both methods are usually done on a Q-meter, it is sometimes more convenient to use a grid dip meter for the second method. Because there will be dips for both windings, the grid dip meter should be used with care, so as to identify each dip with its corresponding winding.

An example:

With the secondary open, a transformer is resonated with 45 µµf. The secondary is then short-circuited and, at the same frequency, the primary resonates with 60 µµf. On Nomogram 1 draw a straight line from $C_1 = 45$ µµf to $C_2 = 60$ µµf and read $k = 0.5$ where the line crosses the center scale.

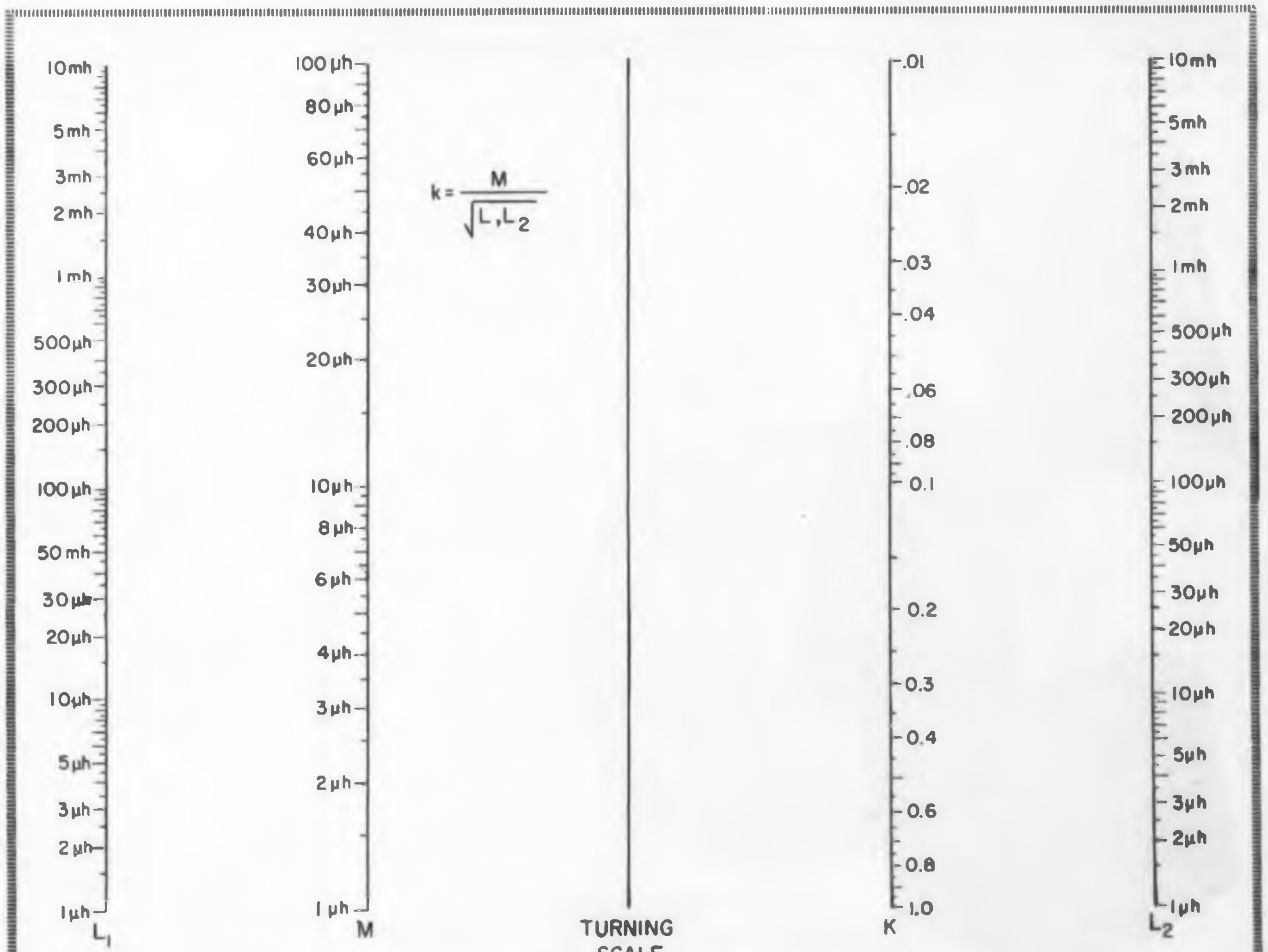
Because of approximations in the equations, reliability of the results is questionable for coefficients of coupling less than 0.2.

Mutual Induction Method

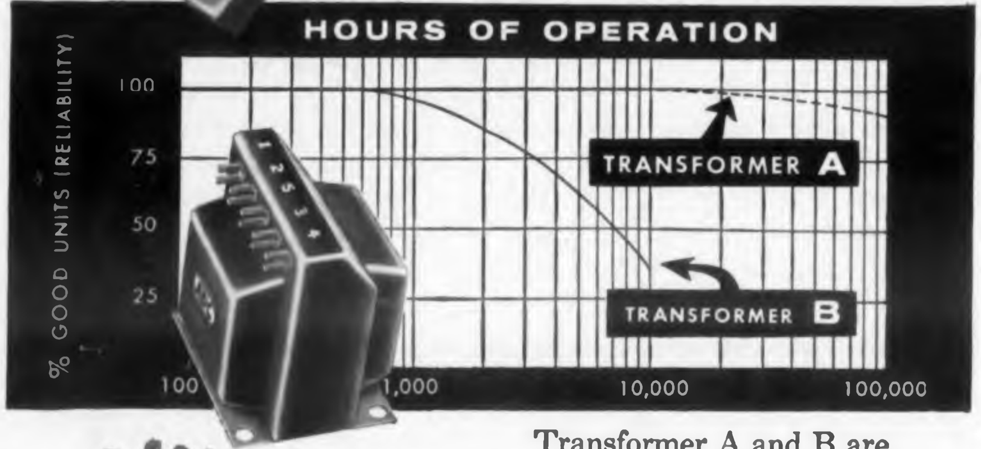
An entirely different method uses the inductances of both windings and the mutual inductance.

$$k = M/\sqrt{L_1 L_2}\,.$$

On Nomogram 3 draw a straight line from L_1 to L_2. From the point where this line crosses the turning scale, draw a line to M and extend the line back to the k scale. ■ ■



Nomogram 3. Coefficient of coupling, given primary and secondary inductances and mutual inductance of the two.



NEW LITERATURE

Recording Heads 291

Specifications and mounting arrangements of approximately 60 different designs of standard recording heads appear in this four-page bulletin. Digital heads, analog heads, and special heads are dealt with. Applied Magnetics Corp., Box 368, Building 304, Santa Barbara Airport, Goleta, Calif.

Power Supplies 292

Airborne transistorized power supplies, models TPC-18A and 19A, are described and illustrated in this two-page data sheet. The units are designed for replacement of D-10A dynamotors as the power supply for aircraft communications and navigation receivers. Applications, schematic drawings, and specifications are included. Southwestern Industrial Electronics Co., A Div. of Dresser Industries, Inc., 10201 Westheimer Road, Box 22187, Houston 27, Tex.

Etching Printed Circuits 293

Booklet No. Q-24, entitled "Industrial Uses of Kodak Photo Resist," contains complete instructions for the use of the firm's etching materials in printed circuit applications. The products are used where extreme definition with copper plates or copper laminates is required. Graphic Reproduction Sales Div., Eastman Kodak Co., Rochester 4, N.Y.

Radar and Communications 294

An airborne manual and panoramic receiver, missile electronic program generator, air to ground transceiver, and a mobile communications center are some of the systems illustrated in this 19-page brochure. Radar systems featuring size and weight reduction, transistorized X-band radar and transponder beacons are included. Military communications projects are illustrated by photographs and line drawings. Designers for Industry, Inc., 4241 Fulton Parkway, Cleveland 9, Ohio.

Transistors 295

Electrical and mechanical data, and performance design characteristics for a series of pnp silicon alloy transistor are covered in three bulletins, two pages each. The transistors, types 2N1440, 2N1441, and 2N1442, meet the requirements of JEDEC 30 and MIL-T-19500 A. Design characteristics include 200 C junction temperature, device dissipation of 400 mw at 25 C and 170 mw at 125 C. The components are designed for low level amplification, small signal and medium power applications. National Semiconductor Corp., Danbury, Conn.

Servo Analyzers 296

Block diagrams, performance details, and a list of applications for the 200 series of servo analyzers are included in this four-page brochure. Details are given relative to direct readout and automatic plotting capabilities which provide frequency in cps, phase angle in degrees, and amplitude ratio in db. Metrolog Corp., 169 N. Halstead St., Pasadena, Calif.

Metals and Alloys 297

Lists of metals and alloys for the semiconductor field, and high-purity metals for special solder applications appear in this six-page catalog. Phase diagrams and charts of the elements are also included. The materials come in microform spheres, dots, washers, ribbon, or wire made to individual requirements. Anchor Alloys, Inc., 968 Meeker Ave., Brooklyn 22, N.Y.

Pulse Generator 298

Complete specifications, in addition to a photograph, of model 4120B pulse generator appear in this one-page data sheet. The unit is a source of medium power, has modular circuitry, and has a repetition rate that may be internally or externally controlled, or operated single shot. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Molded Plastics

A value analysis approach to the design and purchase of plastic parts and components is presented in this eight-page illustrated brochure. Standard stock knobs that are made by the firm are also described. *Write on company letterhead to Chicago Molded Products Corp., Dept. ED, 1020 N. Kolmar Ave., Chicago 51, Ill.*

RF Chokes and Coils 299

Electrical parameters for the complete line of Variable Inductors are given in this two-page data sheet. The coils are available in a range of inductances from 0.1 μh to 4700 μh in 29 overlapping ranges. They are designed for printed circuit board mounting. Nytronics, Inc., Essex Electronics Div., 550 Springfield Ave., Berkeley Heights, N.J.

Wire and Cable Charts 300

Four color-coded data charts contain composite information on wires, cables, and power cords. A specification sheet, diameter and wall thickness sheet, weight sheet, and price sheet are included. All are 8-1/2 x 11 in. with universal binder punch. Hatfield Wire & Cable Div. of Continental Copper & Steel Industries, Inc., Hillside 5, N.J.

Speed Recorder 301

Industrial applications, principles of operation, and general specifications of type HF multi-range strip chart speed recorder are given in this four-page booklet, No. GET-2741-3A. A schematic of the instrument and a description of available accessories are included. General Electric Co., Schenectady 5, N. Y.

Anodizing Aluminum

This booklet, entitled "Questions and Answers About Anodizing," gives information on the cost of anodizing aluminum, the forming of anodized parts, the amount of heat anodic films can withstand, and the effect of anodizing upon the dimension of a part. *Write on company letterhead to Reynolds Metals Co., Dept. ED, Richmond 18, Va.*

Timing and Computer Systems 302

Three data sheets describe the ZA-26211 airborne time code generator, an all transistorized unit with an accuracy of one part in 10^5; the ZA-23833 search and control system; and the ZA-25159 computer format converter for converting radar data into magnetic tape or NRZ format. Electronic Engineering Co. of Calif., Technical Literature Section, 1601 E. Chestnut Ave., Santa Ana, Calif.

Pioneers in Electricity

"Ten Founding Fathers of the Electrical Science," the 48-page illustrated monograph on electricity's pioneers by Dr. Bern Dibner, fellow of the AIEE, is now being offered in a reprinted version. The men whose biographical sketches appear in this book are Dr. William Gilbert, Otto von Guericke, Benjamin Franklin, Alessandro Volta, Andre Marie Ampère, Georg Simon Ohm, Karl Friedrich Gauss, Michael Faraday, Joseph Henry, and James Clerk Maxwell. *Copies are available at $1.00 each from the Burndy Library, Dept. ED, Norwalk, Conn.*

Laminated Plastics 303

Two copper-clad, flame retardant laminated plastics are described in bulletin No. 3.1.25.1, two pages. Fireban 321-R is a rolled copper foil material; Fireban 321-E has the copper foil electrolytically deposited. Taylor Fibre Co., Norristown, Pa.

HF Driver and Network 304

Bulletin No. SB1018, two pages, describes and illustrates the LE30 driver and LX3 dividing network. The units in conjunction reproduce the entire upper half of the audio spectrum. James B. Lansing Sound, Inc., 3249 Casitas Ave., Los Angeles 39, Calif.

Paper Tape Accessories 305

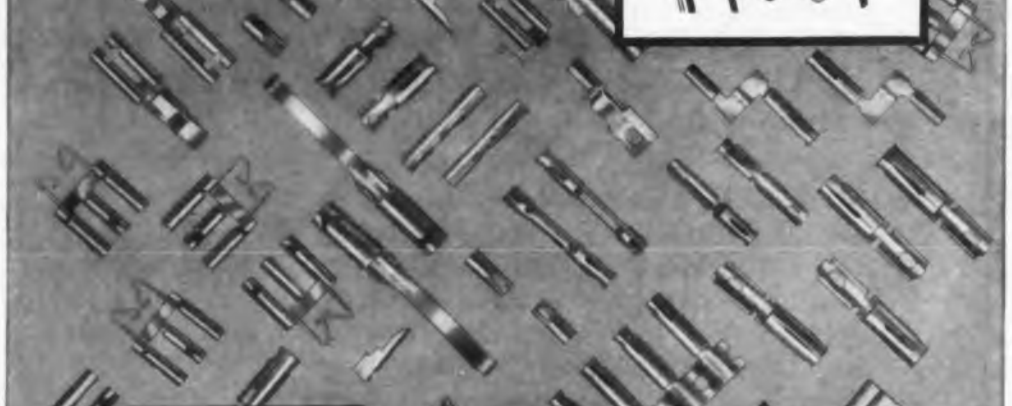
Models PR-1 auxiliary photoelectric paper tape reader, PR-2 multi-code high-speed tape reader, and PTP-1 auxiliary paper tape punch are described in this two-page data sheet. Bendix Aviation Corp., Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.

MICRO-PROCESSED FOR COMPLETE RELIABILITY

I-S **beryllium copper electrical contacts**

- Excellent Electrical Characteristics
- Precision Accuracy
- Freedom from Fatigue
- High Efficiency at Elevated Temperatures
- Corrosion Resistance
- Uniform Quality

Increase Dependability of Your Miniature Sockets and Terminal Boards



Request your copy of the I-S catalog on beryllium copper compression springs, flat springs, strip springs, contact strips, contact rings and screw machine parts. Send drawings and specifications for quotations on your specific requirements.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE OR WRITE FOR COPY

I-S Beryllium Copper contacts provide important advantages both electrically and mechanically. They offer designers and engineers the increased reliability required for today's most critical applications. Custom made contact springs of the types illustrated are produced economically in large quantities by means of automatic tooling. I-S engineers are available to help work out your contact problems and will gladly make recommendations on receipt of your application data; no obligations.

INSTRUMENT SPECIALTIES CO • INC

270 Bergen Blvd., Little Falls, N. J.
Telephone: CLifford 6-3500

"MICRO- ...PROCESSED" I-S BERYLLIUM COPPER SPRINGS

VISIT BOOTH 4313 I.R.E. SHOW

CIRCLE 307 ON READER-SERVICE CARD

NEW LITERATURE

Epoxy Resins 308

This 28-page illustrated booklet discusses Scotchcast brand resins as an insulation system. A section on "Techniques and Tips on the Use of Epoxy Resins" tells how to store and prepare resins; explains handling, application and curing techniques; discusses molds and mold releases, and suggests methods of component design and preparation. Minnesota Mining & Manufacturing Co., Dept. WO-10, 900 Bush Ave., St. Paul 6, Minn.

Semiconductor Directory 309

Expanded to 36 pages, this semiconductor directory provides a comprehensive listing of the latest in diodes, tunnel diodes, rectifiers, germanium transistors, and silicon transistors, with selected schematics for industrial circuit applications. All major manufacturers and types are numerically listed complete with specifications, applications, and prices. The directory is suitable for loose-leaf insertion. Lafayette Radio Corp., 165-08 Liberty Ave., Jamaica 33, N.Y.

Miniature Batteries 310

This illustrated eight-page bulletin describes the Silvercel battery system in general, and lists specific data for the 20xPA50 automatically activated primary battery, and two types of rechargeable batteries. Data listed in bulletin No. Z-101 includes electrical, physical, environmental, and typical application characteristics, as well as discharge curves. Yardney Electric Corp., 40-50 Leonard St., New York 13, N.Y.

Mercury Thermostats 311

Three types of mercury thermostats are described in this 18-page catalog: the well-type for sensing case temperature, the duct-type for gas or fluid temperature sensing, and the surface-type for area contact sensing. Specifications include temperature settings, contact ratings, operating voltage, and dielectric strength. The catalog also contains outline drawings and mounting instructions. Vapor Heating Corp., Vap-Air Div., 6420 W. Howard St., Chicago 48, Ill.

HOPKINS

polystyrene film capacitors

–for critical circuits requiring high stability and close tolerances

In these Hopkins capacitors, you get a typical long-term stability to .1% per year, and a temperature coefficient of 120 PPM per degree C. Tolerances are available down to ±1%, with guaranteed accuracy.

High insulation resistance—1,000,000 megohms is typical. Dielectric absorption is very low—only .05%. Units are manufactured under close quality control to insure utmost reliability.

Available as film-wrapped types, and in all case styles in hermetically sealed brass tubes, bathtubs, and decades. Rated .001 to 1.0 mfds., 100 to 600 VDC. Higher values to customer specifications. Send for catalog C-104A.

SEE CATALOG IN eem

HOPKINS Engineering COMPANY

12900 Foothill Blvd., San Fernando, Calif. Tel. EMpire 1-8691

CIRCLE 312 ON READER-SERVICE CARD

Potentiometer 313

A conductive plastic potentiometer called the Acemho is described in this bulletin containing full electrical and mechanical specifications. The unit is available in both standard servo and bushing configurations. Ace Electronics Assoc., Inc., 99 Dover St., Somerville 44, Mass.

Servo Systems 314

This special report, eight pages, illustrates how the Servolab packaged assembly of electronic and electromechanical components permits students to build and test their own servo systems. Formula derivation and practical application are demonstrated. Photographs and diagrams show how a number of servo systems can be demonstrated quickly in a few steps. Servo Corp. of America, 111 New S. Road, Hicksville, Long Island, N.Y.

Audio Bandpass Filters 315

Data sheet No. 701, one page, lists six models of audio bandpass filters designed for alternate band separation use. A table gives typical characteristics of each model at 1.5 db bandwidth and 35 db frequencies as well as shape factor and dimensions. Control Electronics Co., Inc., 10 Stepar Place, Huntington Sta., Long Island, N.Y.

Selenium Rectifiers 316

Bulletin No. 287A, four pages, describes the firm's line of selenium rectifiers. Included are a description of the stack coding system, a computation table for stack dimensions, and cell rating tables for both convection and forced air cooling. Typical performance characteristic curves are also shown. Radio Receptor Co., Inc., Selenium Div., 240 Wythe Ave., Brooklyn, N.Y.

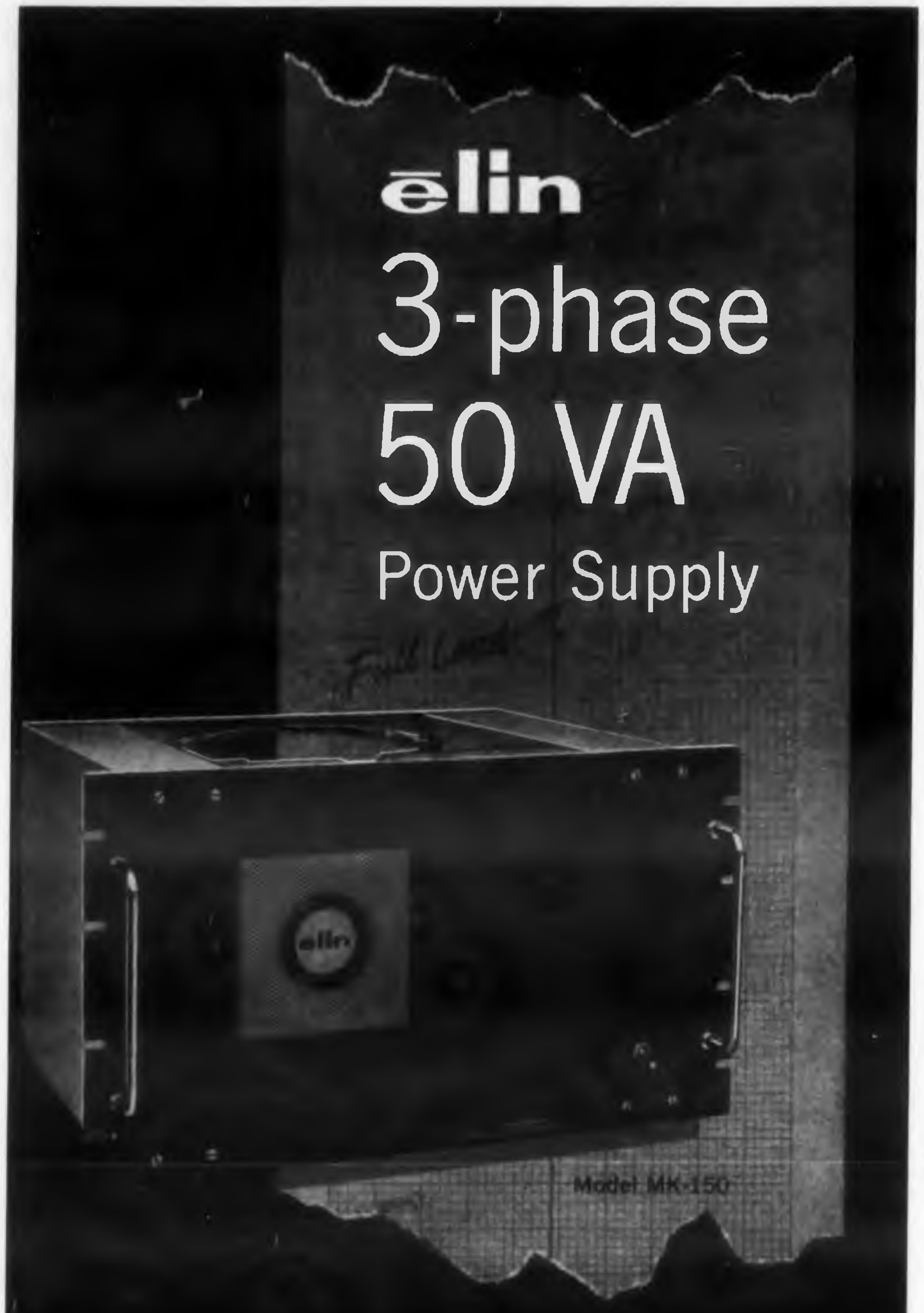
Fused Quartz Products 317

Products made of pure fused quartz and silica are illustrated and described in this 30-page catalog. Introductory pages give electrical and mechanical data, and dielectric properties of Vitreosil. The rest of the catalog is divided into two classifications, Laboratory Ware and Industrial Ware. Thermal American Fused Quartz Co., 18-20B N. Salem St., Dover, N. J.


Quickest to Handle.

Easiest to Assemble.


Simplest to Mount and Extend.



NEW LITERATURE

Coaxial Cables 321

Coaxial cables of semi-air-space design, and for use at 300 and 500 C, are described in this 28-page technical report. The report, which was presented at the Eighth Annual Symposium of the Communication Wire and Cable Section of the United States Signal Engineering Labs, contains complete specifications of the cables, and explains fully the steps followed in their development. Performance curves illustrate temperature and frequency characteristics, and dielectric power factors and strengths. Phelps Dodge Copper Products Corp., 300 Park Ave., New York 22, N.Y.

Transformers 322

Catalogs S-105 and CT9-59 carry detailed listings of stock transformers for military, communications, radio, TV, and power circuit applications. Included are specifications for many units for transistor applications. Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill.

Fusion Sealed Capacitors

Fusion sealed glass capacitors that meet all requirements of MIL-C-11272A, MIL-STD-202, and MIL-STD-202A, are described in this four-page booklet. Characteristics include voltage rating, temperature coefficient, tolerance, and insulation and moisture resistances. The booklet also contains performance curves and tables. *To obtain reference file No. CE-1.01, write on company letterhead to Corning Glass Works, Electronic Components Div., Dept. ED, Bradford, Pa.*

Plastics Table of Properties 323

Properties for nine thermoplastic materials are given on this table. Properties shown include: tensile, impact flexural and compressive strength; resistance to sunlight, water, weak and strong acids and alkalies; dielectric short-time strengths and constants; power factors; machining qualities, harness, flexibility and thermal properties. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

XY Recorder 325

Bulletin No. 794-1, two pages, gives complete data on model HR-94 XY recorder. The unit offers direct differential transformer or ac transducer input. The data sheet contains a functional block diagram. Houston Instrument Corp., Box 22234, Houston 27, Tex.

Theodolites 326

A series of theodolites used to obtain azimuth accuracy of inertially guided ballistic missiles is described in this eight-page brochure. Specifications for four models include nominal range, azimuth rotation, azimuth monitoring range, and linear sway tolerance. Operational characteristics and accessories are also described. Perkin-Elmer Corp., Electro-Optical Div., Norwalk, Conn.

Relay Magnetic Amplifier 327

Bulletin No. 70 has 10 schematic diagrams and graphs describing the design and application techniques of single-ended magnetic preamplifiers. Some of the topics covered are: ac doubler circuits, dc double bridge circuits, snap action or bi-stable characteristics, and magnetic amplifier thermistor systems. The six-page bulletin also describes models 701, 706, 711, and 761 relay magnetic amplifiers. Acromag, Inc., 22519 Telegraph Road, Southfield, Mich.

Soldering Iron 328

A low-tension, miniature soldering iron for use on printed circuit boards, transistors and diodes, under a loupe or magnifying glass, and on subminiature assemblies, is described in this data sheet. Accessories for the Ersa-Minitype are also described. Caig Laboratories, 46 Stanwood Road, New Hyde Park, Long Island, N.Y.

Self Locking Nut 329

Bulletins No. 3002 and 3003 list sizes and dimensions for the Tru-Lok self locking aluminum nut. The bulletins contain temperature, strength-to-weight, and reusability data. Waltham Precision Instrument Co., 221 Crescent St., Waltham 54, Mass.

NOW in 50 WATTS for MINIATURE and SUBMINIATURE PRODUCTION SOLDERING JOBS

the NEW, American Beauty BANTAM "X" series

Designed with 50 watt input, these fine soldering irons will give greater productivity and do industry's most exacting soldering jobs easier, faster, better. SLOTTED STAINLESS STEEL CASINGS MAKE THE HANDLES REALLY COOL, ending operator complaints. There's no waiting or fumbling with these light, flexible tools — they're always ready. American Beauty soldering irons are known the world over for their dependability, durability and efficiency. Learn more about these fine soldering tools today.

Shown below are other shapes and tip-size irons available in the BANTAM "X" series.

YOU CAN'T BEAT A SOLDERED CONNECTION

WRITE FOR DESCRIPTIVE CATALOG SHEET, FORM NO. 222-CT

AMERICAN ELECTRICAL HEATER COMPANY
DETROIT 2, MICHIGAN

CIRCLE 330 ON READER-SERVICE CARD

STEPPER SYNCHRO POSITIONER

Accuracy: Within 6 min. of arc when driven by either motor.

Incremental shaft rotation: 2 degrees.

This is one of the many applications for the Stepper Motor — a device for translating electrical pulses into accurate, bi-directional, incremental shaft displacements.

The Synchro Positioner uses two Stepping Motors, an Autosyn differential, and a built-in pulse generator. One motor positions the Autosyn Shaft in coarse increments in either direction, while the other motor, using a different gear ratio, positions the same shaft in vernier increments in either direction. As the reset command signal is of steady-state type, the built-in pulse generator permits use of the driving motors for the reset function.

STEPPER MOTORS CORPORATION
Subsidiary of California Eastern Aviation, Inc.
7443 West Wilson Avenue • Chicago 31, Illinois
• WEST COAST · · · 11879 W. FLORENCE AVE. · · · CULVER CITY, CALIF.

CIRCLE 331 ON READER-SERVICE CARD

NEW LITERATURE

Aluminum Foil Capacitors 333

Specifications and performance characteristics of miniature and subminiature aluminum foil capacitors are described in this eight-page bulletin, No. 81558. Operating factors include dc leakage current, dissipation factor, capacitance and tolerance, operating temperature range, dc working voltage rating, and surge voltage. Standard rating and selection charts for aluminum encased and ceramic encased capacitors are given in the bulletin. International Electronic Industries, Inc., Box R 23, Nashville, Tenn.

Insulating Material 334

This two-page data sheet discusses electrical, chemical, and physical properties of Rexolite 2200, a reinforced thermosetting plastic insulating material designed for use at ultra high and microwave frequencies in both wet and dry locations. The sheet includes curves for dissipation factor, dielectric constant, and attenuation. Rex Corp., West Acton, Mass.

Plastic Sheets, Tubes, and Rods 335

Applications, special and detailed characteristics, and available sizes of over 50 grades of laminated plastic sheets, tubes, and rods are given in this 16-page catalog, No. 2B Gen. Included are phenolics, silicones, melamines, and epoxies with filler bases of paper, nylon, cotton, asbestos, and glass fabric. Also shown are properties of copper clad laminates for printed circuits. General Electric Co., Laminated Products Dept., Coshocton, Ohio.

Headsets 336

Moving-coil dynamic headsets are described and illustrated in this two-page data sheet. Wiring changes in the three-circuit jack permit use of the headsets for series, parallel, monaural, binaural, or stereo listening. The bulletin includes data on ear cushions and microphones. Permadyne Div. of Melody Master Manufacturing Co., 2149-51 W. Roscoe St., Chicago 18, Ill.

Capacitors 338

Series TS tantalum slug capacitors are described in bulletin No. 159. The electrolytic capacitors meet the physical and performance requirements of MIL-C-3965B, and are available in insulated and uninsulated styles. Ohmite Manufacturing Co., 3693 Howard St., Skokie, Ill.

Insulation Blankets 339

This four-page bulletin, No. 6019, contains results of thermal tests conducted by the firm. The thermal conductivity of various metals, insulating materials, and other miscellaneous materials, are listed. Electrofilm Technical Service, 7116 Laurel Canyon Blvd., N. Hollywood, Calif.

Potentiometers 340

Series 7230 ten-turn potentiometers for servo-mounting are covered in this four-page data sheet, No. 60150. They are rated at 2 w and 65 C, derating to 0 at 125 C. Included are complete preliminary specifications, environmental characteristics, coil data, dimensional drawings, and photographs. Beckman Instruments Inc., Helipot Technical Information Service, 2500 Fullerton Road, Fullerton, Calif.

Radiation Monitoring 341

Automatic monitoring of gamma and beta radiation using model DZ14 radiation supervisor is discussed in this booklet. The unit may be used to monitor background in low level counting rooms, in working areas of "hot" laboratories, and in radiography installations. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

Power Supplies 342

The PI series of miniaturized all solid state power supplies is covered in this two-page data sheet. In addition to specifications, voltage, current, and dimensions are given for seven models in the series. Load and line regulation data also appears in the bulletin, No. PS2013. Deltron Inc., 2905 N. Leithgow St., Philadelphia 33, Pa.

versatile
tool
for system
design
engineers

- Solves differential equations by ROOT LOCUS plots.
- Provides BODE phase and gain plots from system poles and zeros.
- Synthesizes compensation networks.
- Evaluates residues.
- Factors polynomials.
- Analyzes sampled data systems.
- Solves non-linear problems involving hysteresis or saturation by the describing function technique.
- Designs process control systems.
- Derives process transfer functions from power density spectra.
- Uses rapid, logical pole-zero programming.
- Provides permanent, plotted graphs for all stages of dynamic system design.

esiac

A complete analog computer that increases system design productivity more than five fold at a net price less than the yearly salary of a design engineer. The Esiac rapidly solves generalized system equations expressed in the following forms:

$$F = \pm K s^{n_0} (s - s_1)^{n_1} (s - s_2)^{n_2} (s - s_3)^{n_3} \ldots$$

or

$$F = \pm K s^{n_0} \left(1 - \frac{s}{s_1}\right)^{n_1} \left(1 - \frac{s}{s_2}\right)^{n_2} \left(1 - \frac{s}{s_3}\right)^{n_3} \ldots$$

Telephone collect to discuss your system design problems with an Esiac engineer. Write for descriptive engineering bulletins, Esiac solutions to system design problems, or an Esiac demonstration in your plant.

SEND FOR DESCRIPTIVE LITERATURE

See it demonstrated
MARCH IRE SHOW
Booth 3010-3011

esi®

Electro Scientific Industries
7524 S.W. MACADAM • PORTLAND 19, OREGON
CHerry 6-3331

formerly ELECTRO-MEASUREMENTS, INC.

ESI has outstanding opportunities for design and applications engineers. Call or write Mr. Davis.
CIRCLE 345 ON READER-SERVICE CARD

NEW LITERATURE

Electroforming 346

"Current Uses for Electroforming—a Manual for Designers, Engineers, and Manufacturers" is an illustrated technical handbook that incorporates the latest technical information on electroforming, the process of building a structural part by electro-deposition. Included in the 32-page manual are chapters on what the electroforming process is, where it is used, "do's and don'ts" for designers, and charts and tables of engineering data. Allied Record Manufacturing Co., Allied Research & Engineering Div., 6916 Santa Monica Blvd., Los Angeles 38, Calif.

Potentiometer 347

Specifications of the model 215 potentiometer appear in this two-page data sheet. The component comes in three terminal configurations: stranded teflon insulated leads, solder lugs, and printed circuit pins. Standard resistances, specifications, and dimensions are given in the bulletin. Bourns, Inc., Trimpot Div., Box 2112, Riverside, Calif.

Variable Resistors 348

Type 2W wirewound variable resistors are described in four-page bulletin No. A-3b. Dimensional drawings, electrical and mechanical specifications, L and T pad controls and performance specifications, and a table of standards for flatted and slotted shafts are included. CTS of Asheville, Inc., Skyland, N.C.

Silicon Zener Diodes 349

Bulletin No. SR-260 presents a listing of silicon Zener diodes in standard RETMA decade listings. Included is the complete tabulation of 5%, 10%, and 20% standard tolerance types currently available. The bulletin, six pages, contains dimension drawings, derating of power dissipation vs ambient temperature graphs, and typical reverse voltage characteristics graph. Zener diode substitution boxes and voltage reference packs are illustrated. International Rectifier Corp., Product Information Dept., 1521 E. Grand Ave., El Segundo, Calif.

Available now!

THE NEW TELREX CATALOG AND TECHNICAL DATA BOOK

See us at Booth 1317 Radio Engineering Show!

Reserve your copy!
Just write us on your company letterhead; your free copy will be sent as soon as available. Please address requests to Dept. TC.

A veritable handbook on antennas and systems everyone in communications, commercial or military, will find informative and helpful. Complete information on everything from antennas and towers to rotation and indication systems.

ANTENNAS SINCE 1921
Communication and TV Antennas
telrex LABORATORIES
ASBURY PARK 41, NEW JERSEY, U.S.A.
CIRCLE 350 ON READER-SERVICE CARD

Plastics 711

This 16-page booklet outlines properties, applications, and availabilities of plastic mill shapes and machined parts, tubing and hose, sintered plastic parts, molding resins, and coating materials. The Polymer Corp., 2120 Fairmont Ave., Reading, Pa.

Rectifier Analyzer 712

Model 141A rectifier analyzer, a 20-amp test set with forward current and reverse voltage independently adjustable, is described and illustrated in data sheet No. 106, two pages. Specifications and performance curves are included. Wallson Assoc., Inc., 912-914 Westfield Ave., Elizabeth, N.J.

PDM Telemetry 713

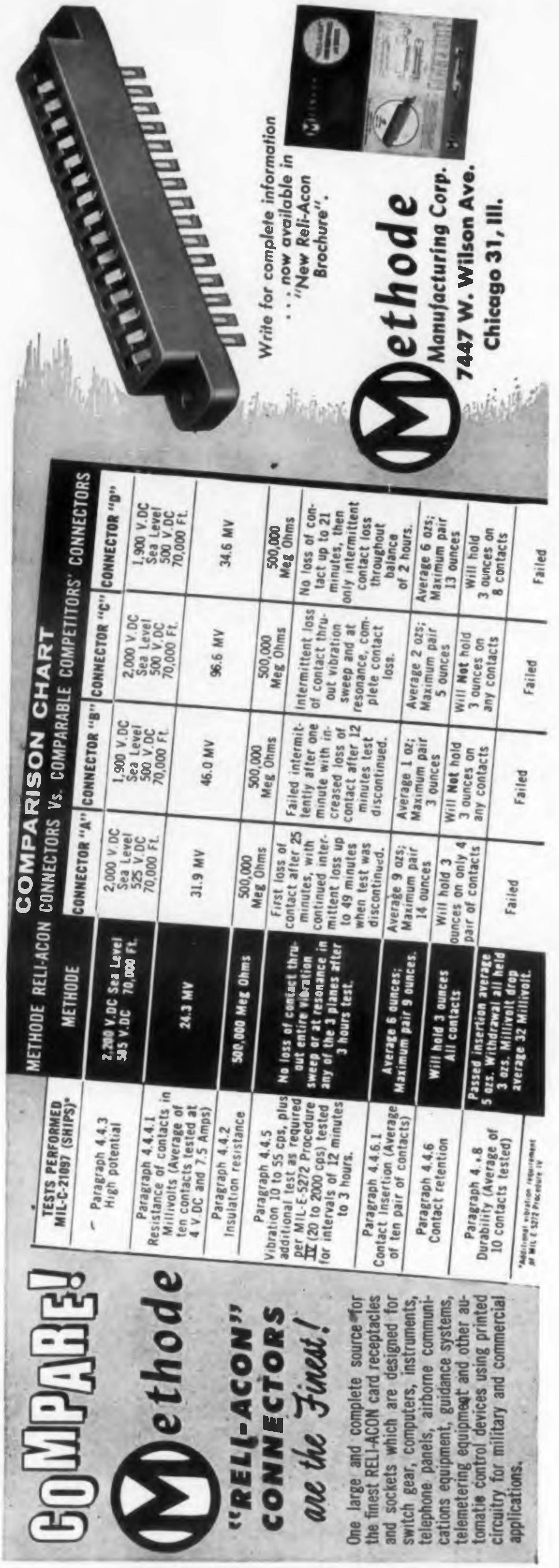
This 12-page, two-color illustrated brochure, No. 935, describes a commutator, transistorized pulse-width modulator, and crystal-stabilized transmitter designed for airborne PDM telemetry systems. The brochure includes detailed electrical, environmental, and physical characteristics in addition to outline drawings. Tele-Dynamics Inc., 5000 Parkside Ave., Philadelphia 31, Pa.

Coating Machine 714

Model HD-2, an automatic spray coater, is described and illustrated in this two-page data sheet. The machine applies a continuous coating of resinuous compositions, such as epoxy compounds, to electrical and electronic components having coaxial leads. Conforming Matrix Corp., 476 Toledo Factories Bldg., Toledo 2, Ohio.

Molded and Laminated Plastics 715

Insurok molded and laminated plastic sheets, rods, tubes, and fabricated parts are covered in this eight-page catalog, No. 20.000.13. Tables list physical, electrical, and mechanical properties, in addition to bonding strength, suggested uses, and general characteristics. Photographs illustrate the materials as used for printed circuitry and electronic components. The Richardson Co., 2731 Lake St., Melrose Park, Ill.



COMPARE!

Methode

"RELI-ACON" CONNECTORS are the Finest!

One large and complete source for the finest RELI-ACON card receptacles and sockets which are designed for switch gear, computers, instruments, telephone panels, airborne communications equipment, guidance systems, telemetering equipment and other automatic control devices using printed circuitry for military and commercial applications.

COMPARISON CHART
METHODE RELI-ACON CONNECTORS Vs. COMPARABLE COMPETITORS' CONNECTORS

TESTS PERFORMED MIL-C-21097 (SHIPS)*	METHODE	CONNECTOR "A"	CONNECTOR "B"	CONNECTOR "C"	CONNECTOR "D"
Paragraph 4.4.3 High potential	2,200 V.DC Sea Level 585 V.DC 70,000 Ft.	2,000 V.DC Sea Level 525 V.DC 70,000 Ft.	1,900 V.DC Sea Level 500 V.DC 70,000 Ft.	2,000 V.DC Sea Level 500 V.DC 70,000 Ft.	1,900 V.DC Sea Level 500 V.DC 70,000 Ft.
Paragraph 4.4.4.1 Resistance of contacts in Millivolts (Average of ten contacts tested at 4 V.DC and 7.5 Amps)	24.3 MV	31.9 MV	46.0 MV	96.6 MV	34.6 MV
Paragraph 4.4.2 Insulation resistance	500,000 Meg Ohms	500,000 Meg Ohms	500,000 Meg Ohms	500,000 Meg Ohms	500,000 Meg Ohms
Paragraph 4.4.5 Vibration 10 to 55 cps, plus additional test as required per MIL-E-5272 Procedure IV (20 to 2000 cps) tested for intervals of 12 minutes to 3 hours.	No loss of contact thru-out entire vibration sweep or at resonance in any of the 3 planes after 3 hours test.	First loss of contact after 25 minutes, with continued intermittent loss up to 49 minutes when test was discontinued.	Failed intermittently after one minute with increased loss of contact after 12 minutes test discontinued.	Intermittent loss of contact thru-out vibration sweep and at resonance, complete contact loss.	No loss of contact up to 21 minutes, then only intermittent contact loss throughout balance of 2 hours.
Paragraph 4.4.6.1 Contact Insertion (Average of ten pair of contacts)	Average 6 ounces; Maximum pair 9 ounces.	Average 9 ozs; Maximum pair 14 ounces	Average 1 oz; Maximum pair 3 ounces	Average 2 ozs; Maximum pair 5 ounces	Average 6 ozs; Maximum pair 13 ounces
Paragraph 4.4.6 Contact retention	Will hold 3 ounces All contacts	Will hold 3 ounces on only 4 pair of contacts	Will **Not** hold 3 ounces on any contacts	Will **Not** hold 3 ounces on any contacts	Will hold 3 ounces on 8 contacts
Paragraph 4. .8 Durability (Average of 10 contacts tested)	Passed insertion average 5 ozs. Withdrawal all held 3 ozs. Millivolt drop average 32 Millivolt.	Failed	Failed	Failed	Failed

*Additional vibration requirement of MIL E 5272 Procedure IV

Write for complete information . . . now available in "New Reli-Acon Brochure".

Methode
Manufacturing Corp.
7447 W. Wilson Ave.
Chicago 31, Ill.

CIRCLE 718 ON READER-SERVICE CARD

Dynamotor Power Source Supplies Low Voltage, High Current

SEVERAL amperes of well-filtered dc power with a continuously variable output voltage can be obtained from a dc conversion generator, or dynamotor. Such an energy source is very useful when working with power transistor circuitry or servo amplifiers.

An examination of one of these dynamotors, Fig. 1, reveals that the field is excited in shunt with the low-voltage armature winding. Thus, when power is applied in the normal fashion to the machine, the field is automatically excited. The high-voltage armature winding provides the output.

By reversing the direction of power flow, it is possible to obtain an output from the low-voltage winding. Excitation is obtained from a high-voltage supply, as shown in Fig. 2. Because the field structure is common to both armature windings, the ratio of voltages developed is determined entirely by the ratio of active conductors in these

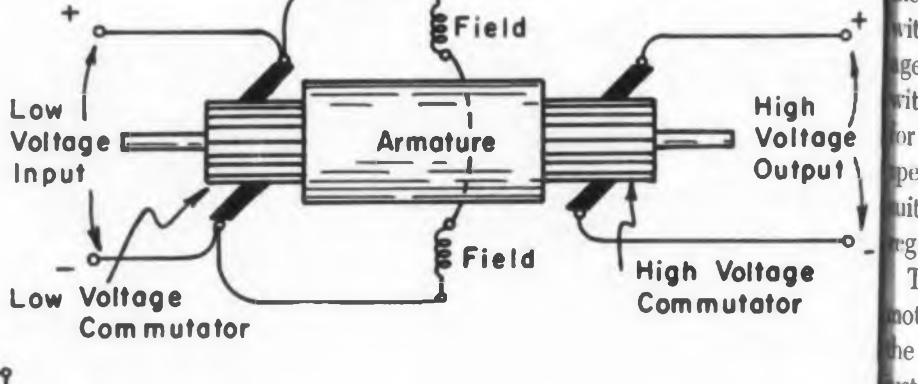


Fig. 1. In normal dynamotor operation, a low-voltage, high-current input is converted to a high-voltage, low-current output.

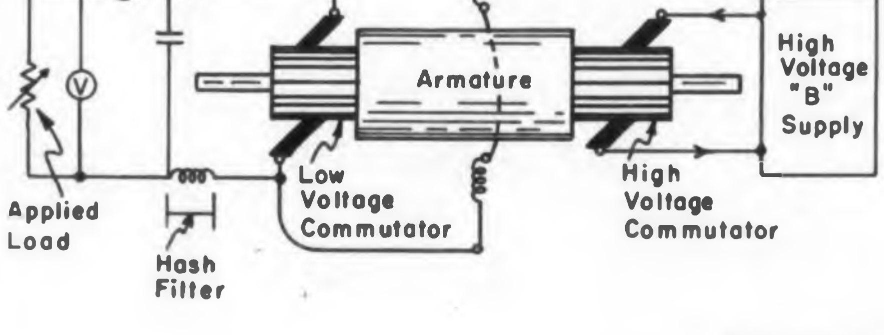


Fig. 2. Operated in reverse, the dynamotor supplies a low-voltage, high-current load from a standard high-voltage power supply.

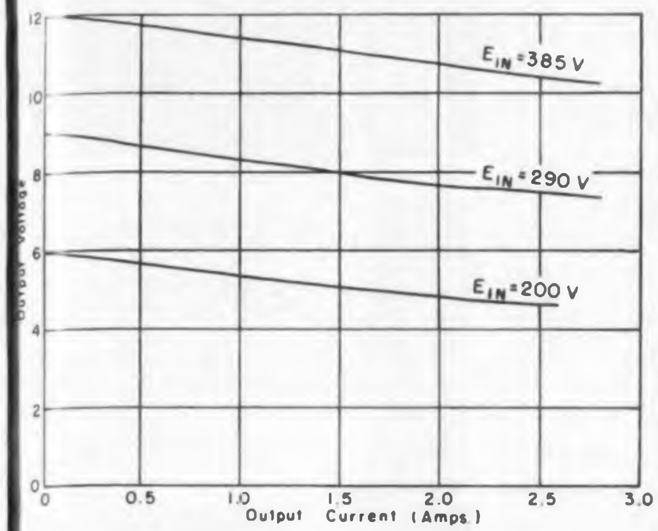


Fig. 3. The regulation curves for a reverse operated dynamotor, connected as in Fig. 2.

windings. It is virtually independent of the field current. However, the field current determines the motor torque and speed. In general, high field current is associated with low armature speed and vice versa. Residual magnetism in the steel poles insures that the motor is self-starting.

Used as shown in Fig. 2, the dynamotors do not have their full rated power handling capacity. This is because additional power must be supplied to account for the inefficiency of the machine. Despite the reduced rating, sufficient output can still be obtained to make the reverse method of operation useful.

Fig. 3 shows the results of such operation. The motor used was manufactured by Eicore. It was rated at 14 v, 6.4 amp input, 330 v, 150 ma output. With the rated high-voltage current of 150 ma, only about 3 amp could be drained from the low-voltage end, illustrating the unit's reduced power handling capability.

Because of internal resistance in the machine, the output voltage falls off practically linearly with increased load. In each case, the output voltage level was set by adjusting the output varies with load, it was found to be satisfactorily constant for the current range needed. If more stringent specifications were imposed on the regulation, a suitable feedback circuit could be designed to regulate the output.

There are several advantages in using a dynamotor to obtain the low-voltage energy. First, the output voltage can be easily varied by adjusting the level of the dc voltage applied to the high-voltage commutator. Second, because the ac component appearing in the output is mostly high frequency ripple, filtering is not difficult. The ripple can be reduced to a low level with a simple ash filter. Also, because only commonly available items are used, this low-voltage source is relatively inexpensive and easily built.

Jack Bacon, Ohio State University, Columbus, Ohio.

ELECTROMAGNETIC & MAGNETOSTRICTIVE
Fixed, Tapped and Variable
DELAY LINES
AUDIO, HIGH FREQUENCY
AND MICROWAVE
FILTERS

YOUR COMPLETE SOURCE FOR DELAY LINES, FILTERS AND ASSOCIATED CIRCUITRY.


Variable Magnetostrictive Delay: 2 to 500 μsecs


Variable, Lumped Constant Rectilinear Delay: 0 to 20 μsecs.


Variable, rotary commutating. Delay: 0 to 3 μsecs

C.E.C. offers special delay lines, delay systems and integrated engineering services to customer requirements. Engineering services have been rendered for: remote controlled delay systems; delay line-amplifier combinations, motor commutated, ruggedized variable delay lines; microwave delay lines; lines matched to high simularity; very high delay accuracies, variable lines with non-linear taper and highly miniaturized printed circuit lines.

AUDIO, HIGH FREQUENCY AND MICROWAVE FILTERS

C.E.C.'s Filter Engineering Dept. offers standard and special design filters to customers requirements. This includes special variations in passband width, impedance, frequency response and attenuation to meet the required specifications. C.E.C. covers the entire spectrum from the audio frequencies through the microwave region, with low, high, bandpass, and RF filters.


Audio Bandpass f_c 1.05 kcs to 52.6 kcs


Microwave Bandpass f_c 9 kmc

See us at IRE Show, Booth 1902

ENGINEERS: Your career starts on a higher platform at C.E.C.

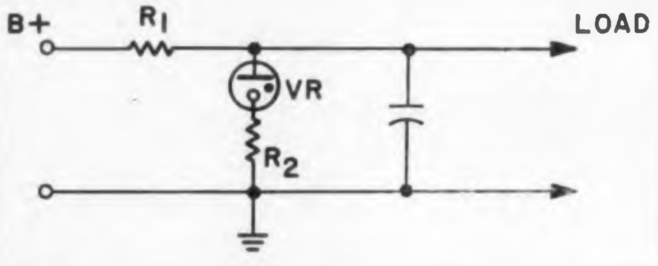
CONTROL ELECTRONICS CO., INC.
Ten Stepar Place, Huntington Station, New York

CIRCLE 720 ON READER-SERVICE CARD

Eliminating VR Tube Oscillations

In a plate supply filter it is sometimes necessary to use a VR tube regulator shunted by a large capacitor. The capacitor is required because pulses of energy may be desired, as in a thyratron circuit, which cannot be supplied through the VR tube dropping resistor, R_1. However, since a VR tube and shunt capacitor form a relaxation oscillator, it is often assumed these cannot be used in parallel.

The relaxation oscillations occur because the VR tube, especially at low currents, has a small equivalent series resistance. The oscillations are eliminated by inserting a resistor R_2 in series with the VR tube sufficient to off-set the negative resistance component. In practice, this resistance, which actually may improve the regulation, is usually about 100 ohms. It is preferable, however, to use about twice the minimum resistance required and to raise the VR current by lowering the series dropping resistor.



Lawrence G. Cowles, Electronic Design Engineer, The Superior Oil Co., Bellaire, Tex.

Low-Level Signal Gate Circuit Relies On Diode Conduction Potential

A null bucking configuration and diode clamping circuit provide a gate which will not pass low-level signals or noise, but which will pass higher-level signals virtually undisturbed. Since this method does not use vacuum tubes, or additional batteries, it is especially useful for transistor applications.

The circuit operation is illustrated in Fig. 1. The signal is impressed on the transformer primary. The secondary windings are bucking each

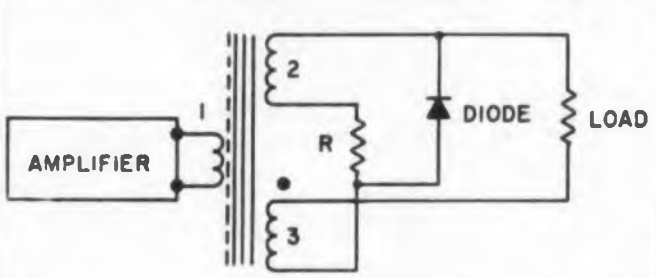


Fig. 1. Signals, or noise, below the diode conduction potential will not be passed to the load because of the bucking action of the transformer secondary windings.

ONE IN A SER

Bendix
Craftsmanship
at work for you

New Bendix
BACKWARD-WAVE
OSCILLATOR TUBES
OPERATE IN
FREQUENCIES
FROM 40 KMC/S
TO 75 KMC/S

The new line of Bendix® Backward-Wave Oscillator Tubes generates microwave energy at extremely high frequencies never before available.

These new tubes provide a wide range of usable frequencies for applications in: advanced types of multichannel telephone and television systems, high definition short-range radar, highly directive communications, microwave spectroscopy and other fields where low power voltage-tuned millimeter wave-length radio frequency energy is required.

For more detailed information on these tubes, write to: ELECTRON TUBE PRODUCTS, RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, N. J.

MECHANICAL DATA

Output Flange	Special adapter to RG-98 U (RG-97/U for TE-75
Maximum Diameter	0.625"
Length	8"
Mounting Position	Any
Weight	5 oz.*

*Without magnet (tube only). Magnet are available.

Available types
Type TE-75 with frequenc range of 40 Kmc to 50 Km
Type TE-67 with frequenc range of 49 Kmc to 59 Km
Type TE-66 with frequenc range of 61 Kmc to 71 Km
Type TE-71 with frequenc range of 65 Kmc to 75 Km

VISIT US AT THE N.Y. IRE SHOW BOOTH 2228

ELECTRON TUBE PRODUCTS
Red Bank Division
Bendix

West Coast Sales & Service: 117 E. Providencia Ave Burbank, Calif. • Export Sales & Service: Bend International Division, 205 E. 42nd St., New York 17 N. Y. • Canadian Distributor: Computing Devices Canada, Ltd., P. O. Box 508, Ottawa 4, Ontar

CIRCLE 721 ON READER-SERVICE CARD

ALWAYS A WINNING HAND—WHEN YOU SPECIFY

C-A-C

"POKER CHIPS"

Epoxy cast units resulting from C-A-C design engineering:

SATURABLE REACTORS
Pulse transformers;
DC to DC converters
400 cycle power transformers.

Can be subminiaturized within performance limits. Terminal arrangements to meet requirements. Mil. Specs. Fast Delivery.

Send us your specifications for quotations and/or engineering advice.

See us at the IRE Booth 2809-2811

C-A-C

304

COMMUNICATION ACCESSORIES COMPANY
LEE'S SUMMIT, MISSOURI

CIRCLE 722 ON READER-SERVICE CARD

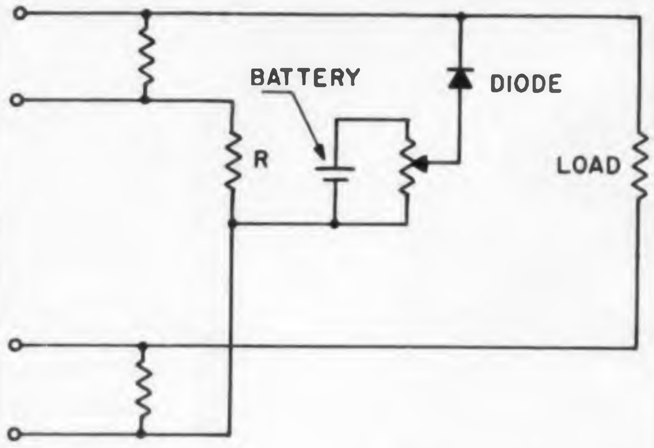


Fig. 2. Low-level gating can be obtained with resistive coupling and a battery to vary the clamping potential.

other and the diode acts to set a clamping action across the winding 2. Resistor *R* develops the clamping voltage across the diode and limits the current flow through it. Low-level signals, or noise, below the diode conducting voltage cause no clamping action. The signal potentials generated in coils 2 and 3 cancel so that no potential difference appears at the load. As the signal level is increased above the level of the diode forward voltage drop, diode current flows through resistor *R* on the positive segment of the signal. This causes an unbalance in signal between transformer coils 2 and 3 and a half wave rectified signal appears at the load, proportional to the signal amplitude. A sine-wave load signal can be obtained by placing a second diode in parallel, but reversed, across the diode shown. The clamping potential can be varied by selection of the type of diode, by adding diodes in series or, if an exact value is required, by the addition of a potentiometer and battery in series with the diode.

Fig. 2 illustrates a biasing circuit using resistive coupling. Two clamping diodes and potentials as described will allow a satisfactory sine-wave output, although the cross-over section of the sine-wave will be missing.

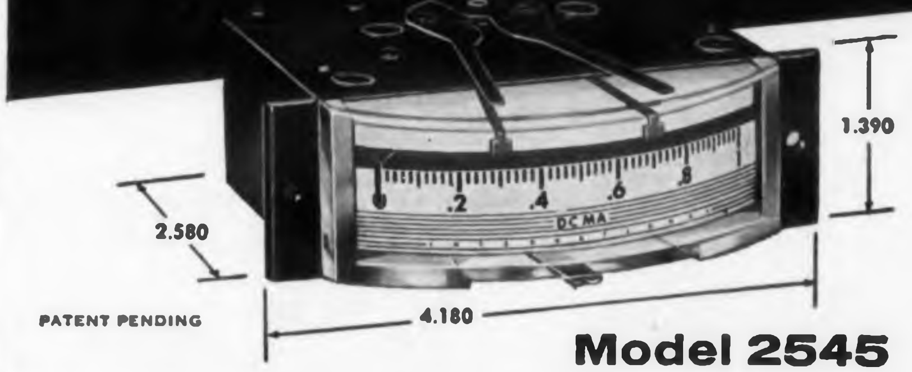
Metallic diodes are recommended in this circuit but vacuum-tube diodes will function if the Edison current through resistor *R* is balanced out. For optimum performance, resistor *R* should have the same impedance as the secondary winding. However the resistance value is not critical. Electrostatic shielding between windings is desirable.

The complete details of these circuits can be obtained by referring to patent number 2,867,735 issued January 6, 1959.

Edwin N. Kaufman, Litton Industries, Beverly Hills, Calif.

Don't miss an issue of ELECTRONIC DESIGN; return your renewal card today.

NEW ELECTRONIC CONTROL METER



PATENT PENDING

Model 2545

Operates WITHOUT Contacts at the Switching Points!

Offering You these Important Advantages:—

- **ONLY MINIATURIZED CONTROL METER** . . . now available without contacts.
- **MORE RELIABLE SWITCHING** . . . with elimination of contact resistance, arcing and corrosion. Signal does not depend on pointer contact.
- **FULL-SCALE USE** . . . of indicating meter always available, regardless of control point settings.
- **MORE ACCURATE READINGS** . . . with indicating circuit completely isolated from the switching circuit.
- **SIMPLEST SYSTEM** . . . with no need for pull-in or locking coils and no re-set mechanism.
- **EXTERNAL ZERO ADJUSTER**

for Applications like these--

- Automatic Process Control
- Missile Check-out
- Nuclear Instrumentation
- Machine Tool Control

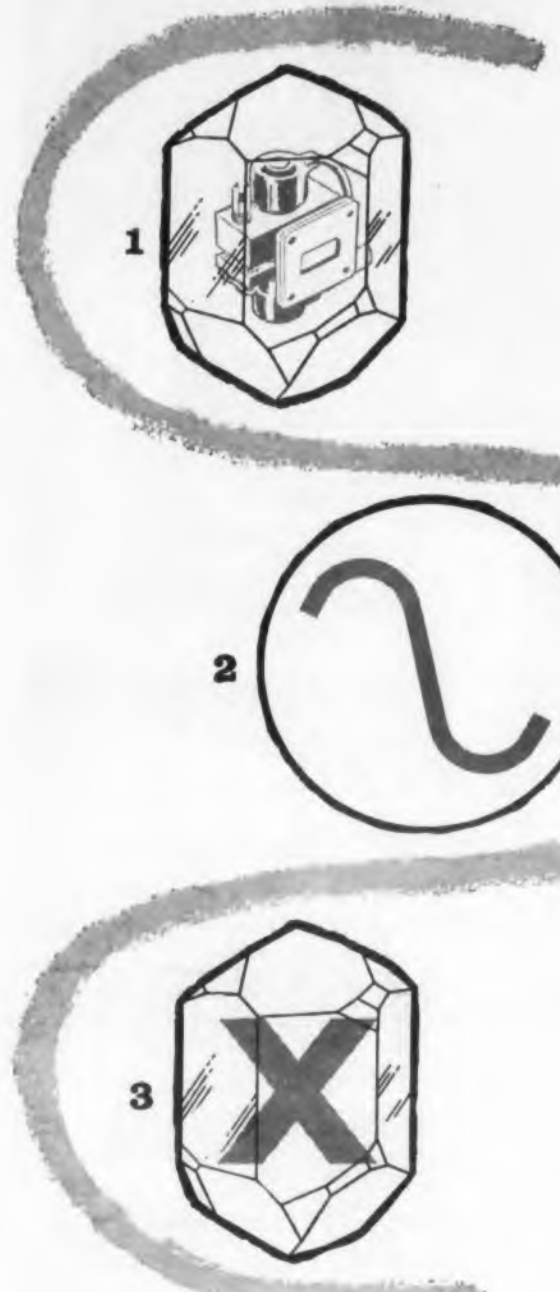
SEE THE NEW MODEL 2546 CONTROL METER AT THE IRE SHOW BOOTH NO. 2813

Switching is accomplished by a metal shield attached to the pointer passing between 2 mutually coupled coils of a self-contained, transistorized oscillator-detector-amplifier. Positions of the 2 control points are manually set by means of external arms. Provides the same scale length as conventional 4½" meters. Accuracy held to ±2% of full-scale for dc and ±5% for ac.

Write **FOR ENGINEERING DATA SHEETS ON ELECTRONIC CONTROL METER AND:** Side Indicators; 1½" Ruggedized Meters; 1" and 1½" Panel Meters; 1½" VU, and Db Meters; Sub-Miniature Rotary and Lever Switches; Miniature Multitesters.

MINIATURIZATION HEADQUARTERS
international instruments
INCORPORATED
P.O. BOX 2954, NEW HAVEN 15, CONN. • Cable: "INTERINST"

CIRCLE 723 ON READER-SERVICE CARD



IDEAS FOR DESIGN

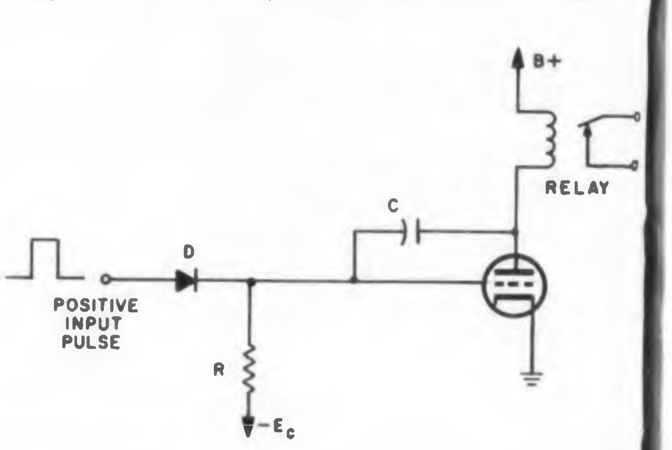
Miller Effect Extends Relay Close Time

Use was made of the Miller effect to provide an extended time delay in a relay circuit.

A relay had to be closed, without any delay, by a positive pulse. The relay was to remain closed for an extended time. For long close times, very large values for resistance and capacitance were required when conventional RC timing circuits were considered.

In the circuit shown, the tube is held cut-off by the bias voltage $-E_c$. A positive input pulse charges capacitor C_1; the tube conducts and closes the relay. The relay remains closed until the capacitor C discharges through R. However, the Miller effect has increased the effective capacity by a factor of $1 + A$, where A is the amplifier gain. This serves to extend the relay close time, and allows the use of comparatively smaller RC values.

Richard Steinberg, Member of the Technical Staff, Hughes Aircraft Co., Culver City, Calif.

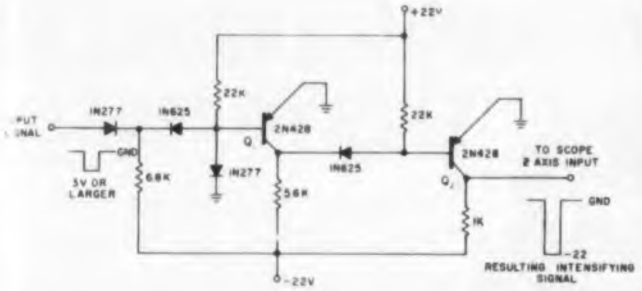


Miller effect is used to increase RC time constant and extend relay close time.

Logic Signal Intensifies Scope Display

During check-out of a digital computing system, it became necessary to intensify the oscilloscope display at a particular logical time in order to pinpoint the location of certain data.

The circuit shown, when connected to the scope's Z axis input, used computer derived logical signals to intensify the scope display. The intensifying signal I requires a negative pulse of 3-v amplitude or greater, referenced to ground. It is applied to the input diode of the inverter amplifier C_1. Previously cut-off, Q_1 suddenly saturates, causing inverter stage Q_2 to cut-off. The collector



Logical pulse is applied at the input of the intensifying circuit which drives the Z axis input.

(output voltage of Q_2, previously at zero, drops to −22 v causing the scope display intensity to increase greatly. When the input signal returns to ground, the collector voltage of stage Q_2 returns to zero and the scope intensity returns to normal.

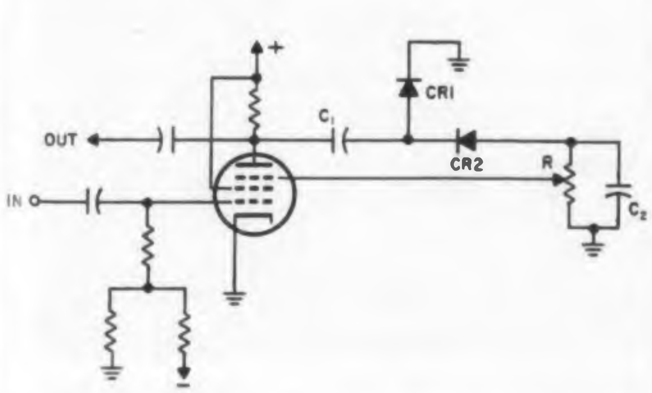
D. R. Shalita, Electronic Engineer, Litton Industries, Culver City, Calif.

Suppressor Grid Voltage Varied for Constant Amplitude Pulses

By feeding back a proportionate signal to the suppressor grid of a pentode, a pulse amplifier was designed whose output remained relatively constant as the input signal varied.

The signal of pulses is applied at the grid of the Class A operated pentode circuit shown in the accompanying figure. The tube can be a 6A56 or a type having a similar value of suppressor grid-to-plate transconductance. At the plate, the positive side of the amplified signal is clamped to ground by CR_1. It is then peak-detected to produce a negative voltage at the junction of R and C_2. This voltage is then tapped and fed to the suppressor grid. Since the suppressor grid voltage will vary directly with the plate signal, the gain of the tube will vary inversely with the control grid amplitude. This will tend to keep the output pulse-amplitude constant as the input-amplitude is varied.

Arthur M. Goldschmidt, Electronic Engineer, Moorestown, N. J.



Output amplitude is maintained constant by varying the negative suppressor grid voltage, thereby controlling the stage gain.

CIRCLE 725 ON READER-SERVICE CARD

6 good reasons for letting KNAPIC grow your Silicon Crystals

HIGHEST QUALITY
UNLIMITED PRODUCTION CAPACITY
LOWEST COST PER GRAM
NO CAPITAL INVESTMENT
NEW MATERIAL RESEARCH
SPECIFICATIONS TO ORDER

KNAPIC specializes in Silicon and Germanium Crystals for Semiconductor, Solar Cell and Infrared uses

Major manufacturers of semiconductor devices have found that Knapic Electro-Physics, Inc. can provide production quantities of highest quality silicon and germanium monocrystals far quicker, more economically, and to much tighter specifications than they can produce themselves.

The reason? Knapic Electro-Physics are *specialists* with accelerated experience in growing new materials to specification.

Why not let us grow your crystals too?

Dislocation density. Knapic silicon monocrystals grown by a modified Czochralski technique: Crystal diameter to ⅜"—None; ⅜" to ¾"—less than 10 per sq. cm.; ¾" to 1¼"—less than 100 per sq. cm.; 1½" to 2" less than 1000 per sq. cm.

Check These Advantages

☐ **Extremely** low dislocation densities.
☐ **Tight** horizontal and vertical resistivity tolerances.
☐ **Diameters** from ¼" to 2". Wt. to 250 grams per crystal. Individual crystal lengths to 10
☐ **Low Oxygen content** 1×10^{17} per cc., 1×10^{16} for special Knapic small diameter material.
☐ **Doping** subject to customer specification, usually boron for P type, phosphorous for N type.
☐ **Lifetimes:** 1 to 15 ohm cm.—over 50 microseconds; 15 to 100 ohm cm.—over 100 microseconds; 100 to 1000 ohm cm.—over 300 microseconds. Special Knapic small diameter material over 1000 microseconds.

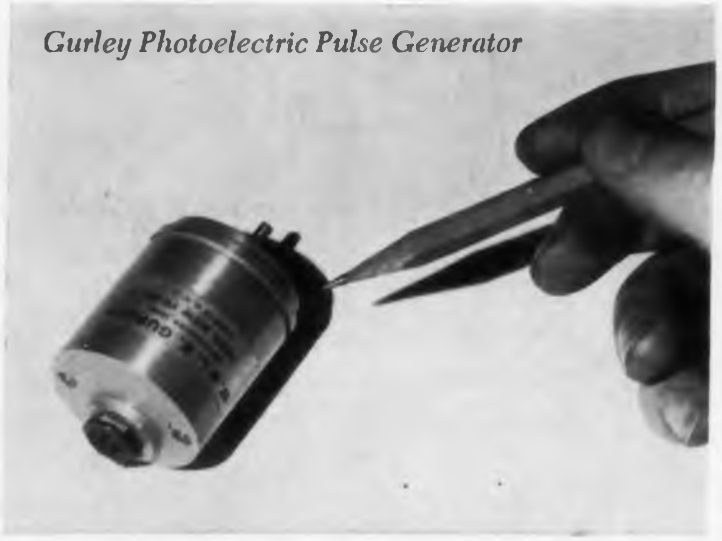
Knapic Electro-Physics, Inc.

936-938 Industrial Avenue, Palo Alto, California
Phone: DAvenport 1-5544

Specification Sheets Available

. . . Also manufacturer of large diameter silicon and germanium lenses and cut domes for infrared use

CIRCLE 726 ON READER-SERVICE CARD



Rate Generator or Angle Reader

Gurley Photoelectric Pulse Generator is a shaft-driven device delivering electrical pulses at output terminals ...Pulse frequency is directly proportional to shaft rpm ...*Two basic uses:* as a rate generator (output frequency may be read in terms of shaft rpm) or as an angle-measuring device ("total angle" is determined by "totalizing" individual pulses). Write for brochure.

W. & L. E. Gurley
525 Fulton Street, Troy, New York

CIRCLE 727 ON READER-SERVICE CARD

OCTAVE RF AMPLIFIERS
for Low Noise,
BROADBAND RECEIVING SYSTEMS

Useful in Radar systems requiring extremely wide bandwidths such as countermeasures, surveillance, high resolution and special communications equipment. Standard units available in octave bands from 40 to 600mc. Broad band units are available to 1000mc on request.

Typical Specifications:

Gain	30db
Ripple	<1/2db
VSWR Input	<1.5
Source, Load Impedances	50 ohms

Rack mounted with self contained power supply.

Send for comprehensive Microwave, IF, RF Amplifier Catalog.

LEL INC 380 OAK STREET, COPIAGUE, N. Y.

See us at the IRE Show—Booth 2102

CIRCLE 728 ON READER-SERVICE CARD

Mounting Stud Cast From Encapsulating Material

By casting a mounting stud as part of the encapsulating material, miniature transformers can be easily attached to printed-circuit boards. The material used must be sufficiently strong so that the stud, thread-casted, can be secured directly to the printed board with a nut and a lock washer.

The photo shows a transformer with its mounting stud, which has been cast in a split mold of Teflon. An epoxy resin was used as the encapsulating material. The transformer cavity in the Teflon was cylindrical, slightly larger in diameter than the stud. The stud cavity was drilled and tapped in the bottom of the larger cavity. The greater diameter of the transformer material enabled it to act as a collar when the transformer was mounted.

It was found that this mounting method could withstand considerable shock and vibration. Important, also, was the ease with which the mounting stud could be fabricated.

R. J. Allen, Advanced Design Engineer, The Martin Co., Baltimore, Md.

Miniature transformer is cast in a split Teflon-core with threaded mounting stud as part of encapsulating material.

Photostats Yield Clear Scope-Trace Copies

Here is an accurate, inexpensive method for reproducing Polaroid oscilloscope photos in the limited quantities usually needed for engineering reports.

1. Photos are trimmed.
2. Photos are mounted on a sheet of 8 1/2 x 11 black paper in the desired layout.
3. Titles, numbers, etc., are lettered on the paper with white ink, or
4. Alternatively, titles are typed on strips of white paper and pasted in place.
5. Photostats of the paste-up are made in the desired quantity. The paste-up is then filed with the master copy of the report.

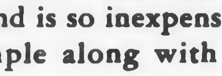
This process yields beautiful, black scope traces

ELECTRONIC ENGINEERS EVERYWHERE!

● Heed a colleague who never did, and ask for your FREE MUELLER CATALOG of ELECTRIC CLIPS AND INSULATORS. Do it today, while you're still young! You'll make better connections in the future, with this handy illustrated index of electric clips for every type of quick test connection.

We've been making newer and better clips since 1908 and recently designed the world's only truly miniaturized test clip. It's called the "Mini-gator", and is so inexpensive we'll send you a free sample along with the catalog.

THE "MINI-GATOR"



Shown actual size

WRITE FACTORY—FREE "MINI-GATOR" AND CATALOG

Mueller Electric Co.
1580H EAST 31st STREET • CLEVELAND 14, OHIO

CIRCLE 729 ON READER-SERVICE CARD

If You Want a Thermostat That's Rugged...

that operates dependably at settings as low as −40°F. and as high as +300°F....

G-V's C8 Series of hermetically sealed electrical thermostats is specially designed to meet the difficult operating conditions of electronic and aircraft applications. Operating points, regardless of settings, are not changed by exposure to temperatures ranging from −100°F. to +300°F. Shocks up to 150g for 3 milliseconds, vibration of 25g up to 1000 cps, and vibration of 10g up to 2000 cps do not damage these thermostats nor change their setting.

Write for complete technical and application data

G-V **G-V CONTROLS INC.**
LIVINGSTON, NEW JERSEY

CIRCLE 730 ON READER-SERVICE CARD

on white paper. They are easy to read and certainly make for a neat, good looking report.

George D. Curtis, Project Engineer, Chance Vought Aircraft, San Diego, Calif.

Rubber-Core Terminals Hold Wires Securely

Clamp-on, screw-on or other metal-to-metal terminals for fast, temporary connections can cause trouble when the wires to be clamped are of difficult diameter. Often the larger wire springs open the holding device. Used on breadboards, such clips or screw terminals may be susceptible to vibration or shock.

With a new terminal consisting of a gold plated eyelet and rubber core, wires of different diameters are gripped firmly. To insert a component lead, the rubber core is stretched upward, leaving space to slip the wire against the side of the eyelet. Releasing the core presses the wire firmly against the gold-plated surface. Vibration and shock immunity are exceptionally good.

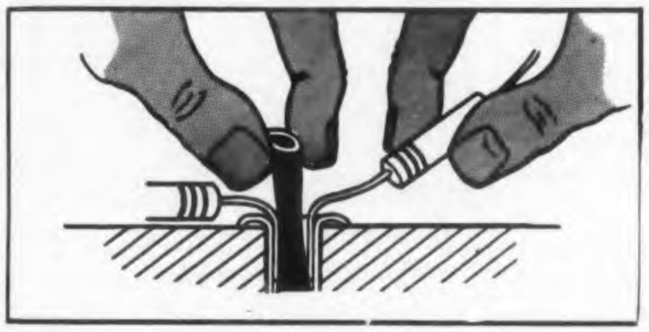


Fig. 1. By stretching the rubber core, different diameter wires are inserted and gripped firmly in this interesting terminal design.

Fig. 2. The terminal cells are shown supporting different wires on a breadboard layout. Wires are easily inserted with no soldering or screw-turning required.

E. L. Van Deusen, Plastic Associates, Laguna Beach, Calif.

MORE CAPACITANCE, LESS WEIGHT — Combined volume of 40 TES Capacitors equals that of large paper capacitor which far outweighs them. But combined capacitance of TES capacitors is 24,000 microfarads to only 4 for paper capacitor.

FOR FULL DETAILS on TES plug-in or other types of tantalum capacitors, write Tansitor Electronics, Inc., Dept. 11, West Road, Bennington, Vermont.

NEW TANSITOR TANTALUM CAPACITORS PROVIDE MORE CAPACITANCE, LESS WEIGHT

Both leads of these new TANSITOR TES-type capacitors emerge from one end. So, only one seal is required, with consequent savings in length.

Welded leads are completely encapsulated too. Hence, soldering can be done close to the end of the capacitor without damaging the welds. Space savings up to 50% are thus possible.

Applications? Printed and transistorized circuits for miniaturized military or commercial electronic equipment are typical.

CHARACTERISTICS

Operate at surge temperatures up to 125C
with some voltage derating.

- Polar or non-polar
- Plain or etched foil
- Neutral electrolyte
- Low leakage current
- Long shelf life

TANSITOR
ELECTRONICS INCORPORATED
Where Reliability Comes First
Tantalum Capacitors

TANSITOR DISTRIBUTORS

Electronics Center, Inc.
211 West 19th St.
New York 11, N. Y.
AL 5-4600

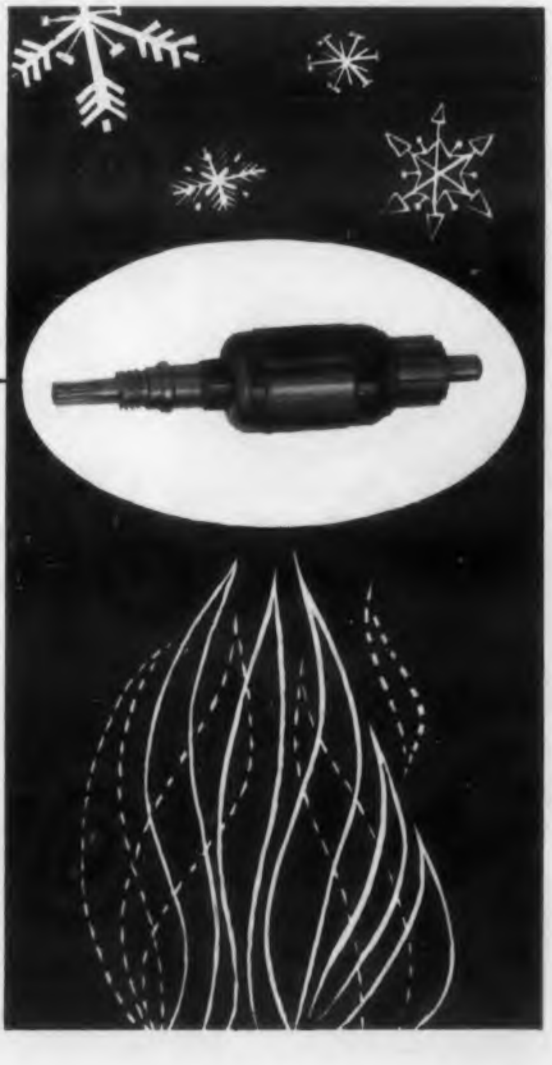
Peerless
Radio Distributors Inc.
92-93 Merrick Road
Jamaica 33, N. Y.
RE 9-6080

CIRCLE 731 ON READER-SERVICE CARD

furane's

EPOXY SOLVENTLESS VARNISHES

. . . for Impregnating
Motors, Transformers and Wire-Wound Devices



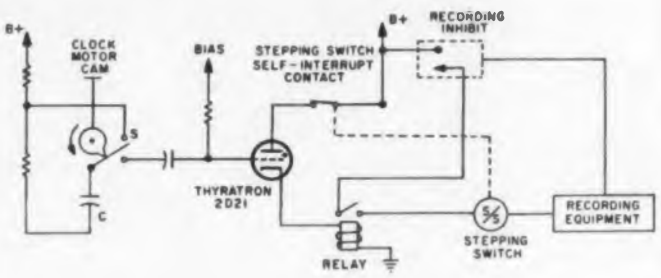
Resistant to acids, JP fuels and Skydrol, Furane's Epoxy Solventless Varnishes are outstanding dielectric materials that penetrate and insulate. Dimensionally stable, 100% solid Varnishes 3-A and 3-B aid in eliminating fire hazards and allow motors to operate at lower temperatures, with resultant greater efficiency, economy and long life.

Low initial viscosity, ability to gel readily at 150° - 200°F., and a pot life of approximately 30 days make Furane's Solventless Varnishes easy and economical to use. Approved on MIL Specs, they have outstanding resistance to both thermal and mechanical shock.

For concise technical information on these and other Furane Epoxies, call or write for **Electrical and Physical Properties Chart.** On special problems, request our **Application Questionnaire** for an exact solution.

furane plastics, INCORPORATED
DEPT. EO 4516 BRAZIL STREET • LOS ANGELES 39, CALIF. • CHapman 5-1151
Visit our I. R. E. Show booth — #4050

CIRCLE 732 ON READER-SERVICE CARD



Thyratron Delays Digital Clock Pulse

A digital data recording system made use of motor generated clock pulses to advance a stepping switch. While data was actually being recorded, any clock pulse which might appear was not to be passed on to the switch. The circuit shown allows the stepping switch to advance one step per clock motor revolution, but delays its advance until a recording interval is completed.

When the clock motor cam closes switch *S*, the charged capacitor *C* discharges and fires the cut-off thyratron. Firing the thyratron energizes the relay. When data is not being recorded, B+ is fed through the closed recording-inhibit contacts (activated by other circuitry), but the closed relay contacts, to the stepping switch magnet. The energized stepping switch opens the self-interrupt contacts, extinguishing the thyratron and resetting the relay. Thus, for every clock pulse, the stepping switch is moved one position.

While data is being recorded, the recording-inhibit contacts are opened. If a clock pulse then appears, the thyratron continues to conduct until the recording cycle is completed. When the recording-inhibit contacts close, the stepping switch will advance one step. In effect, the clock pulse has been delayed for the remaining interval of the recording cycle.

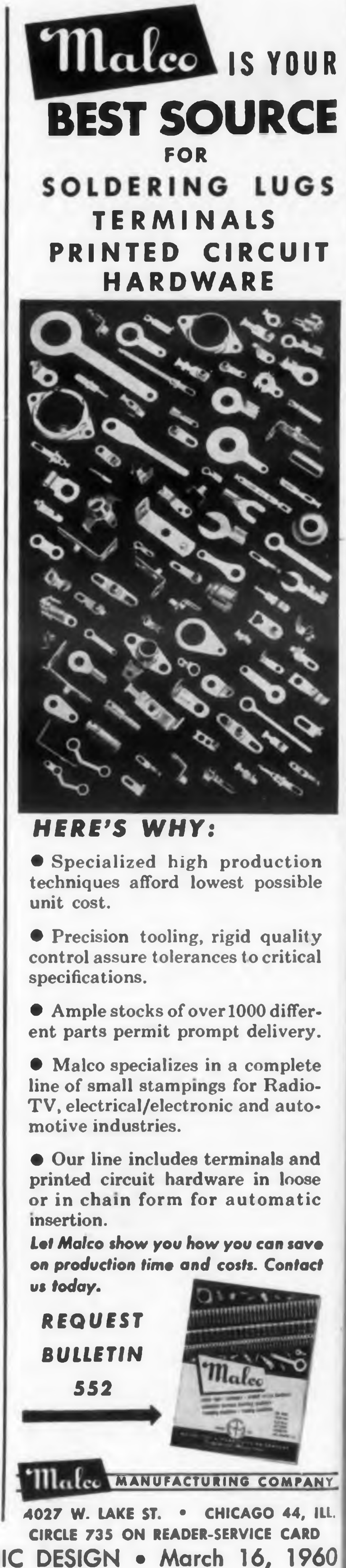
The circuit is reliable enough to maintain the clock to the last whole digit of time, provided the recording interval is less than the clock motor period.

Joseph Piskor, Research Engineer, United Aircraft Research, Hartford, Conn.

Sponge Provides Flexible Short

An inexpensive metal sponge was used to provide a conductive, flexible contact between two brass plates. With the sponge in place, one plate supports the other and is able to move relative to it. Also, an intimate electrical short is constantly maintained between the plates.

The sponge, normally used for household cleaning, is usually purchasable in the shape of a round pad. However, it can be cut to any size and it can be compressed as much as is necessary. Under

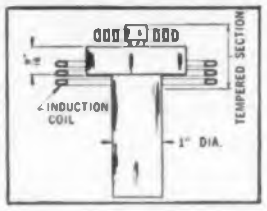


Lepel

HIGH FREQUENCY
INDUCTION
HEATING
UNITS

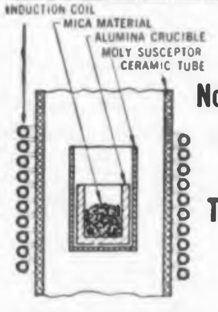
Lepel induction heating equipment represents the most advanced thought in the field of electronics . . . the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS



Punch Heads Selectively Tempered

Diagram shows arrangement for selectively tempering heads of alloy steel punches. The use of a combination type solenoid and pancake induction coil reduces hardness from Rc 55/56 to Rc 41/44, improving resistance to brittle fracture at the head of the punch. In this case a heating cycle of 55 seconds provides uniform tempering. A multiple position fixture, processing 4 pieces at one time, speeds up production.



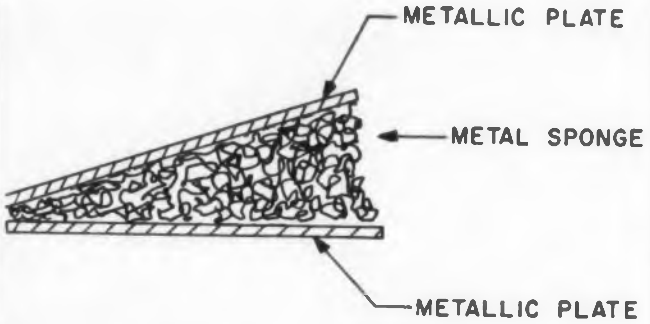
Heating Non-Conducting Materials To High Temperatures

Laboratory analyses frequently require heating of non-conducting materials to temperatures of 3,000 to 3,500° F. in vacuum or special atmosphere. This can be accomplished by induction heating with the aid of a metal susceptor. Diagram shows the fusion of mica samples in an alumina crucible, using molybdenum susceptor. A ceramic tube surrounding the susceptor isolates the work for fusion in a vacuum. The molybdenum susceptor is heated by induction, which in turn, heats the crucible by radiation.

WRITE FOR NEW LEPEL CATALOG
Electronic Tube Generators from 1 Kw to 100 Kw.
Spark Gap Converters from 2 Kw to 30 Kw.

Lepel HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.

CIRCLE 736 ON READER-SERVICE CARD



A metal household cleaning sponge provides an intimate, flexible short between two metal plates.

sufficient pressure no measurable electrical resistance could be observed.

Alfred W. Zinn, Engineer, Farrand Optical Co., Inc., Bronx, N.Y.

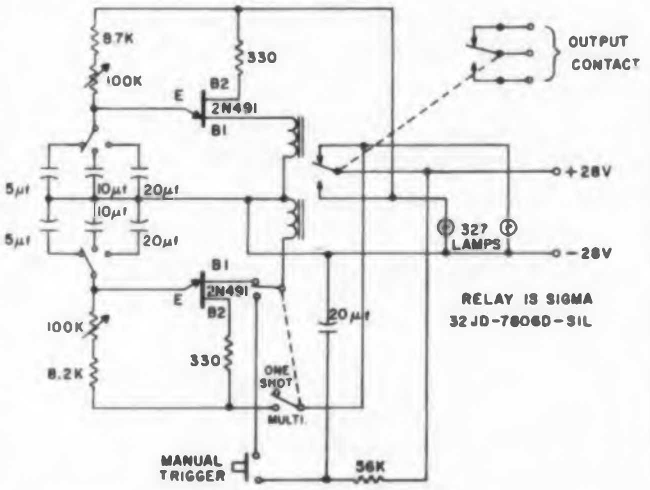
LF Multivibrator Uses Unijunction Transistors

A source of repeating contact closures in the range of 1/10 pulse per second to 10 pulses per second was required for life testing of arc suppressors for relays and stepper switches. It was desirable to vary the on-to-off ratio, and to manually actuate a single shot.

An electro-mechanical multivibrator was built, using RC timing and unijunction transistors to operate the relay. A magnetic latching relay was the bi-stable element.

In operation, the relay applies 28 v to the unijunction transistor and the RC charging circuit. When voltage builds up, as determined by the capacitor selected and the setting of the 100 K potentiometer, the unijunction transistor fires, transferring the relay to its other state. The same action takes place in the second unijunction circuit, causing transfer back to the original state.

For single shot operation, one unijunction circuit is replaced by a push-button, used to discharge a capacitor into the proper relay coil. This switches the relay and initiates the timing action of the remaining unijunction circuit.



Ernest F. Wilson, Senior Electrical Engineer, Edgerton, Germeshausen & Grier, Inc., Boston, Mass.

SIZE SAVINGS TO 75%

with Balco METALLIZED

(Hi-Temp) TEFLON* CAPACITORS

Size Reduction up to 4:1 Self clearing Properties

Balco Metallized Teflon* Capacitors show no performance deterioration when subjected to more than 1000 hours load-life at 200°C and 140% rated voltage.

TYPICAL PERFORMANCE CHARACTERISTICS

- Extended Temperature range available to 250°C
- Power Factor less than .0005 to 150°C
- Insulation Resistance greater than 10^{18} ohms to 125°C
- Capacitance Change less than 2% over repeated temperature cyclings from —70°C to 200°C
- Lowest Dielectric Absorption
- No Deterioration
- Long Life

TYPICAL SIZES AND RATINGS

MFD	HTM-4 (50 WVDC)	HTM-2 (200 WVDC)
	Dia. Length	Dia. Length
0.15	312 x 1-3/8	400 x 1-3/8
0.25	400 x 1-3/8	500 x 1-3/8
0.50	500 x 1-3/8	562 x 1-15/16
1.0	500 x 1-15/16	750 x 1-15/16

Our experience with manufacturing processes wherever capacitors are used are at your service. Contact us today.

*Trademark DuPont "Teflon" Tetrafluoethylene resin.

Balco CAPACITORS

Div. of BALCO Research Laboratories
49-53 EDISON PLACE, NEWARK 2, N. J.

See us at the I.R.E. Show Booth 2431

CIRCLE 737 ON READER-SERVICE CARD

For Economy AND Quality....

Opad TRANSISTOR REGULATED

POWER SUPPLIES

4 to 32 Volts DC

INPUT:
105-125 V. AC.
50/60 CPS.
single phase

AMPS	MODEL
1	TR10
5	TR20
10	TR30
15	TR40

IMMEDIATE DELIVERY

SEND FOR BULLETIN NO. 105

A new series of compact, budget-priced, laboratory power supplies, featuring uncompromising quality of materials and workmanship.

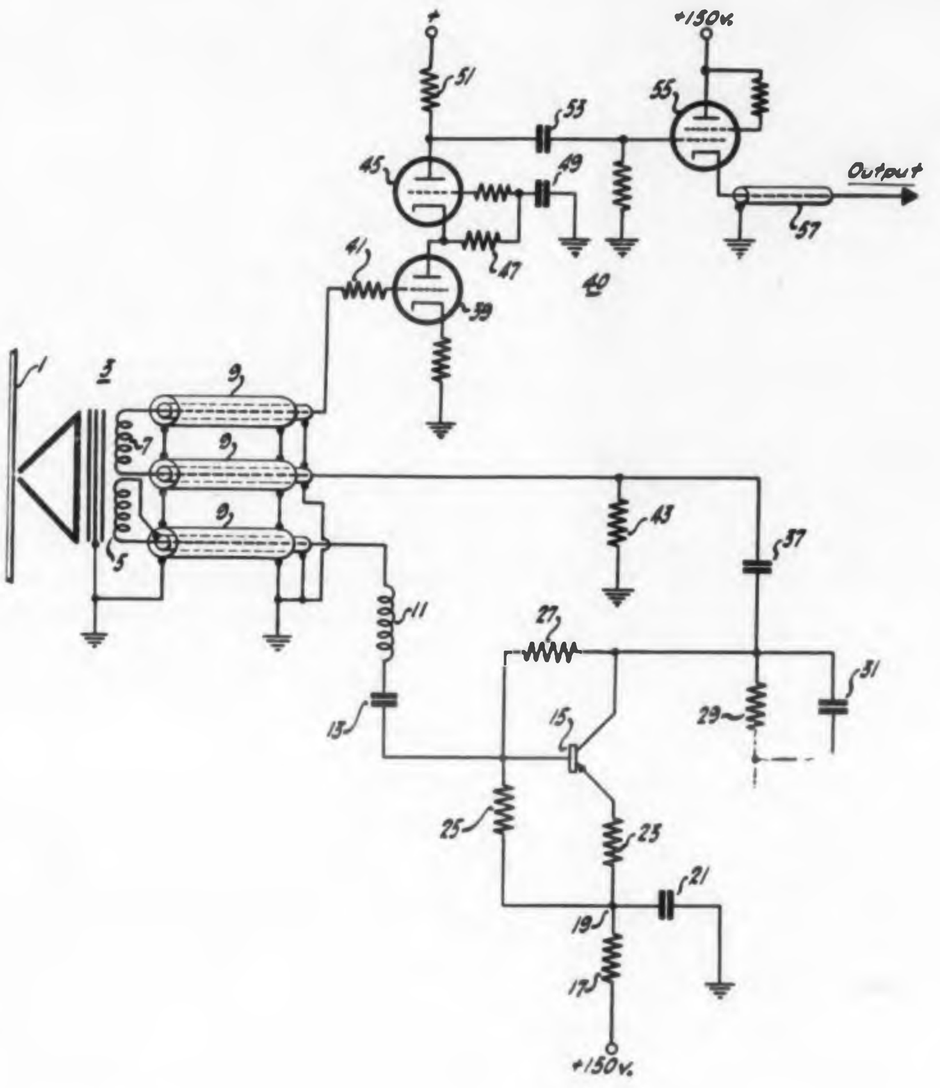
Features:

- Regulation ±½% line & load.
- Zener Diode Reference.
- Ripple less than 5 M. V.
- Vacuum varnish impregnated magnetic components.
- Controls include power switch, fuses, pilot light, voltage control knob and output binding posts.
- Short Circuit Protection.
- 2% Accuracy Panel Meters.
- Both output terminals above ground and isolated from A.C. line.
- Panel type carrying handles.
- Continuous duty ratings.
- High efficiency.

Opad
OPAD ELECTRIC COMPANY
43-16 WALKER STREET • NEW YORK 13, N. Y.
Telephone WOrth 6-0380

CIRCLE 738 ON READER-SERVICE CARD

PATENTS



Low Noise Preamplifier

Patent No. 2,919,313. W. R. Johnson. (Assigned to Minnesota Mining & Manufacturing Co.)

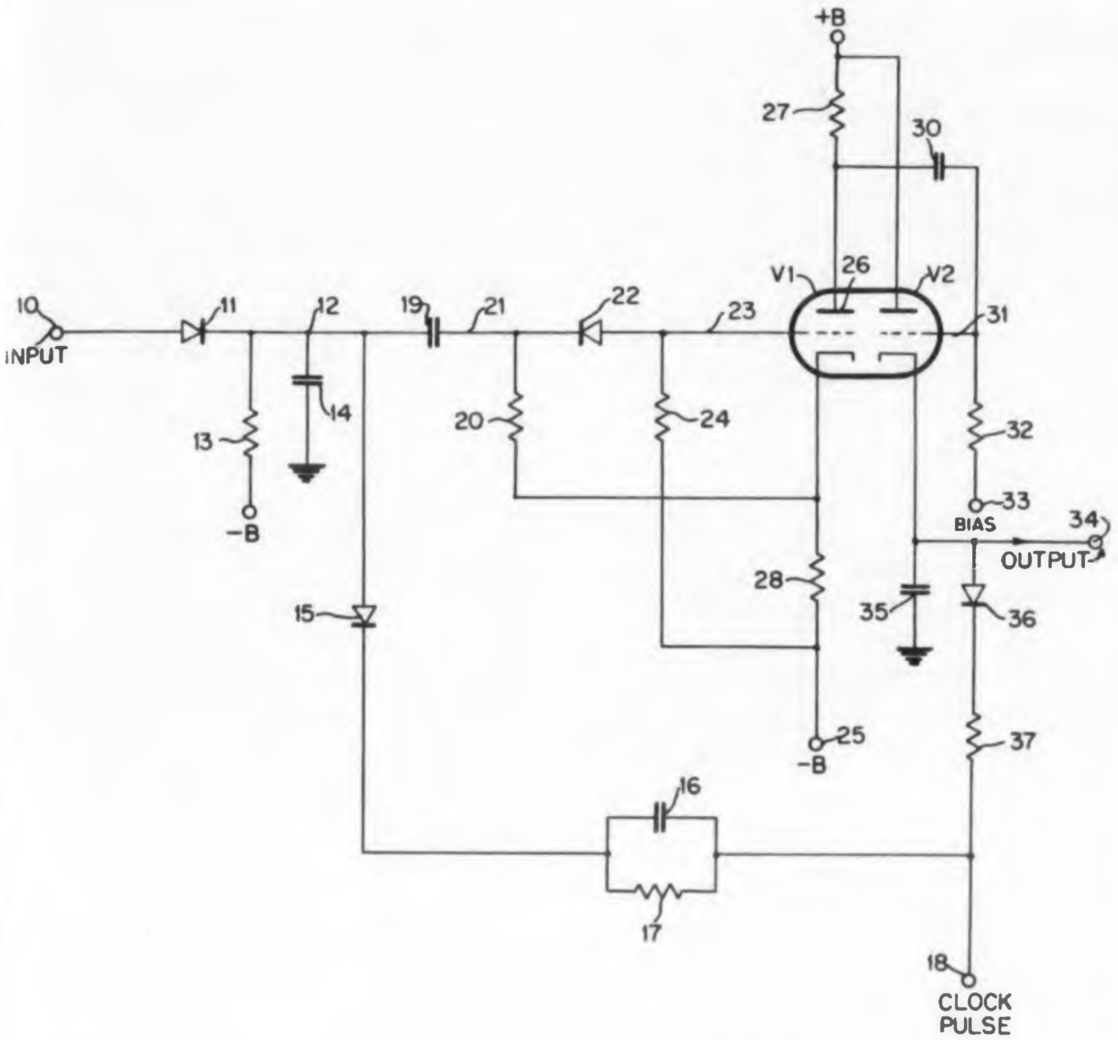
A magnetic tape, suitable for television recording, is equalized by a preamplifier comprising integrating and high pass networks, combined for wide-band frequency response. The low frequencies are amplified by a low-noise pnp fused junction transistor, driving an essentially capacitive load. Vacuum tube microphonic noise and heater hum are eliminated and the low input impedance reduces the thermal noise. High-frequency gain is obtained by a low-noise vacuum tube cascode amplifier.

The essential features of the invention are the dual pickup coils 5 and 7, choke *11* which isolates transistor *15* from the high input frequencies, integrating capacitor *31*, and grid resistor *43*. The signals on coil 7 are combined to drive the high-frequency cascode amplifier circuit. Amplification in the transistor network is kept relatively constant up to 25 kc. At higher frequencies, choke *11* and capacitor *31* isolate the network from the output. The cascode amplifier drives the load resistor *51* of about 2000 ohms. Hence, at high frequencies the gain falls off rather slowly.

Method of Activating Thermionic Emitter

Patent No. 2,913,629. John E. White (Assigned to General Electric Co.)

The electrolytic method of activating an oxide-coated cathode is improved by periodically applying an accelerating field for temperature limited emission. Oxygen, formed during the pulse period, diffuses rapidly to the surface and completely evaporates, leaving a free, alkaline-coated cathode. By this means, the activation time is reduced to one-thirtieth of that previously required. A very uniform electron emitting surface is produced. Schedules are tabulated for the activation of tube types 6SN7, 6AU6 and 12AU7.

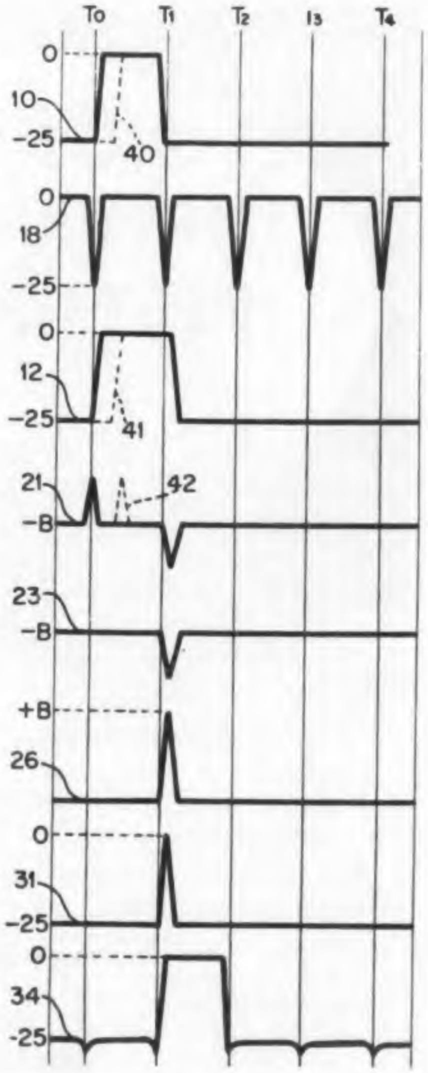


Timed Pulse Delay Circuit

Patent No. 2,910,583. James W. Toner. (Assigned to IBM Corp.).

Pulse delay is effectively obtained by generating an output of fixed duration in response to the mere existence of an applied voltage. The output is initiated independent of both the leading and trailing edges of the input waveform.

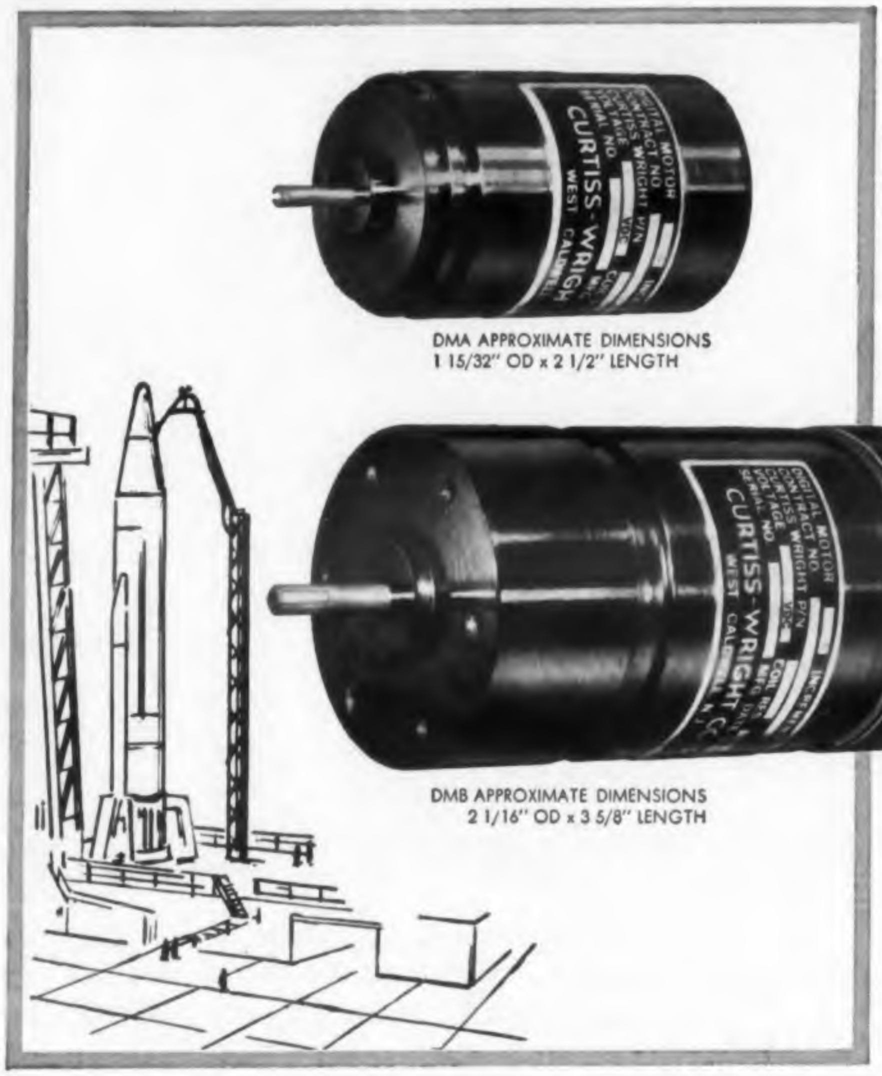
Briefly, positive going input *10* charges capacitor *14* which is then discharged by a clock pulse *18* connected through diode *15*. After differentiation the negative going trigger *23* passing through diode *22* and inverter V_1 causes capacitor *35* to charge. Subsequently, source *18* discharges this capacitor resulting in pulse *34* whose duration equals the interval between clock pulses.



Don't miss an issue of ELECTRONIC DESIGN; return your renewal card today.

Stepping Motors

HIGH RELIABILITY
POSITIVE LOCK
BI-DIRECTIONAL ROTATION



Curtiss-Wright Stepping Motors convert digital pulses into mechanical motion or work. Available in two models. Features include: Complete static and dynamic balance • Withstand high shock and vibration • Long life, light weight • High starting torque • Withstand environmental temperatures of +165°F.

Write for complete Components Catalog 260 to help you select Curtiss-Wright electronic components for use where dependability is essential.

NEW CURTISS-WRIGHT DUAL TIME DELAY RELAYS

Our new series of Dual Relays include these outstanding features: Instantaneous resetting contacts, chatter-free operation, voltage and high temperature compensation, compact size, designed for use in critical shock and vibration environments.

COMPONENTS DEPARTMENT • ELECTRONICS DIVISION

CURTISS WRIGHT

CORPORATION • EAST PATERSON, N. J.

TIME DELAY RELAYS • DELAY LINES • ROTARY SOLENOIDS • DIGITAL MOTORS • TIMING DEVICES • DUAL RELAYS • SOLID STATE COMPONENTS

CIRCLE 741 ON READER-SERVICE CARD

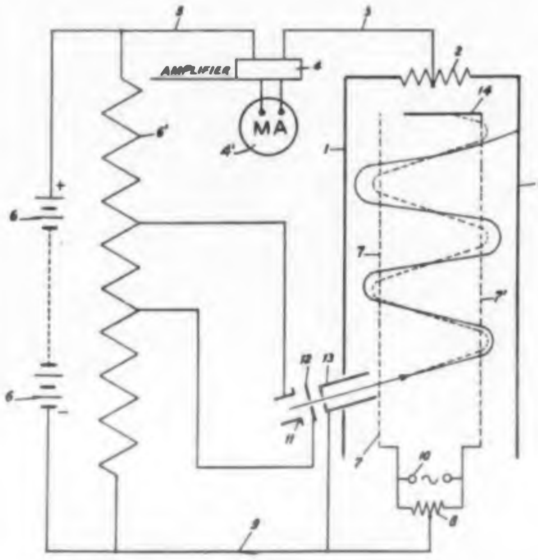
PATENTS

Device For The Separation of Gas Ions

Patent No. 2,919,348. Aron Bierman.

A simple electrostatic system separates gas ions of different mass due to their relative zig-zag motion in and out of a potential well.

Diagrammatically, the ions from source *11* are accelerated toward concave plate *1'* at a specified angle to the tube axis.



The repelling forces developed by grids *7'* and *7* make their path cyclical and the particles ultimately are collected at plate *14*. However, the high frequency source *10* may be adjusted to resonate with the motion of a particle of a selected mass number. The amplitude of the motion then regularly increases, until the energy is sufficient to overcome the barrier of grid *7'* and the particle strikes plate *1'*, preferably at a window.

Ghost images caused by ions whose mass have a whole number ratio to the mass of the ions under consideration are reduced. The energy built up by the undesired ions is insufficient to permit them to reach either plate *1* or *1'* and their path is eventually interrupted by plate *14*.

Pulsed Magnetron Instability Detector

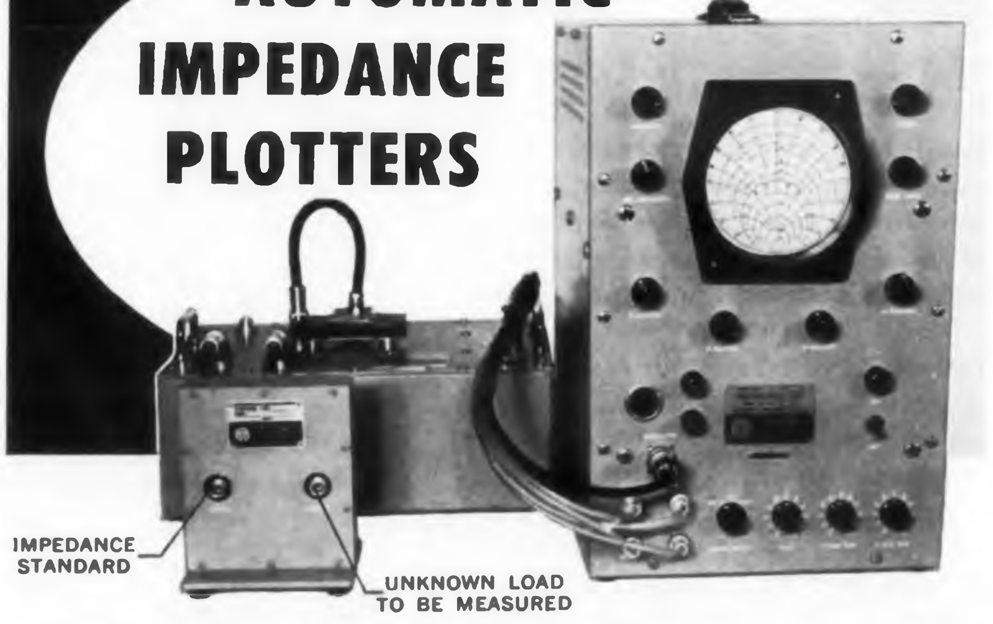
Patent No. 2,895,107. Gerald I. Klein. (Assigned to United States of America)

The number of times a magnetron is unstable, or has its output fall below a fixed level, is counted by an anticoinci-

NEW

TYPE 14

AUTOMATIC
IMPEDANCE
PLOTTERS



- Presents effectively continuous impedance information over a frequency band.
- Entirely self-contained except for the use of an external oscillator.
- Models available to cover 2.5-250 mc, 30-400 mc and 180-1100 mc.

Write for complete information on AMCI Automatic Impedance Plotter

ANTENNA SYSTEMS – COMPONENTS – AIR NAVIGATION AIDS – INSTRUMENTS

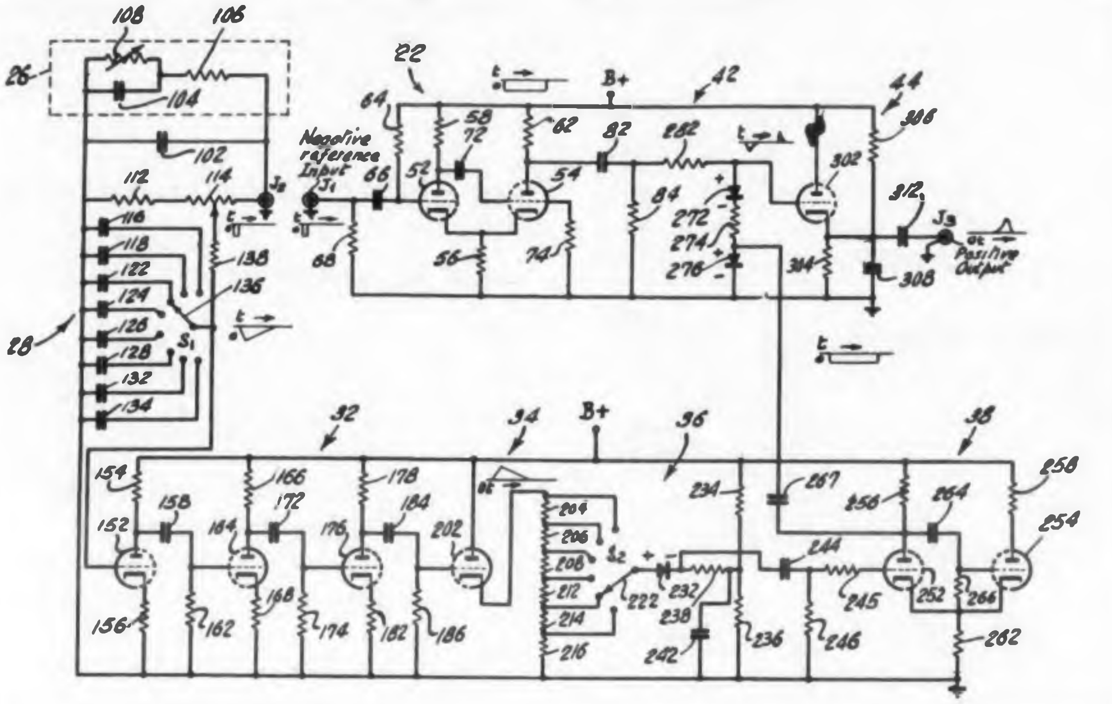
AMCI ALFORD Manufacturing Company

299 ATLANTIC AVE., BOSTON, MASS

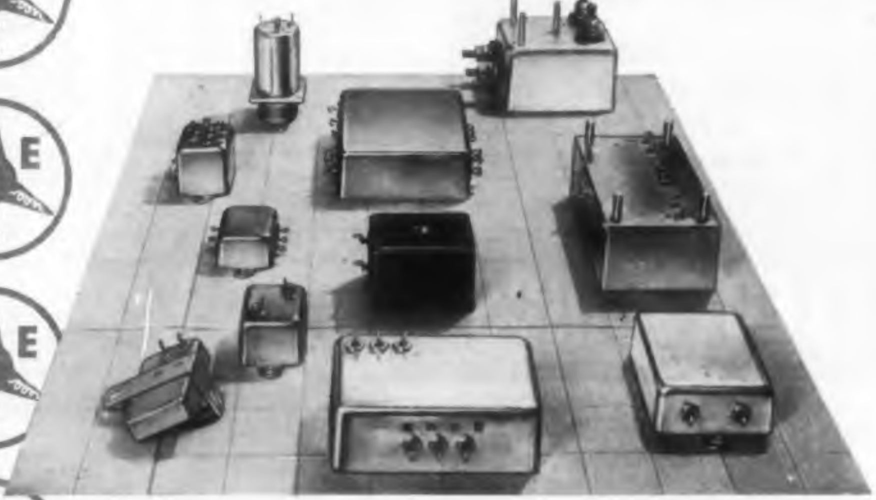
CIRCLE 742 ON READER-SERVICE CARD

ence circuit. The apparatus used is the standard JAN test setup for determining conformance with magnetron specifications.

Essentially, diodes *272* and *274* of network *42* compares the outputs from two multivibrators. Multivibrator *22* is driven directly by a pulser and multivibrator *38* is triggered by the detected magnetron output set by pedestal network *36.* In a stable magnetron, cancellation of the pulses in network *42* is complete and zero output appears at junction J_3. With instability, the cancellation is incomplete, especially when the magnetron fails to fire in the specified mode, and triode *302* couples a signal to the counter at the output junction J_3.



Radio Interference Filters



Standard has proven it knows the noise filter problem—and how to cope with it! Modern production facilities and skilled engineering assure you economically produced filters to your exacting specifications. Prompt, scheduled delivery also!

Let filter specialists solve your filter supply problems. Send your specifications and quantity requirements for a quote.

STANDARD ELECTRONICS COMPANY

1611 W. 63rd St. • Chicago 21, Ill. • PRospect 8-4222

CIRCLE 743 ON READER-SERVICE CARD

Montrose DIVISION | Bendix AVIATION CORPORATION

SYNCHROS

MIL-S-20708 | MIL-S-2335

Your complete source for all military type synchros with "off the shelf" delivery

SIZE 11	CT4c, 26V-CT4c, CX4c, 26V-CX4b, CDX4a, 26V-CDX4b, TR4b, 26V-TR4b, TX4b, 26V-TX4b
SIZE 15	CT4b, CX4b, CDX4b, TR4c, TX4b, TDX4b, CT6b, CX6b, CDX6b, TR6a
SIZE 18	CT4b, CX4b, CDX4b, TR4b, TDX4b, CT6b, CX6b, CDX6b, TX6a, TRX6a
SIZE 23	CT4, CT4a, CT4b, CX4, CX4a, CX4b, CDX4, CDX4a, CDX4b, TR4, TR4a, TR4b, TX4, TX4a, TX4b, TDX4, TDX4a, TDX4b, TDR4, TDR4a, TDR4b, CT6, CT6a, CT6c, CX6, CX6a, CX6c, CDX6, CDX6a, CDX6b, TR6, TR6a, TX6, TX6a, TX6b, TDX6, TDX6a, TDX6b, TDR6, TDR6a, TRX6a
SIZE 31	TR4d, TX4a, TX4d, TDX4b, TDR4b, TR6b, TX6b, TDX6b, TDR6b
SIZE 37	TR4a, TX4b, TDX4a, TDR4a, TR6b, TX6b, TDX6a, TDR6a
TYPE 1	1D, 1F, 1HCT, 1HDG, 1HG
TYPE 3	3D, 3F, 3HCT, 3HDG, 3HG
TYPE 5	5D, 5F, 5HCT, 5HDG, 5HG, 5N
TYPE 6	6HDG, 6HG

WRITE FOR FREE

Rapid Reference Guide to Military Synchros. ⟶

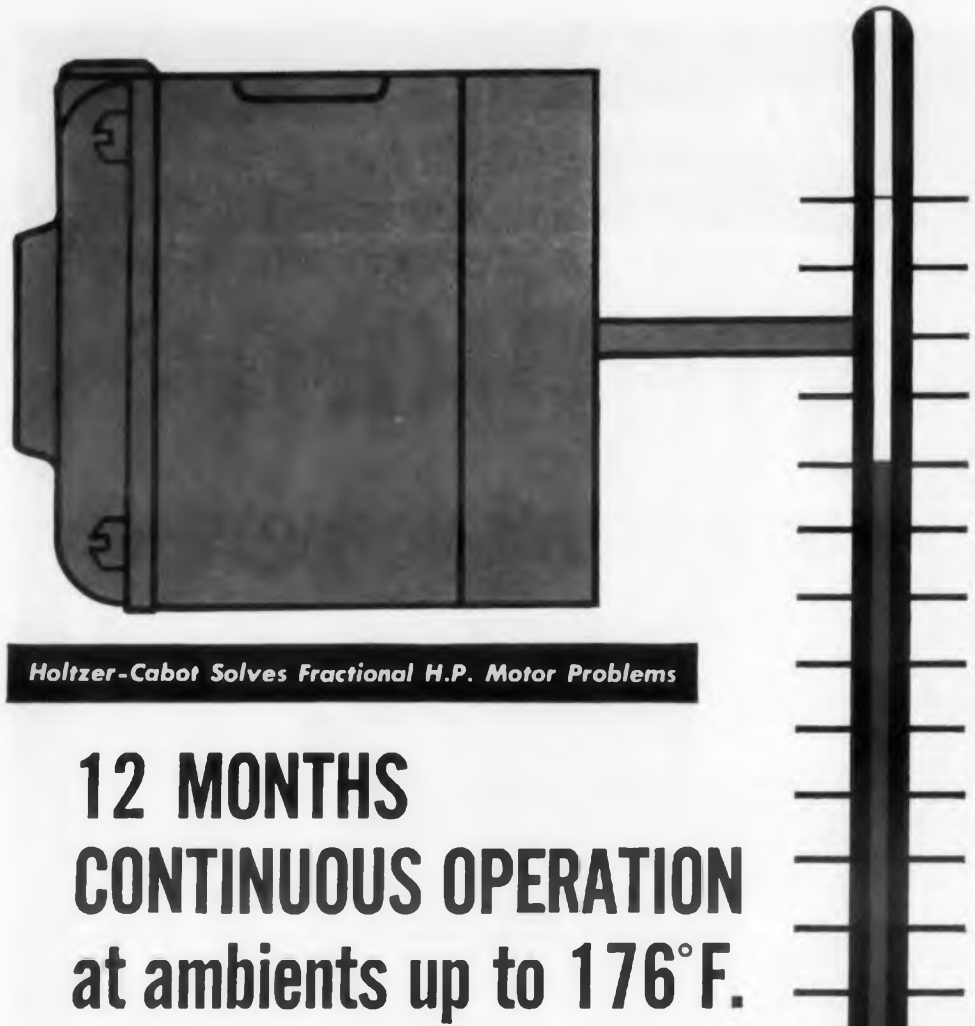
Write on company letterhead for Synchro Engineering Catalog.

West Coast Sales and Service Office—117 East Providencia Avenue, Burbank, California
Canadian Sales Office—Aviation Electric Limited, 200 Laurentien Blvd., Montreal, Quebec, Canada
Export Sales and Service—Bendix International, 205 East 42nd St., New York 17, New York

Montrose Division
SOUTH MONTROSE, PA.

Bendix AVIATION CORPORATION

CIRCLE 744 ON READER-SERVICE CARD



Holtzer-Cabot Solves Fractional H.P. Motor Problems

12 MONTHS CONTINUOUS OPERATION at ambients up to 176°F.

A leading instrument manufacturer*, had the problem of continual motor failures after 2 to 3 months service in an instrument which required a minimum of one year's continuous duty in maintained ambients up to 80° C. (176° F.)

The thermostated, infra-red instrument in which the motor was to be used, required a 24-hour stabilizing period, dictating that no maintenance be performed.

To solve this problem, engineers from both the instrument company and from Holtzer-Cabot cooperated in the development of a motor with increased radiation area, plus reduced power input. This resulted in a motor temperature rise of only 20° C. as compared with 35° C. in the motors formerly used.

To provide positive lubrication, grease reservoirs were provided outside the bearing and a long-life stable grease suitable for high temperature was selected.

The result was a motor which has now been in successful operation for over 12 months without any motor failure or trace of bearing wear.

*Name on request

Write for Information! Holtzer-Cabot specializes in the design and manufacture of fractional horsepower motors for all types of applications. For complete details on Holtzer-Cabot motors for specific applications, and a copy of "Key Factors in Selecting AC Motors for Instrument Service" write direct or use Readers Service Card.

HOLTZER-CABOT ESTABLISHED 1875 HC NP

HOLTZER-CABOT

MOTOR DIVISION

National Pneumatic Co., Inc., Boston 19, Mass.

CIRCLE 745 ON READER-SERVICE CARD

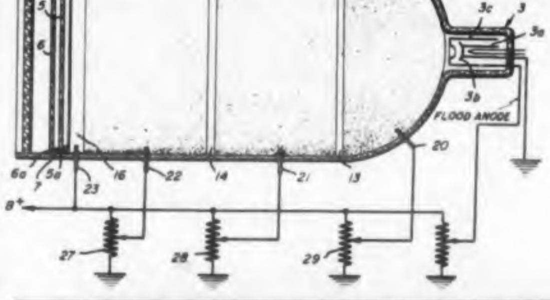
PATENTS

Electron Discharge Devices

Patent No. 2,917,658. R. W. Hunter. (Assigned to International Telephone and Telegraph Corp.)

The electron beam generated by an Iatron flood gun is allowed to diverge slightly so that the planar target is uniformly illuminated. Proper design limits the beam within the diverging lens to reduce spherical aberration.

The operation of the tube is as follows: Whiting gun *4* writes the charge pattern on target screen *6* according to the control signal. A low voltage Pierce gun *3* floods the target with electrons which pass to phosphor *2* to generate the display as modulated by the target screen. To collimate all electrons at right angles to the target surface, the voltage of aquadag ring *11* is depressed below the voltages applied to rings *10* and *12*. Electrons slow down and the beam diverges in plane *13* so that the lens increases the apparent beam angle. In plane *14*, the beam again converges to focus uniformly on the target screen.



Charged Particle Beam Focusing System

Patent No. 2,902,622. Michiaki Ito (Assigned to International Standard Electric Corp.)

Periodic electrostatic focusing of a long electron beam is obtained by applying ac, preferably polyphase, to the focusing structure. Regulated dc sources are thereby eliminated in this quasi-static system, since the electrical focusing alternations at 60 cycles are effectively stationary with respect to the high velocity electrons.

The beam generated by cathode *11*

Complete **LACING CORD** line designed by **Electronic Specialists** for **ELECTRONICS**

Who knows better about lacing cord than the leader who has been designing and manufacturing electronic wire and custom cables for 38 years?

- round cords and flat-braided tapes
- nylon, dacron and teflon-fiberglass
- finishes: micro-crystalline wax, synthetic rubber-like resin, teflon resin, synthetic rubber
- meets industrial specifications and MIL-T-713A
- each spool individually packaged in boxes

Available for immediate delivery from your local Alpha Wire electronic parts distributor. Write for free Catalog I-59.

ALPHA electronics WIRE

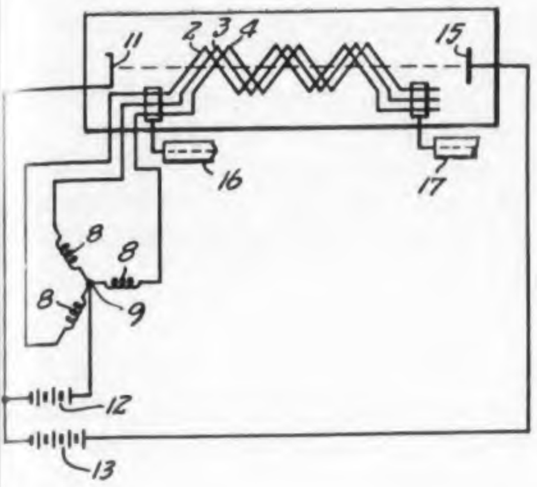
Wire & Cable • ALPHLEX® Tubing & Sleeving • Lacing Cord

ALPHA WIRE CORPORATION • 200 Varick Street, New York 14, N. Y.

In the 13 Western States, call on our new Pacific Division: 1871 South Orange Drive Los Angeles 19, California

IRE Booth 4103 ● IRE Booth 4103 ●

CIRCLE 746 ON READER-SERVICE CARD

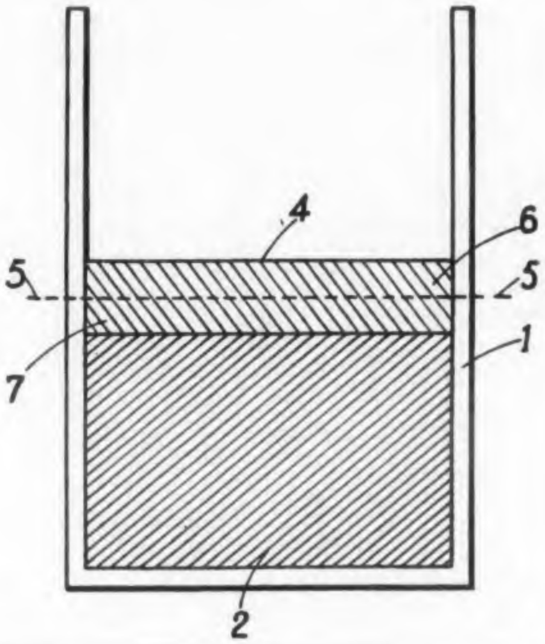


passes through coils *2*, *3*, and *4*, distributed along the path leading to collector plate *15*. The focusing current delivered to the coils is generated in the 3-phase windings *8*, connected to a suitable ac generator.

Manufacture of Sintered Cathodes

Patent No. 2,913,812. H. Huber, J. Freytag and J. Reynaud. (Assigned to Compagnie Generale de Telegraphie)

A dispenser cathode is formed by compressing the emissive material, *2*, coating it with a layer of high refractory metal, *4*, and then sintering and machining it to the desired surface contour of the porous outer layer. The unique feature of the process is that, after sintering in an argon atmosphere, the layer of porous tungsten above the barium tungstate emissive material, *2*, is cut through along plane *5-5*. Grinding and polishing can then produce a surface layer no more than 20 microns thick.



VISIT
COMINCO
BOOTH
4511
IRE
SHOW
NEW
YORK
MARCH
21-24

TADANAC BRAND
High Purity
LEAD

TADANAC Brand High Purity Lead is 99.9999% pure and is available in ingots, rods, powder, sheets and shot. It is also available as disc and spherical pellets and washers, suitable as solder preforms or for direct alloying with germanium in the production of alloy-junction transistors or diodes.

Other high purity TADANAC Brand metals or compounds include Special Research Grade antimony, indium and tin; High Purity Grade bismuth, cadmium, indium, silver, tin, zinc and indium antimonide. Send for our brochure—TADANAC Brand High Purity Metals.

COMINCO

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED
215 ST. JAMES ST. W., MONTREAL 1, QUEBEC, CANADA · PHONE AVenue 8-3103

0162

CIRCLE 747 ON READER-SERVICE CARD

SPRAGUE® RELIABILITY
in these two dependable wirewound resistors

Sprague's new improved construction gives greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.

They are ideal for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

Get complete data on these dependable minified resistors, ***write for Engineering Bulletin 7410.***

TAB-TYPE BLUE JACKETS: For industrial applications, select wattage ratings from 5 to 218 watts in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. ***For complete data, send for Engineering Bulletin 7400A.***

New Koolohm construction features include welded leads and winding terminations—Ceron ceramic-insulated resistance wire, wound on special ceramic core—multi-layer non-inductive windings or high resistance value conventional windings—sealed, insulated, non-porous ceramic outer shells—*aged-on-load* to stabilize resistance value.

You can depend upon them to carry maximum rated load for any given physical size.

Send for Engineering Bulletin 7300 for complete technical data.

ALL UNITS ACTUAL SIZE

SPRAGUE ELECTRIC COMPANY
347 MARSHALL STREET • NORTH ADAMS, MASS.

SPRAGUE COMPONENTS:
RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

SPRAGUE®
THE MARK OF RELIABILITY

CIRCLE 748 ON READER-SERVICE CARD

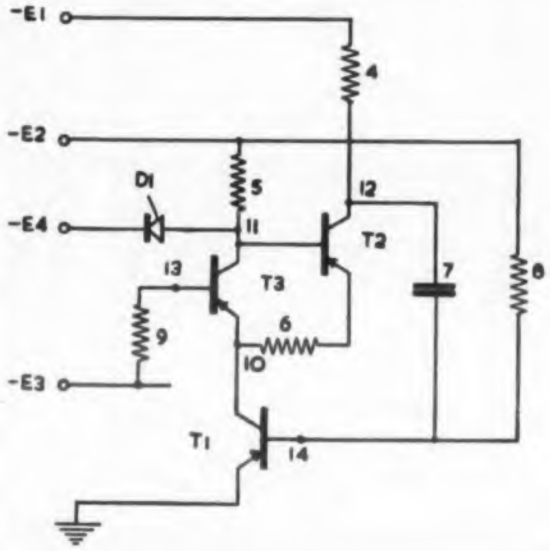
PATENTS

Electric Circuit for Generating Substantially Linear Voltage Changes

Patent No. 2,916,705. W. L. Stephenson. (Assigned to North American Philips Co.)

A simple transistor configuration provides monostable operation and generates a linear output waveform.

As illustrated, pnp transistors T_3 and T_2 are initially fully conducting. A positive pulse applied to paint *13* causes T_2 to conduct harder and the positive pulse coupled to T_1 causes T_3 to cut off. Capacitor *7* discharges linearly and the negative feedback through T_1 raises the potential of point *10* so that T_3 is no longer cut off. Regenerative dc coupling between T_3 and T_2 resets these transistors to full conduction.



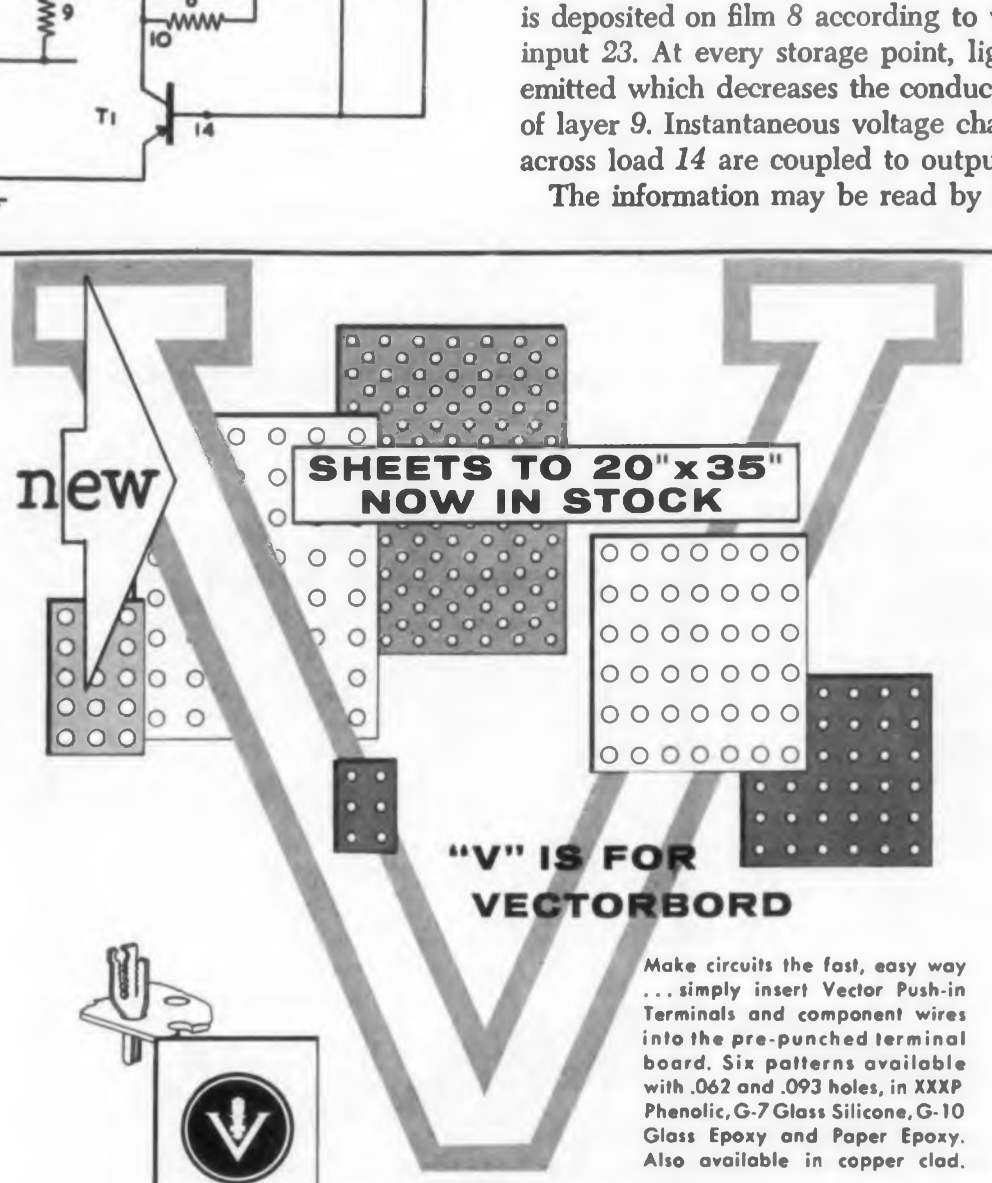
Information Stores

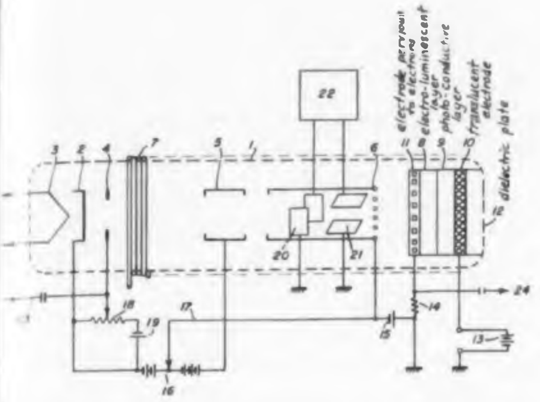
Patent No. 2,919,377. J. M. N. Hanlet (Assigned to Societe d'Electronique et d'Automatisme)

Information is stored by the controlled intensity modulation of a low velocity crt beam which scans an electroluminescent material deposited upon a photoconductor.

In the writing position, the voltage between control grid *4* and electrode *11* is set to about 3 v. The electron beam is deflected by plates *20* and *21* and a charge is deposited on film *8* according to video input *23*. At every storage point, light is emitted which decreases the conductivity of layer *9*. Instantaneous voltage changes across load *14* are coupled to output *24*.

The information may be read by scan-





ning the stored surface repeatedly with a 1.5-v, low velocity beam. All points previously illuminated by the electron beam will be reinforced in brightness, further decreasing the photoconductivity to produce useful output.

Erasure occurs when the stored surface is set at the voltage of the scanning electron beam.

Servo Arm For Phonograph Pickups

Patent No. 2,915,315. J. Rabinow

Phonograph reproduction is improved by supporting the pickup on a plate moved by a separate motor. The motor is controlled by the instantaneous position of the pickup arm. The technique makes the pickup move tangent to the record groove.

In operation, the pickup arm 3 follows the track cut in record *12*. Since the arm swings clockwise, switch contacts *30* and *31* periodically join and motor *23* is energized. This motor moves plate *7* through flexible shaft *21*, producing straight line motion of stylus tip *1*. The main bending forces are borne by the motor-driven platform, rather than by the pickup arm. Thus, the angle the arm is bent becomes very small.

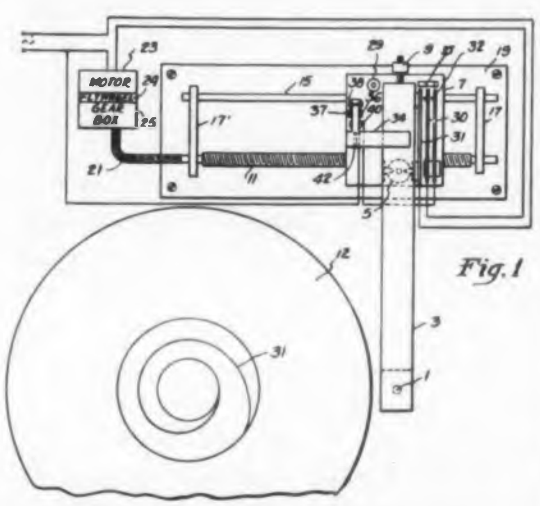
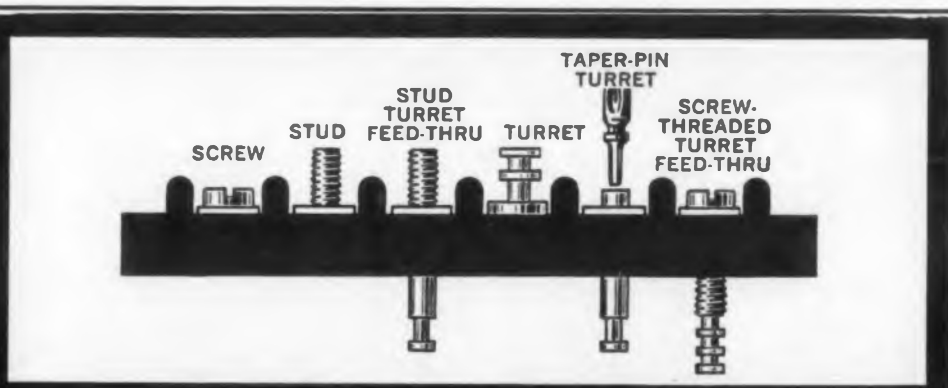


Fig. 1



Pick your TERMINALS with KULKA TERMINAL BLOCKS!

What do you prefer for your connections—screw, stud, nut, turret, threaded-turret, taper-pin, feed-thru, or other terminal style? No longer must you compromise or improvise. Instead...

Select the terminal style or styles, together with type and size of terminal block. The Kulka Terminal Program will combine the two factors in a terminal block **custom-fitted** to your wiring and assembly needs. It's simple, expeditious, economical!

LITERATURE...Ask for the Kulka Terminal Style Catalog, listing many terminal designs and combinations. Let us quote on your requirements.

KULKA

KULKA ELECTRIC CORP.
633-643 So. Fulton Avenue
Mount Vernon, N.Y.

"VISIT US AT I.R.E. SHOW BOOTH 2900"
CIRCLE 751 ON READER-SERVICE CARD

When you specify MASSA you specify reliability versatility and...

12 CHANNEL
DIRECT INK OR ELECTRIC
RECTILINEAR
RECORDING SYSTEM

MORE DATA

PER DOLLAR

This new Recording System, Model BSA-1200, combines all the advantages of rectilinear recording with the economy of ink writing in 1/3 less space than any comparable system. At an average chart speed of 50 mm/sec., for example, you save $10,000 every 200 hours in chart costs alone when compared to other rectilinear recording systems. In addition, this system is designed to accept a wide choice of different interchangeable plug-in preamplifiers for each of the 12 recording channels.

ADDITIONAL FEATURES

- **High Speed Rectilinear Recording with *Ink*. Unique pen design provides splatterproof writing to 200 cycles.**
- **Wide Frequency Range reproduces signals from DC to 200 cps on rectangular coordinate chart paper**
- **Interchangeable Plug-in Preamplifiers — Low, Medium, High Gain DC, AC, Chopper, Carrier, and Servo**
- **Automatic one second timer and manual EVENT MARKER**
- **18 Speeds — Push-button Controls (Remote control optional)**
- **Individual Power Supplies and Transistorized Driver Amplifiers for each channel. Prevents cross-talk between channels**
- **Pen Motor Overload protection**
- **Interchangeable pens for either Ink or Electric Writing**
- **Micrometer Pen Motor Adjustments for accurate pen alignment**
- **Plug-in provisions for remote or centralized control of all functions**
- **Modular Design throughout for ease of servicing**

Write for complete information on
High Speed Recording Systems

OTHER MASSA PRODUCTS
TRANSDUCERS
Sonar, Ultrasonic
ACCELEROMETERS
MICROPHONES
HYDROPHONES
AMPLIFIERS
COMPLETE LINE OF MULTI-CHANNEL AND
PORTABLE RECORDING SYSTEMS

IRE SHOW
Booth Nos.
3609 to
3611

MASSA
A DIVISION OF
COHU
ELECTRONICS INC
9 FOTTLER ROAD
HINGHAM, MASSACHUSETTS

CIRCLE 752 ON READER-SERVICE CARD

The NEW Series BH100

MILLI-V-METER®

THE INSTRUMENT
with the TAPE-SLIDEWIRE

1/10 THE SIZE...
10 TIMES THE ACCURACY
OF STANDARD INSTRUMENTS!

- Resolution: 1 part in 10,000
- LABORATORY PRECISION for the operating plant.
- COMPATIBLE with any transducer—AC or DC.
- For strain gage, linear differential transformer, thermocouple, thermistor, resistance thermometer, pulse or variable frequency circuits or systems.
- Parabolic or logarithmic functions are linearized for direct digital reading.
- Every scale unit is a calibrated value.

Produced by the makers of the JETCAL® jet engine Analyzer... in worldwide military and airline use!

® TRADE MARK

Full information is available for the asking!

B & H INSTRUMENT CO., INC.
3479 West Vickery Blvd., Fort Worth 7, Texas

Sales-Engineering Offices:
ATLANTA, GA., COMPTON, CAL., DAYTON, OHIO, VALLEY STREAM, L.I., N.Y., WICHITA, KAN.
TORONTO, ONT. (George Kelk Ltd.), MITCHAM, SURREY, ENGLAND (Bryans Aeroquipment Ltd.)

CIRCLE 753 ON READER-SERVICE CARD

BOOKS

Fundamentals of Electronics

E. Norman Lurch, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 631 pp, $8.25.

Planned to meet the need of the technician who is to work in the electronics field, this book provides a firm background in electronics fundamentals. It is intended as an introduction to the field as a whole and prepares the reader for the more specialized aspects of electronics: communications, industrial electronics, television, microwaves, and computing systems.

In following the text material, only a working knowledge of dc fundamentals, algebra and right-angle trigonometry is required. Also, if not prerequisite, the student should be studying ac circuits concurrently with the first six chapters which deal with electronic devices. The level of the text enables the student to make gain calculations, compute power outputs, perform graphical solutions, determine the modulation applied to a carrier wave, and solve other similar problems. However, he will not be prepared to handle the design calculations and original derivations that are expected of the electronic engineer.

The development of the text assumes that the vacuum tube and the transistor are of equal importance. In the application chapters, for example, the chapters on rectifiers and nonsinusoidal oscillators, these elements are treated simultaneously. Other chapter headings include: The Vacuum-Tube Amplifier, The Transistor Amplifier, Transformers and Transformer-Coupled Amplifiers, High Frequency

PC

Variable and close tolerance
Polystyrene Capacitors

All types have power factor of less than .05% at 1000 CPS.

Type PV and Type PW variable polystyrene capacitors in bathtub containers. Highly stable and adjustable over the range of plus - minus 1% of the nominal capacitance.

Type PX close tolerance polystyrene capacitors in bathtub containers. Tolerances available 1%, 0.5%, 0.25% and 0.1%. Stability better than 0.1% per year of life.

Write for free bulletin Type PV.

Plastic Capacitors, INC.
2620 N. Clybourn Chicago 14, Illinois DI 8-3735

CIRCLE 754 ON READER-SERVICE CARD

mplifiers, Feedback Oscillators, Modu tion, Detection, and Push-Pull and hase Inversion. The text is amply illus ated and much of the discussion is done ith equivalent circuits and, where help ul, graphs are used to explain circuit operation. The end of each chapter consists of review questions, problems, and a suggested reference list for further study.

Electrical Engineering Fundamentals

J. P. Neal, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y., 402 pp, 8.50.

A thorough introduction to the fundamentals of electrical engineering theory is presented in this new undergraduate text. It is assumed that the reader has had college physics courses in mechanics, electricity, and magnetism and mathematics courses in analytic geometry, algebra and calculus.

Engineering interpretations of the physical characteristics and laws of electromagnetic systems and their equivalent mathematical models are presented in terms of the rationalized mks system of measures, using scalars and vectors, as appropriate. A careful review of the essentials of elementary vector mathematics is also included.

The introduction to elementary classical electromagnetic field theory leads us to an understanding of the laws of Faraday, Ampère, and Gauss, as expressed in Maxwell's equations in integral form. Practical examples and problems demonstrate the applications of these laws to simple symmetrical physical systems. However, the more sophisticated point concepts, such as divergence, curl, Poisson's equation, and Maxwell's equations in point form, are not discussed in this book.

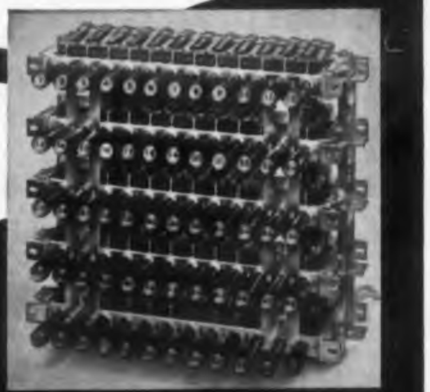
The discussion of elementary network theory introduces Kirchoff's network equations as derived from Maxwell's field equations. The network equations are applied to magnetic networks and dc electric networks. The branch, circuit, and node methods for solving dc networks are presented.

The relations between elementary field theory and elementary network theory are frequently illustrated by applying field theory to the derivation of the parameters of equivalent electric and magnetic network elements for simple physical devices.

SWITCHCRAFT® INC.

"Multi-Switch"

A COMBINATION TO MEET EVERY OPERATING SITUATION



Flexible Switchcraft design makes it possible to connect two or more rows of Multi-Switches and provide inter-action between all buttons.

Illuminated or Non-illuminated Push Buttons, 1 to 37 Stations in a Row.

- **VERSATILE DESIGN—** Easily adapted to individual requirements.
- **CHOICE OF 2 MOUNTING CENTERS.**
- **UNUSUAL CHOICE OF FUNCTIONS.**

STACK SWITCHES—Mounted on separate plate. Up to 4 stacks can be operated with each button.

Many other features available such as Lock-Out Bars, and Solenoid Release Devices. *Write for Catalog S-581.*

BOOTH 2827—Radio Engineering Show—N.Y. Coliseum—Mar. 21-24

SWITCHCRAFT® INC.

5529 N. Elston Ave., Chicago 30, Ill.
Canadian Rep.: Atlas Radio Corp., Ltd.
50 Wingold Ave., Toronto, Canada.

AVAILABLE AT ALL LEADING RADIO PARTS JOBBERS •

CIRCLE 755 ON READER-SERVICE CARD

AIRPAX

EXHIBITING IN BOOTHS 2306 - 08 AT THE IRE SHOW

TRANSISTOR CHOPPER
Miniature transistor chopper with self-contained drive transformer operates from fifty to five thousand CPS.

PREAC AMPLIFIERS
Preac magnetic amplifiers are high sensitivity DC units having an extremely stable null. For 60 and 400 CPS sources.

CHOPPER TYPE 2300
Low noise type for null seeking servos, instrumentation, instrument amplifiers, telemetering and control systems.

FERRAC MOLDED AMPLIFIER
Fast response, wide dynamic range and high gain characterize this rugged Ferrac molded magnetic amplifier. Weight only 7.5 ounces.

AIRPAX FM TELEMETRY MONITOR
Nine channel FM Telemetry Monitor. Deviation from center frequency of each telemetry sub-channel is displayed and measured.

INSTANTANEOUS ACTING MINIATURE MAGNETIC CIRCUIT BREAKERS
Miniature hermetically sealed magnetic circuit breakers with inverse time delay provide positive protection in critical circuits. Trip level is independent of temperature.

Airpax engineers resolve the most advanced technological problems met with in the fast-moving electronics and electro-mechanical fields. Subminiaturization, abnormal temperatures, super-reliability, space utilization and similar subjects are constantly under investigation in the quest for designs to meet the demands of tomorrow.

AIRPAX ELECTRONICS INCORPORATED

AB11

CAMBRIDGE, MARYLAND FORT LAUDERDALE, FLORIDA

CIRCLE 756 ON READER-SERVICE CARD

Final-Stage Design of a Vertical Sweep Generator

A. A. Zakharov

THE OPERATION of the output stage of a vertical sweep generator is analyzed for both inductive and transformer loads. A simple method for designing the circuits is described which results in good output current linearity.

Inductive Load Design

The output stage of a vertical sweep generator with a choke load is shown in Fig. 1a. The equivalent diagram of the plate circuit of this stage is given in Fig. 1b, with

$$C_e = \frac{C_c\, C_b}{C_c + C_b} \qquad (1)$$

It is assumed that the entire ac component of the tube current flows through capacitors C_e and C_b.

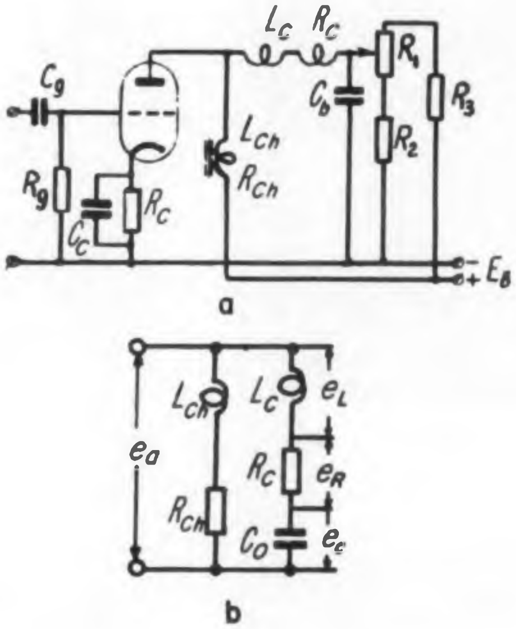


Fig. 1. a) Output circuit of a vertical sweep generator with choke load. b) Equivalent output stage circuit.

The output current waveform applied to the deflecting coils is shown in Fig. 2. It is expressed by Eq. 2:

$$i_c = I_c\left(\frac{t}{T} - 0.5\right) \text{ for } 0 \leq t \leq T \qquad (2)$$

repeating periodically for $t > T$. The return time is assumed to be zero. The distributed capacitances of the deflecting coils and of the choke are neglected.

The voltage drop across the inductance and resistance of the deflecting coil and across capacitance C_O is

$$e_{ac} = e_L + e_R + e_c = \frac{-I_c}{2C_o\,T}\,t^2 - I_c\left(\frac{R_g}{T} - \frac{1}{2C_o}\right)t$$

$$+ L_c\, I_c\, \delta\,(t) + 0.5\, R_c\, I_c - \frac{L_c\, I_c}{T} - \frac{I_c\, T}{12C_o} \qquad (3)$$

where δ (t) is the δ_- function corresponding to $t = nT$.

The same voltage, due to the current flowing through it, is impressed across the choke. It is convenient to consider the choke current as consisting of four components:

$$i_{ch} = i_{ch1} + i_{ch2} + i_{ch3} + i_{ch4} \qquad (4)$$

With

$$f_1\,(i_{ch1}) = -\frac{I_c}{2\,C_o T}\,t^2$$

$$f_2\,(i_{ch2}) = -I_c\left(\frac{R_c}{T} - \frac{1}{2C_o}\right)t \qquad (5)$$

$$f_3\,(i_{ch3}) = L_c\, I_c\, \delta\,(t)$$

$$f_4\,(i_{ch4}) = I_c\left(0.5\, R_c - \frac{L_c}{T} - \frac{T}{12C_o}\right)$$

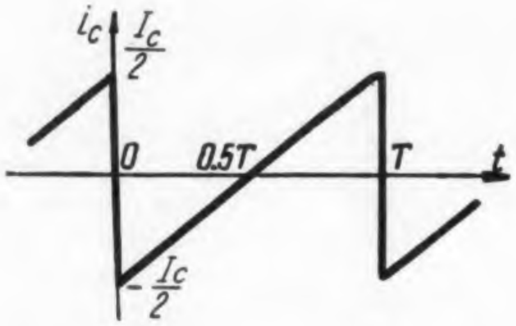


Fig. 2. Output current waveform of the sweep generator. The return time is assumed to be zero.

The current i_{ch1} is obtained from:

$$L_{ch}\frac{di_{ch1}}{dt} - R_{ch}\, i_{ch1} = -\frac{I_c}{2C_oT}\, t^2 \qquad (6)$$

The function on the right side of the equation is periodic, with a period T. This differential equation is solved by operational calculus methods.

$$i_{ch1}\,(p) = \frac{I_c}{2C_oT}\left[\frac{t^2\,(p)}{pL_{ch} + R_{ch}}\right] \qquad (7)$$

where:

$$t^2(p) = \frac{1}{1 - e^{-pt}}\int_0^T t^2\, e^{-pt}\, dt = \frac{T^2\, e^{-pt}}{p(1 - e^{-pt})}$$

$$-\frac{2T\, e^{-pt}}{p^2(1 - e^{-pt})} + \frac{2}{p^3} \qquad (8)$$

The inverse transform of i_{ch1} is found by integrating over the contour L, which includes the imaginary axis of the complex plane p, Fig. 3.

$$i_{ch1}\,(t) = \frac{1}{2\,\pi\, i}\int_L i_{ch1}\,(p)\; e^{pt}\, dp$$

$$= \frac{I_c}{2C_oT}\left[-\frac{T^2}{2\pi\, i}\int_L \frac{e^{p(t\,-\,T)}\, dp}{p(1 - e^{-pT})(pL_{ch} + R_{ch})}\right.$$

$$-\frac{2T}{2\,\pi\, i}\int_L \frac{e^{p(t\,-\,T)}\, dp}{p^2\,(1 - e^{-pt})(pL_{ch} + R_{ch})}$$

$$+\frac{2}{2\,\pi\, i}\int_L \frac{e^{pt}\, dp}{p^3\,(pL_{ch} + R_{ch})}$$

$$\left. = \frac{I_c}{2C_oT}\left(-\,T^2\int_1 - 2T\int_2 + 2\int_3\right)\right]. \qquad (9)$$

The first integral can be represented as a difference of two integrals, one along the contour L_1, which includes the entire left half plane and the imaginary axis, and the second along the contour

Selecting a duplexer for high-power applications involves consideration of peak power, average power, transmit loss, receive loss, expected life, and versatility of operation.

All Microwave Associates high power gas duplexers utilize special window structures for optimum switching efficiency without sacrifice in low-level loss characteristics. These windows insure reliable, long-life performance. Both our gas and ferrite duplexers may be operated over very broad bandwidths at the common microwave frequencies.

Exceptionally complete ultra-high-power design and test equipment is utilized by our Research and Production Departments. Each duplexer is fully tested at maximum rated power before shipment.

We have extensive experience in designing and manufacturing high-power duplexer devices and are interested in working on newest ultra-high-power applications. We are now developing ultra-high-power duplexers for more efficient switching at UHF, L, C, and S bands.

Our Applications Engineers would like to discuss the future of high power duplexing with you.

LEADS THE INDUSTRY IN ULTRA-HIGH-POWER DUPLEXING

with both GAS DISCHARGE and FERRITE DUPLEXERS

Frequency Band	Duplexer Type	Peak Power	Average Power	Transmit Loss (max.)	*Receive Loss (max.)	Bandwidth
UHF	Gas	5 Mw	300 Kw	0.1 db	0.4 db	Tunable
	Gas	25 Mw	75 Kw	0.1 db	0.4 db	10% Nominal
L	Gas	25 Mw	50 Kw	0.1 db	0.5 db	
S	Gas	6 Mw	30 Kw	0.1 db	0.7 db	
	Ferrite	3 Mw	5 Kw	0.5 db	0.9 db	
C	Gas	5 Mw	5 Kw	0.1 db	0.7 db	
	Ferrite	5 Mw	7.5 Kw	0.3 db	0.8 db	
X	Gas	500 Kw	500 W	0.2 db	1.0 db	
	Ferrite	1 Mw	1 Kw	0.3 db	0.9 db	
Ku	Gas	150 Kw	150 W	0.2 db	1.0 db	
	Ferrite	150 Kw	150 W	0.3 db	0.9 db	
Ka	Ferrite	75 Kw	75 W	0.3 db	1.1 db	4% Nominal

All Microwave Associates duplexers incorporate low-loss, long-life, receiver protectors which guarantee crystal protection over wide temperature ranges and under extreme environmental conditions.

*The duplexer receiver loss includes the loss due to receiver protector TR tubes.

Visit us at IRE Booth 2301-2303

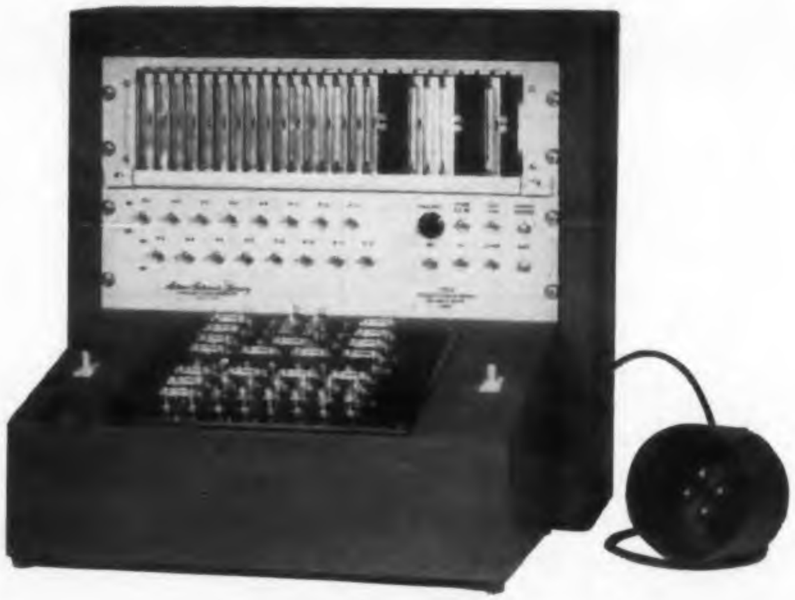
At each frequency band of the microwave spectrum, Microwave Associates has devices for efficient switching of high power.

MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS

Western Union FAX-TWX: Burlington, Mass., 942 • BRowning 2-3000

CIRCLE 759 ON READER-SERVICE CARD



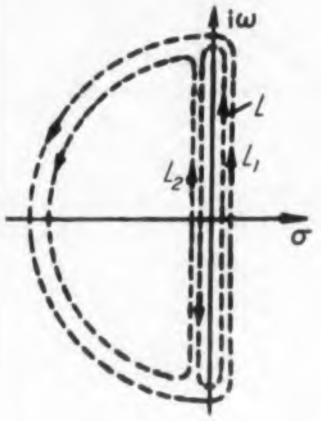


Fig. 3. The choke current can be found by performing two integrations—one along path L_1, whiche includes the entire left half plane and the imaginary axis, and the other along path L_2, which includes only the left half plane.

L_2, which includes only the left half plane, Fig. 3.

$$\int_1 = \frac{1}{2\pi i}\int_{L_1}\frac{e^{p(t-T)}\,dp}{p(1-e^{-pT})(pL_{ch}+R_{ch})} - \frac{1}{2\pi i}\int_{L_2}\frac{e^{p(t-T)}\,dp}{p(1-e^{-pT})(pL_{ch}+R_{ch})} \qquad (10)$$

Since:

$$\frac{1}{1-e^{-pT}} = 1 + e^{-pT} + e^{-2pT} + e^{-3pT} + \ldots \qquad (11)$$

the integral along L_1 can be broken into a series of integrals, the numerator of which is exponential in $p(t-kT)$. To satisfy the Jordan lemma it is necessary that $Re\,[p(t-kT)] < 0$, that is, that the real part of p be positive. This requires that the contour L_1 be closed in the right half plane, where the integrand has no singularity; the integral over L_1 therefore vanishes. The second integral in Eq. 10 is equal to the residue at the pole, $p = -R_{ch}/l_{ch}$, and therefore

$$\int_1 = \frac{-e^{-pt}}{R_{ch}\,(1-e^{-pT})} \qquad (12)$$

where:

$$\alpha = \frac{R_{ch}}{L_{ch}}$$

The integral $\int_2$ can also be found by piecewise integration, with the integral over L_1 again vanishing for the same reason as above, and the integral over L_2 being equal to the residue at the pole, $p = -R_{ch}/L_{ch}$.

$$\int_2 = \frac{L_{ch}}{R_{ch}^2\,(1-e^{\alpha T})} \qquad (13)$$

The integral $\int_3$ equals the residue at the third-order pole, $p = 0$

$$\int_3 = \frac{1}{2\,R_{ch}}\left(\frac{2}{\alpha^2} - \frac{2\,t}{\alpha} + t^2\right) \qquad (14)$$

Thus, the choke current i_{ch1} is equal to

$$i_{ch1} = \frac{I_c}{R_{ch}\,C_oT}\left[\frac{T\left(\frac{T}{2} - \frac{1}{\alpha}\right)}{1 - e^{-\alpha T}}\,e^{-\alpha t} + \frac{1}{\alpha^2} - \frac{t}{\alpha} + \frac{t^2}{2}\right]$$

Expressions for i_{ch2}, i_{ch3} and i_{ch4} are obtained in analogous manner, and the values of these currents are

$$i_{ch2} = \frac{I_cT}{R_{ch}}\left(\frac{R_c}{T} - \frac{1}{2C_o}\right)\left[\frac{t}{T} + \frac{e^{-\alpha t}}{1 - e^{-\alpha T}} - \frac{1}{\alpha T}\right], \quad (16)$$

$$i_{ch3} = -\frac{I_cL_c}{L_{ch}}\,\frac{e^{-\alpha t}}{1 - e^{-\alpha T}}, \quad (17)$$

$$i_{ch4} = \frac{I_c}{R_{ch}}\left[\frac{L_c}{T} - 0.5R_c + \frac{T}{12C_o}\right]. \quad (18)$$

The total ac component of the plate current of the tube is

$$i_{ac} = i_c + i_{ch1} + i_{ch2} + i_{ch3} + i_{ch4}$$

$$= I_c\left[Ae^{-\alpha T}\left(\frac{t}{T}\right) + B\left(\frac{t}{T}\right)^2 + C\,\frac{t}{T} + D\right], \quad (19)$$

where:

$$A = \frac{1}{1 - e^{-\alpha T}}\left(\frac{R_c}{R_{ch}} - \frac{1}{\alpha\,R_{ch}C_o} - \frac{L_c}{L_{ch}}\right), \quad (20)$$

$$B = \frac{T}{2R_{ch}C_o}, \quad (21)$$

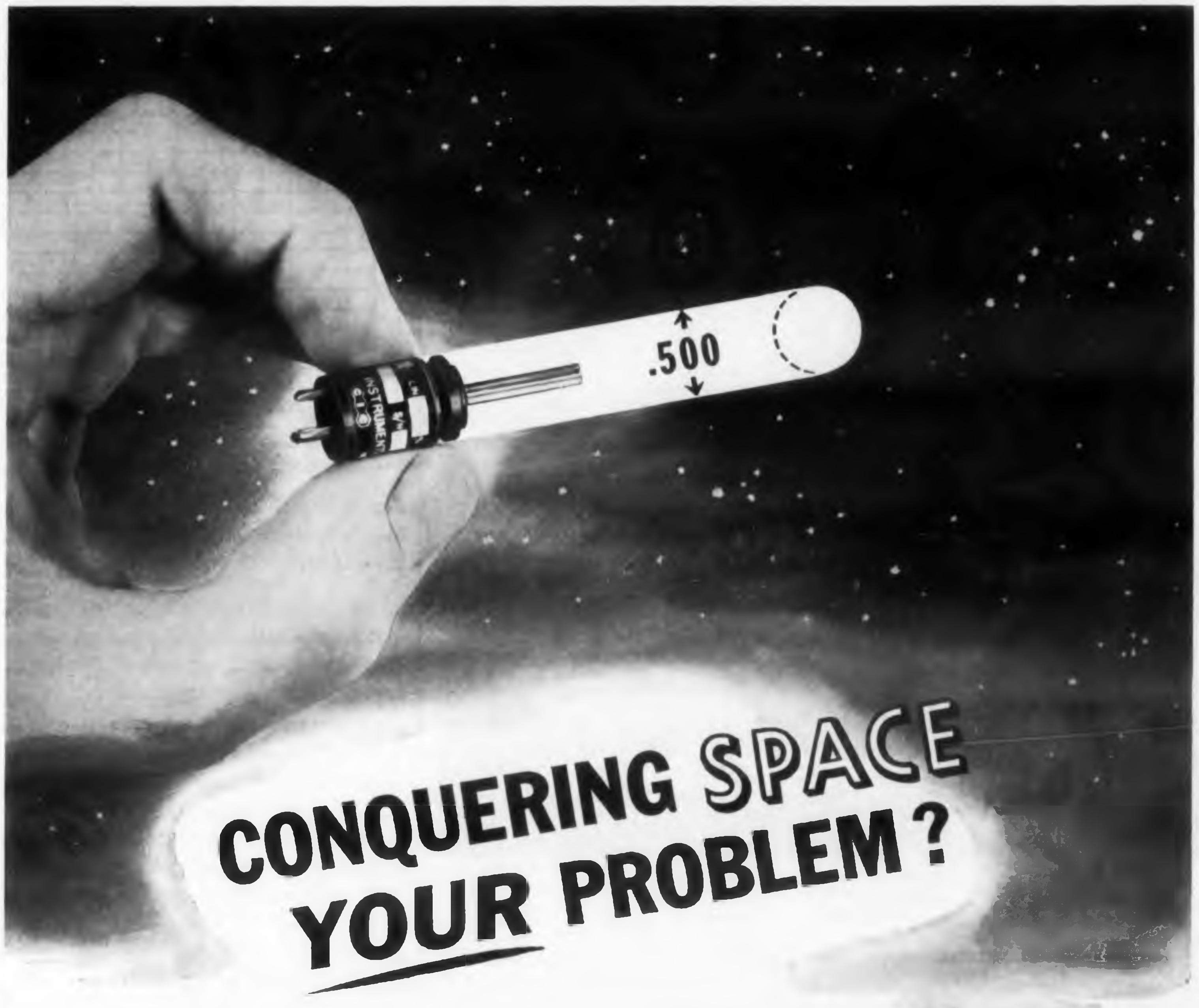
$$C = 1 + \frac{1}{R_{ch}}\left(R_c - \frac{1}{\alpha\,C_o} - \frac{T}{2C_o}\right), \quad (22)$$

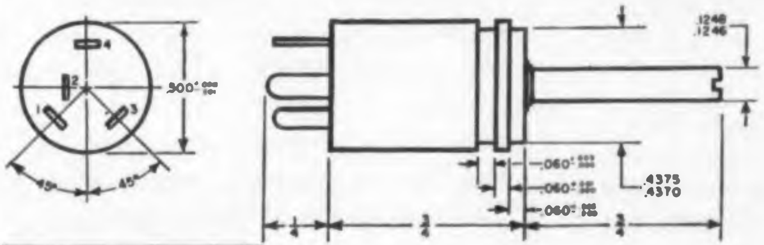
$$D = \frac{1}{R_{ch}}\left[\frac{L_c}{T} + \frac{T}{12C_o} + \left(0.5 + \frac{1}{\alpha\,T}\right)\left(\frac{1}{\alpha\,C_o} - R_c\right)\right]. \quad (23)$$

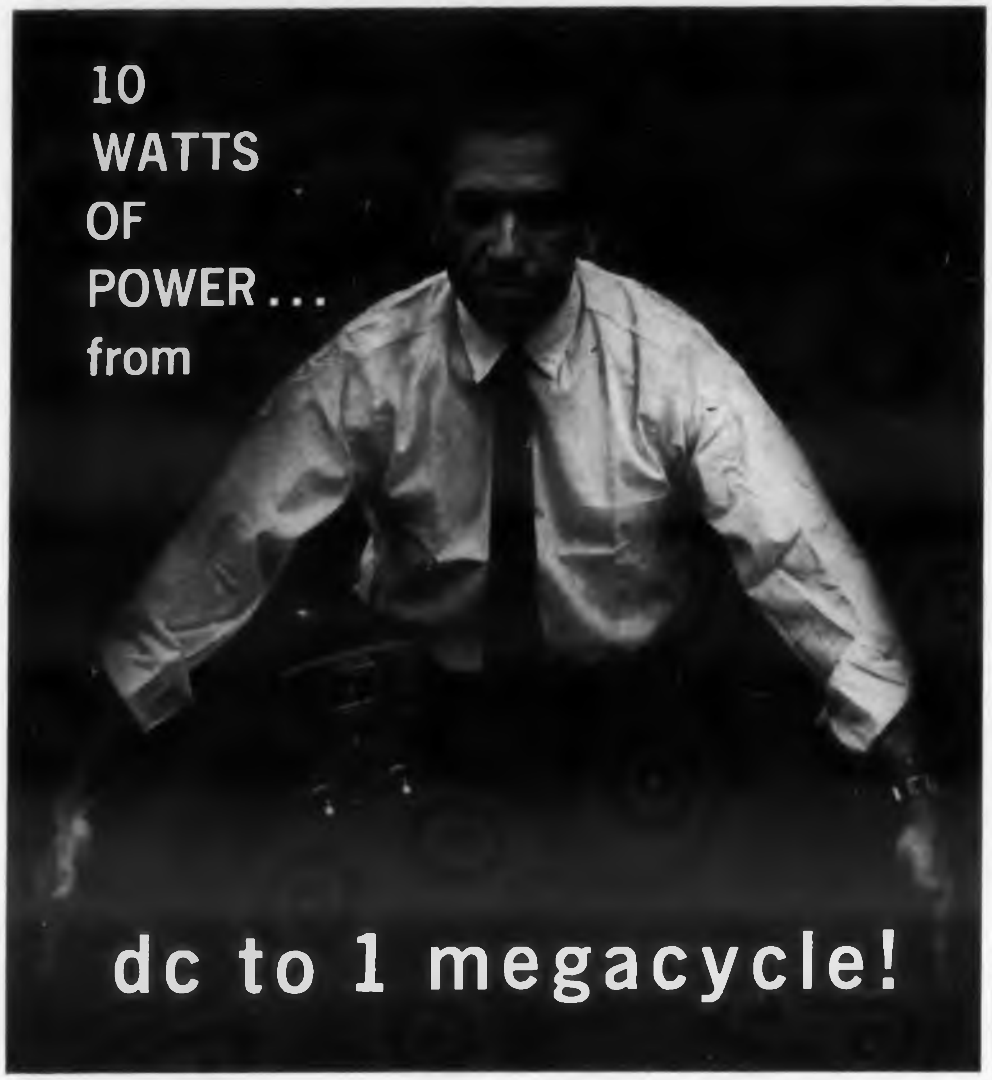
Calculating the Rise Time Excitation

Expressions 3 and 19 make it possible to draw a load line on the tube plate characteristics. With the aid of this load line the required wave form of the excitation voltage during the rise time can be determined. It is necessary to select the values of the dc components of the plate current and plate voltage of the tube, that is, the position of the operating point. This choice is made by a trial and error method in which maximum deflecting current linearity is sought.

In the first trial, it is advisable to select the point corresponding approximately to transformer-coupled operation as the dc operating point. Note that the voltage drop across the choke and the







NEW from Krohn-Hite: this unique combination of power and bandwidth! The Model DCA-10 direct-coupled amplifier allows you to increase power of all sources from dc to one megacycle, without the bother of changing amplifiers or bandswitching!

The DCA-10's low distortion (0.1%) makes it the perfect complement for low-distortion, quality oscillators — for unexcelled performance over the entire frequency range.

Output — to 300 volts peak to peak, to 600 milliamperes peak to peak. Frequency response is flat within one db, from dc to 1 mc. Stability is excellent for both output dc level and gain.

The Model DCA-10 direct-coupled amplifier provides high, distortion-free power over the entire range from sub-sonic into radio-frequencies. Twenty watts of push-pull power can be obtained from two DCA-10's cascaded. If this high-quality, flexible amplifier can fill a need for you, write for full information.

Other Krohn-Hite amplifiers include the direct-coupled 50 watt DCA-50, and the ultra-low distortion (0.005%) 50 watt UF-101A. *Also, Krohn-Hite Oscillators, Filters and Power Supplies.*

See us at IRE Booth 3708-3710

KH

KROHN-HITE CORPORATION
580 Massachusetts Avenue • Cambridge 39, Mass.
Pioneering in Quality Electronic Instruments

CIRCLE 762 ON READER-SERVICE CARD

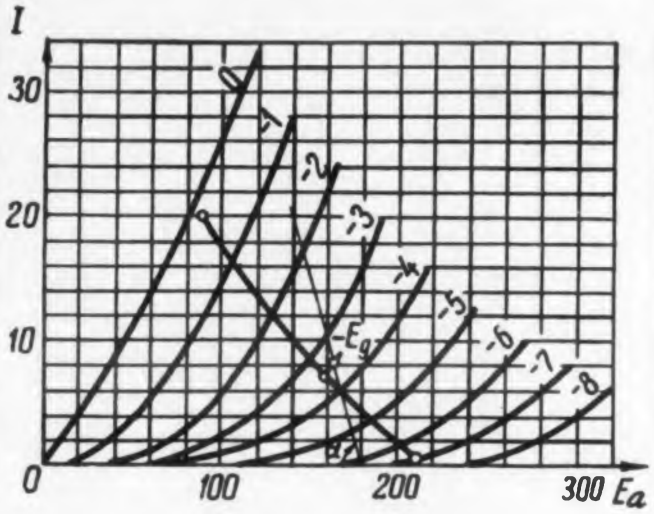


Fig. 4. The dc operating point on the plate characteristics is assumed to be the origin of coordinates for the ac load line.

cathode resistance must be taken into account. From the point $e_a = E_b - |E_g|$ (E_b is the power supply voltage, E_g the grid bias), recommended for transformer-coupled operation, a dc load line is drawn at an angle $\alpha = \cot^{-1} R_{ch}$ to the abscissa. A dc operating point corresponding to $-E_g$, Fig. 4, is marked on this line. In the case of fixed bias, a dc load line is drawn through the point $e_a = E_b$.

The dc operating point is assumed to be the origin of coordinates for the ac components of the plate voltage and current. Using this coordinate system, an ac load line is drawn, from which the required wave form of the excitation voltage is obtained. However, since the required wave form can be determined only approximately, there is no need for drawing the entire line.

At best, the actual excitation voltage, usually obtained by charging a capacitor through a resistance, will coincide with the required sweep voltage in only three points. Therefore, the entire calculation is performed only for these three points, selected beforehand, which are chosen to correspond to $t = 0$, $t = 0.5T$, and $t = T$. For these values of t, the ac components of the plate voltage and current, e_{ac} and i_{ac}, are calculated and note is made of the corresponding points on the family of the plate characteristics, Fig. 4.

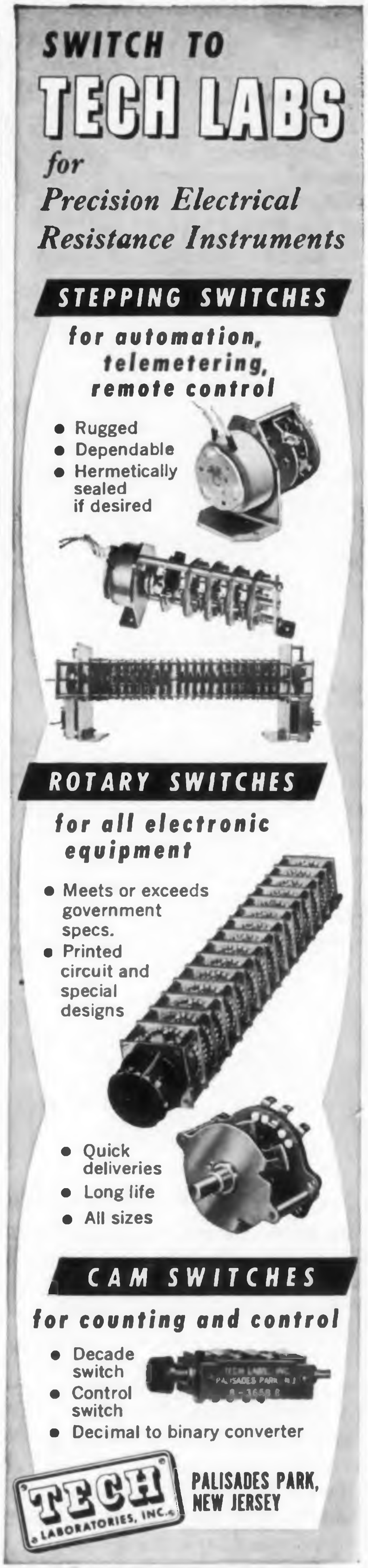
From the positions of these points on the plate characteristics, the necessary instantaneous values of the excitation voltage, e_{g0}, $e_{g0.5}$ *and* e_{gT}, can be determined.

The excitation voltage swing during the rise time is

$$e_{gm} = | e_{gT} - e_{g0} | \qquad (24)$$

The nonlinearity of the excitation voltage is characterized by the quantity

$$\Delta e_g = | e_{g0.5} - e_{g0} | - | e_{gT} - e_{g0.5} | \qquad (25)$$


SWITCH TO
TECH LABS
for
Precision Electrical Resistance Instruments

STEPPING SWITCHES
for automation, telemetering, remote control
- Rugged
- Dependable
- Hermetically sealed if desired

ROTARY SWITCHES
for all electronic equipment
- Meets or exceeds government specs.
- Printed circuit and special designs
- Quick deliveries
- Long life
- All sizes

CAM SWITCHES
for counting and control
- Decade switch
- Control switch
- Decimal to binary converter

TECH LABORATORIES, INC.
PALISADES PARK, NEW JERSEY

SEE US AT BOOTH 2120 I.R.E. SHOW

CIRCLE 763 ON READER-SERVICE CARD

Special Sockets and Connectors

by jettron®

...FROM DESIGN TO PRODUCTION

Jettron is fully-equipped to design and manufacture your precision electronic components including connectors, sockets and cable assemblies. Call or write Jettron for quotations on "specials" for all commercial and military applications.

Ultra High Frequency Socket Type CD-7620
For the 2C39 family of tubes, including the General Electric GL-6897 and the Eimac 3CX100A5, features very low capacitance from cathode or anode to ground.

Input Connector Type CD-7700
For the Western Electric 6280/416B planar type triode. Has 18 spring fingers making contact with the RF cathode; specially designed beryllium copper contacts.

Ultra High Frequency Socket Type CD-8210
Designed by Jettron for use with the General Electric GL-6442 and similar lighthouse tubes. Features very low capacitance from cathode or anode to ground.

JETTRON PRODUCTS • INC
56 Route 10, Hanover, New Jersey
Telephones: TUcker 7-0571-0572
Sales Engineers in Principal Cities

CIRCLE 764 ON READER-SERVICE CARD

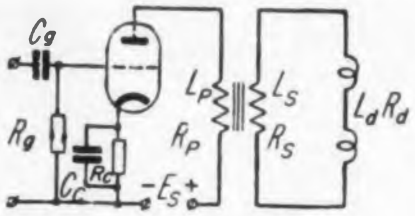


Fig. 5. Output circuit of a vertical sweep generator with transformer-coupled load.

To obtain the required excitation voltage swing during the rise time, and after the maximum circuit charging voltage has been specified, the charging circuit time constant must be determined. The next step is to determine Δe_g of the resultant excitation voltage and to compare it with the specified value of Δe_g. It is desirable that these quantities differ by not more than 5-10 per cent. If the discrepancy is too great, it is necessary to change the position of the computed points (that is, of the load line) by changing the grid bias. All the computation points are shifted by equal displacements along a line inclined to the abscissa at a fixed angle. In the case of a fixed bias, this angle is

$$\alpha = \cot^{-1} R_{ch} \qquad (26)$$

In the case of cathode bias, this angle is

$$\alpha' = \cot^{-1} R_{ch} \frac{\mu - 1 - \dfrac{R_i}{R_{ch}}}{\mu + 1 + \dfrac{R_{ch}}{R_i}} \qquad (27)$$

The foregoing analysis and method of calculation apply only to the rise time of the sweep. The high pulse voltage that develops on the plate during the return sweep means that a negative pulse of definite amplitude must be applied to the grid of the tube. This pulse, as is known, is obtained by means of a peaking resistance, whose value can be calculated from:

$$R_{peak} = \frac{L_e}{C_a\left(R_c + R_i + \dfrac{R_c R_i}{R_{ch}}\right)}$$

where C_a is the capacitance of the charging capacitor, and R_i is the internal resistance of the output tube.

Transformer Load Design

The design of a transformer-coupled output stage is similar to that given above, however the expressions for e_{ac} and i_{ac}, and also for several other quantities, are different.

Fig. 5 shows the output stage with a transformer coupled load, while Fig. 6 shows the corresponding equivalent plate circuits. In these diagrams L_p and R_p are the inductance and resistance of the primary winding, L_s and R_s are the same

DRAFTING TRENDS

This versatile, easy-to-handle, adjustable triangle is made of yellow-tinted optical-grade acrylic plastic. A clean-cut oval track fitted with metal knurled knob assures ease of operation and lasting tight fit.

New combination protractor-triangle speeds up drafting

Architects, Engineers, Builders, Field Surveyors, Mathematicians—anyone who develops solutions to measurement problems indirectly to determine a wanted measurement graphically or mathematically—will find the Trig-Matk Adjustable Triangle a handy tool. It eliminates much of the graphic work necessary in estimating results or in checking for correct answers.

Versatility with accuracy

Basically the new POST Trig-Matk Adjustable Triangle is a mathematician's tool—accurate to three decimal places.

It combines the functions of a protractor and a triangle into a simple unit, with two fundamental trigonometric relationships of a right triangle. The Trig-Matk provides accuracy within 0.1% in problems dealing with any of the six trigonometric ratios of the sides of a right triangle.

The adjustable protractor has three sets of graduations. One set is graduated in half degrees, labeled *Degrees*, and permits the use of the Trig-Matk as a protractor setting for determining any angle from 0 to 90 degrees.

The second set of graduations, labeled *Slope*, shows directly the *Secant* trigonometric ratio of the angle indicated on the degree scale. The third scale, labeled *Rise*, indicates directly the *Tangent* trigonometric ratio shown on the degree scale.

Examples

This new tool has a host of drafting and engineering applications. Highway designers find the Trig-Matk very useful when making cross sections of roadways at ground level or below. By setting the *Slope* scale to the degree desired, road-curve grades are automatically determined. The protractor can be used to determine the angle of highway ingress and egress lanes.

An indicated angle of 40 degrees on the TrigMatk (1589) shows directly that the Rise is 8.4 to the base of 10.

Structural Engineers will find the Trig-Matk Adjustable Triangle a simple tool, eliminating the use of both a scale and individual triangles. In addition to the time saved, many of the errors usually associated with the older method are avoided. The Trig-Matk design eliminates the need of frequent reference to handbooks for information on various bevels.

Two Bases

The Trig-Matk No. 1589-12 has a 12" base scale for handy calculation in terms of feet and inches. Number 1589-10 has a metric base scale of 10.

Keep posted on all the latest trends in drafting. Consult your local POST *dealer, or write to Frederick Post Co., 3644 North Avondale Ave., Chicago 18, Ill.*

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

CIRCLE 765 ON READER-SERVICE CARD


photo ½ actual size

NEW

HIGH-SPEED, MINIATURE STEPPING SWITCH

For: Automatic switching, circuit selection, and timing-control

Featuring: • 80 steps per second on impulse drive • 30 contacts per bank • maximum 12 banks • only 17 oz. in weight • unique sequence switching

Write today for complete technical data on the unique Miniature Uniselector — ALSO on the Two-Way and One-Way Stepping Switches.

IMTRA CORPORATION

11 University Rd., Cambridge 38, Mass.
U.S. AGENTS FOR GENERAL ELECTRIC COMPANY, LTD. OF ENGLAND

CIRCLE 766 ON READER-SERVICE CARD


tOtal2 gives you the Superior Solution to Retaining Ring Problems!

FREE
Technical Bulletin Service
shows how to solve toughest problems!

it takes 2 modern types of retaining rings to solve all of your retaining ring problems
—AND—
only RAMCO has BOTH!

the 360° coil-formed ring SpirOlox
the improved die-formed ring CircOlox

849

Mail this coupon today!

RAMSEY CORPORATION
Box 513, Dept. P St. Louis 66, Missouri
Without cost or obligation, put my name on your Technical Bulletin Service list and send your latest Catalog.
Name..........
Address..........
City..........Zone........State..........

CIRCLE 767 ON READER-SERVICE CARD

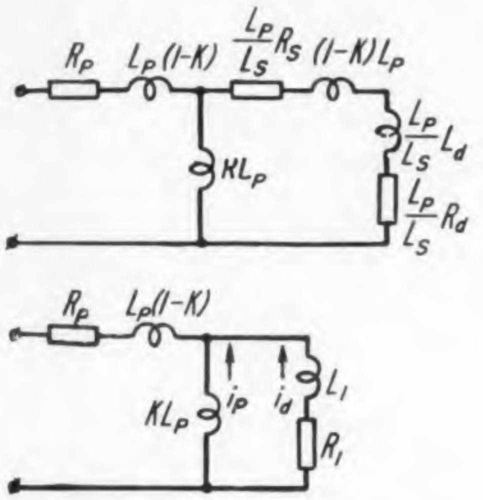


Fig. 6. Equivalent plate circuits for the transformer-coupled output stage.

for the secondary winding, L_d and R_d are the same for the deflecting system, and k is the coupling coefficient for the transformer windings. The analysis is based on the equivalent circuit of Fig. 6b, in which:

$$L_1 = \frac{L_p}{L_s} L_d + (1 - k) L_p \qquad (28)$$

and:

$$R_1 = \frac{L_p}{L_s} (R_d + R_s) \qquad (29)$$

The current in the deflecting plates during the rise time of the sweep is:

$$i_d = I_d \left(\frac{t}{T} - 0.5\right)$$

The current in the L_1 R_1 branch is:

$$i_c' = I_c' \left(\frac{t}{T} - 0.5\right)$$

where:

$$I_c' = I_c \sqrt{\frac{L_s}{L_p}} = I_c \frac{\omega_s}{\omega_p}$$

The voltage across the L_1 R_1 branch is:

$$e_1 = -R_1 I_d' \frac{t}{T} + L_1 I_d' \delta (t) + \left(\frac{R_1}{2} - \frac{L_1}{T}\right) I_d'$$

$$e_1 = -\kappa L_p \frac{di_p}{dt}, \qquad (30)$$

where:

$$i_{pas} = -\frac{1}{\kappa L_p} \int e_1 dt + C' = I_d \left[\frac{R_1 T}{2\kappa L_p} \left(\frac{t}{T}\right)^2\right.$$


Here Is The Answer To Every COIL FORM REQUIREMENT

Complete Coil Form Service....

Arbor List of Over 2000 Sizes

High dielectric kraft, fish paper, cellulose acetate, DuPont Nylon, Resinite and combination tubes for any electrical/electronic application.

Any shape—round, square, oval, rectangular, triangular or special. Any I.D., O.D. or length. All promptly available.

Ask about our special mandril and fabricating services

Request Arbor List and Bulletin today. Send specifications for free samples.

PRECISION PAPER TUBE CO.
2055 WEST CHARLESTON STREET • CHICAGO 47, ILL.
Plant No. 2: 1 Flower Street, Hartford, Conn.
REPRESENTATIVES THROUGHOUT UNITED STATES AND CANADA

CIRCLE 768 ON READER-SERVICE CARD


modern, low-cost way to precision measurements...

AEROVOX DECADE BOXES

Inductance, Resistance and Capacitance Decades in extra-compact and rugged design for accurate and dependable performance. Quality components used throughout to provide the same precise quality standards, electrically and mechanically, as finest lab-style equipment.

Units housed in heavy-duty, seamless steel cases with durable gray finish. All one size—5⅛"L x 3⅛"W x 2$^{13}/_{16}$"H. Black face plates with white markings. Highest value multiplier on left.

Available from all Aerovox Parts Distributors, write for descriptive literature...

AEROVOX CORPORATION
DISTRIBUTOR DIVISION
New Bedford, Massachusetts

CIRCLE 769 ON READER-SERVICE CARD

WHITE METAL

extruded this complex spool member in magnesium alloy AZ-31B. It has three radial support arms, interconnecting hub & external shell. Cylindrical surface takes high finish. 2-1/16" O.D.; 0.12" wall.

see WHITE METAL for your complex MAGNESIUM alloy EXTRUSIONS

WHITE METAL . . . and WHITE METAL alone . . . has the engineering experience and integrated magnesium facilities to turn many "impossible" designs into reliable, spec-meeting extrusions . . . at lower cost.

Versatile WHITELIGHT magnesium gives you a virtually unlimited choice: any length, any shape, any alloy, any finish.

Call on our Sales Engineers for help in solving your complex shape problems. No obligation, of course. WRITE, WIRE OR PHONE TODAY!

Send for fact-filled brochure on properties, uses, etc. of WHITELIGHT MAGNESIUM

WHITE METAL ROLLING & STAMPING CORP.
114 Moultrie St., Brooklyn 22, N. Y. • Phone EV 9-4134
Plants: Warsaw, Ind. & Brooklyn, N. Y.
One of the World's Largest Producers of Magnesium Alloy Mill & Finished Products

CIRCLE 770 ON READER-SERVICE CARD

DRAKE ***"Tinylite"***

Lampholders and Indicator Light Assemblies are the ideal units for space saving . . .

The advent of the much smaller "Tinylite" style lamps opens up many new possibilities for miniaturizing all kinds of devices—dial lighting, instrument indicators, scale lighting on transistor radios, toys and novelties are a few examples.

DRAKE now offers a series of "Tinylite" Midget Screw Lampholders only 1/5 as large as standard units (with lamp installed); and "Tinylite" Type No. 121 Midget Indicator Light Assemblies, the smallest available Indicator Lights with replaceable lamp and completely insulated from housing, supplied either with plastic dome lens or flat cap, lettered or numbered, and complete with lamp.

Investigate the many possibilities with these skilfully engineered subminiature units, which can save you both space and money.

★ SEND FOR DATA SHEETS, QUICK REFERENCE CATALOG OF THE BIG DRAKE LINE

DRAKE MANUFACTURING COMPANY
4624 N. OLCOTT AVENUE • CHICAGO 31, ILLINOIS

MINIATURE LIGHTING SPECIALISTS

CIRCLE 771 ON READER-SERVICE CARD

$$-\frac{T}{\kappa L_p}\left(\frac{R_1}{2}-\frac{L_1}{T}\right)\frac{t}{T}+\frac{T}{2\kappa L_p}\left(\frac{R_1}{6}+\frac{L_1}{T}\right)\Bigg]. \quad (31)$$

The plate current of the tube is:

$$i_{ac} = i_d + i_{p\,ac} = I_d\left[B\left(\frac{t}{T}\right)^2 + C\,\frac{t}{T} - D\right], \quad (32)$$

where:

$$\left.\begin{aligned} B &= \frac{R_1 T}{2\kappa L_p} \\ C &= 1 - \frac{T}{\kappa L_p}\left(\frac{R_1}{2}-\frac{L_1}{T}\right) \\ D &= \frac{1}{2}\left[1-\frac{T}{\kappa L_p}\left(\frac{R_1}{6}-\frac{L_1}{T}\right)\right] \end{aligned}\right\}. \quad (33)$$

This current produces a voltage drop across R_p and L_p $(1 - k)$:

$$\begin{aligned} e_2 = -L_p(1-\kappa)\frac{di_a}{dt} - R_p i_{ac} &= \frac{I_d R_1 R_p T}{2\kappa L_p}\left(\frac{t}{T}\right)^2 \\ &- I_d\left\{\frac{R_1(1-\kappa)}{\kappa} + R_p\left[1-\frac{T}{\kappa L_p}\left(\frac{R_1}{2}-\frac{L_1}{T}\right)\right]\right\} \\ &\frac{t}{T} - \frac{I_d L_p(1-\kappa)}{T}\left[1-\frac{T}{\kappa L_p}\left(\frac{R_1}{2}-\frac{L_1}{T}\right)\right] \\ &+ I_d\frac{R_p}{2}\left[1-\frac{T}{\kappa L_p}\left(\frac{R_1}{6}-\frac{L_1}{T}\right)\right]. \end{aligned} \quad (34)$$

The voltage across the tube plate during rise time is

$$e_{ac} = e_1 + e_2 = I_d\left[K\left(\frac{t}{T}\right)^2 + M\,\frac{t}{T} + N\right], \quad (35)$$

where:

$$\left.\begin{aligned} \kappa &= -\frac{R_1 R_p T}{2\kappa L_p} \\ M &= -\left\{\frac{(1-\kappa)R_1}{\kappa} + \right. \\ &\quad \left. R_p\left[1-\frac{T}{\kappa L_p}\left(\frac{R_1}{2}-\frac{L_1}{T}\right)+R_1\right]\right\} \\ N &= \frac{R_1}{2} - \frac{L_1}{T} - \frac{L_p(1-\kappa)}{T} \\ &\quad \left[1-\frac{T}{\kappa L_p}\left(\frac{R_1}{2}-\frac{L_1}{T}\right)\right] \\ &\quad + \frac{R_p}{2}\left[1-\frac{T}{\kappa L_p}\left(\frac{R_1}{6}-\frac{L_1}{T}\right)\right] \end{aligned}\right\}. \quad (36)$$

Expressions 32 and 35 make it possible to draw the load line and compute the excitation voltage

New Coincidence Indicator For Transistor Monitor Circuitry

KP-150, Actual Size

The KP-150 is a subminiature glow-discharge indicator tube for transistor monitor service, which eliminates over a dozen other circuit components for coincidence applications; acts as an "and" gate; indicates. Its output may be used as a control, e.g., to close a relay. The KP-150 operates (glows) only when two coincident, low voltage signals are applied to its dual grids. This tube is specifically designed for transistor monitor service, and requires very low signal voltage and currents, thus preventing loading of the test circuit. The KP-150, operated, with AC on the anode, is grid-controlled, that is, will conduct (glow) when a grid signal is present, and is off when the signal is removed. For "memory" applications, the KP-150 may be used with DC anode supply. In this case, the operation is that of a conventional thyratron. The tube remains on (glows) until the anode current is interrupted, thus providing an electrical memory. A bright, "ball-of-fire" discharge provides exceptional visual indication which fills the tip of the tube, indicating in areas of high ambient light without special masking. No special mounting orientation is needed, as the tubes may be viewed from any angle. The KP-150 is in production and in stock. A single control type, the KP-145A is also available. For further details, data sheets, etc., contact

KIP ELECTRONICS CORPORATION
Dept. 611, Box 562, Stamford, Connecticut
CIRCLE 772 ON READER-SERVICE CARD

New Cold Cathode Thyratrons Stable, Rugged, Subminiature

The KP-96 is a high gain, grid controlled cold cathode tube for time delay, trigger, counter and energy transfer circuits. New design features include small size (T-2) subminiature envelope, only 0.3" in diameter, rugged construction and stable anode hold-off and grid-firing voltages. Within the anode supply voltage range of 100-300 v, the firing of the tube is controlled by application of voltage to the grid (95v). The transfer current is far lower than previously available, equalling less than 1.0 microampere. The KP-96 offers a higher ratio of anode hold-off voltage to grid-firing voltage than available before, smaller size, rugged structure, operation in both light and total darkness, high efficiency energy transfer. Since it requires no filament power supply, the KP-96 stands by at full sensitivity consuming no power. Radioactivity is included for operation in total darkness. Another model, type KP-96A, is available without radioactivity for use under ambient light conditions. *For details on this and other special purpose electron tubes, write*

KIP ELECTRONICS CORPORATION
Dept. 610, STAMFORD, CONNECTICUT
CIRCLE 773 ON READER-SERVICE CARD

NOW!

deep drawn MAGNESIUM BOXES AND COVERS in standard sizes

NO TOOLING COST!

Now, for the first time you can order standard deep drawn magnesium boxes and covers, in sizes ranging from 1½" to 18½", all in a full range of depths, *from stock tooling!* Thousands of sizes to choose from . . . all with no tooling cost! Fast delivery, in most cases from stock.

Your inquiry is invited on custom magnesium deep drawn parts. Low cost "Zero-Method" tooling makes even short runs practical and economical. Contact your Zero Representative or send print for quotation.

WRITE FOR NEW MAGNESIUM BOX CATALOG

Zero

ZERO MANUFACTURING CO.
1121 Chestnut Street, Burbank, California
Telephone Victoria 9-5521 • TWX BRK-9862
Factories in Burbank, California and Palmer, Mass.
representatives in 26 key cities nationwide

CIRCLE 774 ON READER-SERVICE CARD

* If It's New, It's No Doubt Mystik

NEW! 7000-G TAPE for
Extreme Temperature Range —110° to +550° F.

MYSTIK BRAND FIBERGLAS TAPE
with Silicone Adhesives

A new concept in pressure-sensitive tapes—an essentially inorganic pressure-sensitive tape accepted by the aircraft, electrical and electronics industry.

7000-G has a tightly woven, high-tensile Fiberglas® backing with a pressure-sensitive silicone adhesive. Superior thermal and electrical properties make it ideal for many applications previously not possible for pressure-sensitive tape.

(Conforms to Government Specification MIL-1-19166. Approved as Class H Insulation.)

Write for full information on Mystik Brand 7000-G and the complete Mystik line of high and low temperature tapes using silicones with Mylar®, aluminum, copper, and Teflon.

Mystik Adhesive Products, Inc.
2635 North Kildare Ave.
Chicago 39, Illinois

MYSTIK BRAND TAPES SELF-STIK

PACKAGING • PROTECTIVE COVERING • PRINTABLE • ELECTRICAL TAPES

CIRCLE 775 ON READER-SERVICE CARD

by the three-point method. The following expressions are also used:

$$\alpha = \cot^{-1} R_p, \tag{37}$$

$$\alpha' = \cot^{-1} R_p \frac{\mu - 1 - \frac{R_i}{R_p}}{\mu + 1 + \frac{R_p}{R_i}} \tag{38}$$

$$\tau = \frac{-T}{ln\left(1 - \frac{e_{0m}}{E_0}\right)}, \tag{39}$$

$$\Delta e_g = E_0 \left(1 - e^{-\frac{T}{2\tau}}\right)^2 + \frac{I'_d CT}{4C_c}, \tag{40}$$

where C is determined from

$$\left.\begin{aligned} C &= 1 - \frac{T}{dL_p}\left(\frac{R_i}{2} - \frac{L_1}{T}\right) \\ R_{peak} &= \frac{\frac{L_p}{L_s} L_d + 2\,(1 - d)\, L_p}{C_a\left(R_d + R_i + \frac{R_d R_i}{R_p}\right)} \end{aligned}\right\}. \tag{41}$$

The symbols in these expressions are the same as above.

This article abstracted from Design of Final Stage of a Vertical Sweep Generator by A. A. Zakharov in Radiotekhnika, *No. 11, November 1959, Vol. 14, pp. 43-51.*

Pulse-Input Rise Time in Pulse Transformer Design

L. Z. Gololitsyn

When pulse transformers are used in pulse generator circuits, the duration of the output-pulse front depends on the parameters of the pulse transformer, the resistances of the pulse generator and the load, and on the rise time of the input-pulse front.

The rise time used in the design of pulse transformers is determined from the equivalent circuit of the pulse transformer, Fig. 1. Usually it is assumed that a unit step voltage is applied to the circuit.

The equation for the front of the output pulse contains one variable parameter σ, and is given by the following function of time:

$$U_L(\Theta) = \frac{U_g R_L}{R_g + R_L} \left[1 - e^{-\sigma 2\pi\Theta}\left(\frac{\sigma}{\nu}\sin 2\pi\nu\Theta + \cos 2\pi\nu\Theta\right)\right], \tag{1}$$

where

$$\sigma = \frac{a}{\sqrt{b}}, \quad \Theta = \frac{\sqrt{b}}{2\pi} t, \quad \nu = \sqrt{1 - \sigma^2},$$

$$a = \frac{1}{2}\left(\frac{1}{R_L C} + \frac{R_g}{L}\right), \quad b = \frac{1}{LC}\left(1 + \frac{R_g}{R_L}\right).$$

Here U_L is the load voltage, U_g, the generator voltage, R_L, the load resistance, R_g, the generator resistance, C, the distributed winding capacitance, and L, the leakage inductance.

By plotting $U_L/U_g\,(1 + R_g/R_L)$ vs. Θ for various values of σ, it is possible to select the optimum

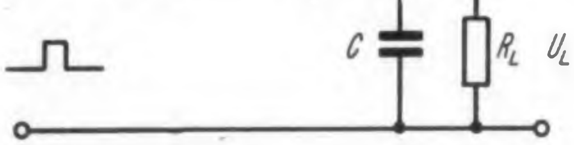


Fig. 1. Pulse transformer equivalent circuit.

CIRCLE 776 ON READER-SERVICE CARD ➤

value of σ, satisfying both qualifications of rise time and specified "overshoot" of the input pulse.

Usually σ is chosen to range from 0.7 to 1.2. For specific R_g and R_L, the length of the front (at $b =$ const) diminishes if $\sigma > 0.7$. However, the overshoot of the pulse will exceed 0.05 U_m, which as a rule is not a recommended load condition. With $\sigma > 1$, there is no overshoot at the peak of the pulse, but the front of the pulse is excessively stretched out.

If a pulse of finite rise time is applied to the transformer input, the transient depends not only on σ, but also on the rate of rise of the input-pulse front. In this case, a value of σ in the range from 0.7 to 1.2 may lead to an undesirable stretching where

$$\delta_0 = \frac{2\pi}{\sqrt{b}}\,\delta$$

In this case, the formula for the front of the output pulse contains the variable parameters σ and δ_0, and is also a function of the time Θ.

The form of the output voltage for different values of σ and δ_0, is shown in Fig. 2. It is seen from these curves that the longer the wave front of the input pulse (decreasing δ_0), the larger the value of σ that can be used as the design parameter for the pulse transformer. This makes it possible to reduce the length of the output pulse and to stay within the permissible overshoot.

These curves are given for frequently encountered values of σ and δ_0, and can be used in practical calculations of the front duration and the voltage overshoot of the output pulse.

For pulses with coefficients of δ_0 that differ from those given in the curves, approximate interpolation can be used, of the output pulse front. This is particularly evident if the pulses are generated by two-terminal networks, in which the pulse front duration is approximately 0.1 or 0.2 of the pulse duration.

Consequently, the transient response of the equivalent circuit must be determined, not for a

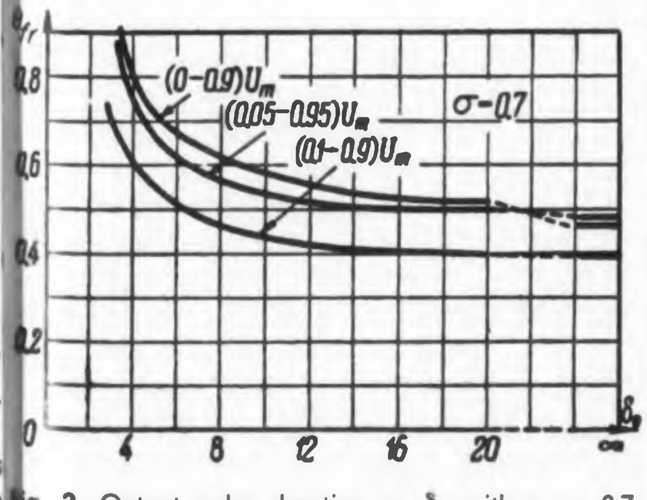


Fig. 3. Output pulse duration vs. δ_0 with $\sigma = 0.7$.

CIRCLE 776 ON READER-SERVICE CARD

FREQUENCY STANDARDS

PRECISION FORK UNIT
TYPE 50
Size 1" dia. x 3¾" H. Wght., 4 oz.*
Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms
*3⅛" high
400 - 1000 cy.

FREQUENCY STANDARD
TYPE 50L
Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

PRECISION FORK UNIT
TYPE 2003
Size 1½" dia. x 4½" H. Wght. 8 oz.*
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above
*3½" high
400 to 500 cy.
optional

FREQUENCY STANDARD
TYPE 2005
Size, 8" x 8" x 7¼" High
Weight, 14 lbs.
Frequencies: 50 to 400 cycles (Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD NEW
TYPE 2007-6
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007–6 (± .02% at —50° to +85°C)
R2007–6 (±.002% at +15° to +35°C)
W2007–6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A
Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2
Size 3¾" x 4½" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C
Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
for TYPE 2001-2
L—For low frequencies multi-vibrator type, 40-200 cy.
D—For low frequencies counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

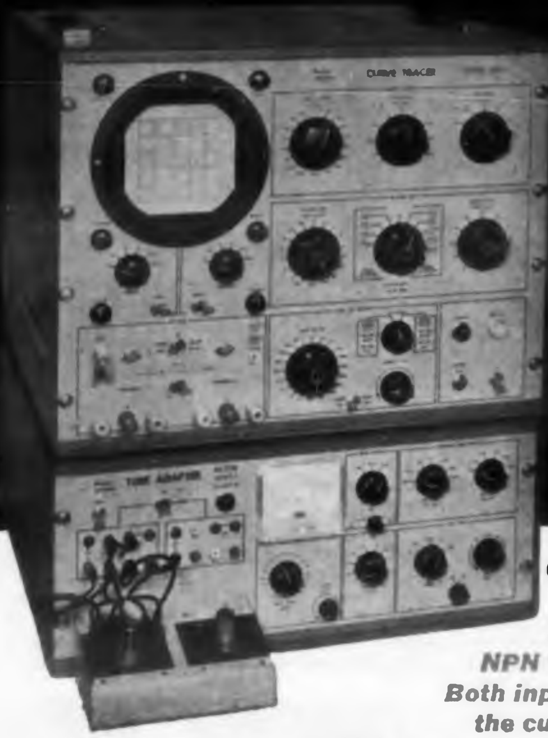
WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.
Watch Master
Timing Systems
Telephone: PLaza 7-1430
580 Fifth Ave., New York 36, N. Y.

CIRCLE 777 ON READER-SERVICE CARD

Baird-Atomic MEETS THE TEST

WITH THE MOST COMPLETE LINE OF TRANSISTOR & SEMICONDUCTOR TEST EQUIPMENT AVAILABLE

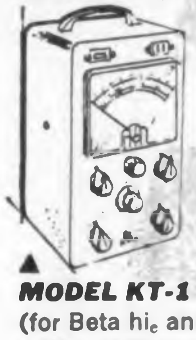


CURVE TRACER, MODEL MW-1 *(Shown with tube adapter)*

Baird-Atomic's Curve Tracer, Model MW-1, is the ***finest of its type.*** *It is designed to display families of characteristic curves for PNP and NPN transistors in either common base or common emitter configurations. Both input and/or output current or voltage may be selected as components of the curves displayed. Its operational range includes the* ***highest maximums*** *(30A collector current continuous duty—50A intermittent and 450 watts maximum) and the* ***lowest impedances*** *(minimum observed .001 ohms to 10 megohms) presently available. Maximum input drive current is 5 amperes and the MW-1 features* ***automatic overload protection.*** *These features make B/A's New Curve Tracer the most versatile on the market.*

MODEL KP-2 SERIES GENERAL PURPOSE TRANSISTOR TEST SET ▶

(for medium power transistors up to 2A)



MODEL GP-4 TRANSISTOR TEST SET ▶

(for low power transistors–h parameters)

▲ ***MODEL KT-1 BETA TESTER***

(for Beta hi_e and Ic_o)

◀ ***MODEL JJ SEMICONDUCTOR MINORITY CARRIER LIFETIME TEST SET***

◀ ***MODEL JN RESISTIVITY TEST SET***

◀ ***MODEL NA-1 COMPONENT SELECTOR***

(for inspection of 2 or 3-terminal components)

For more complete technical data on BA's line of transistor & semiconductor test equipment, write to:

Baird-Atomic, Inc.

33 University Road

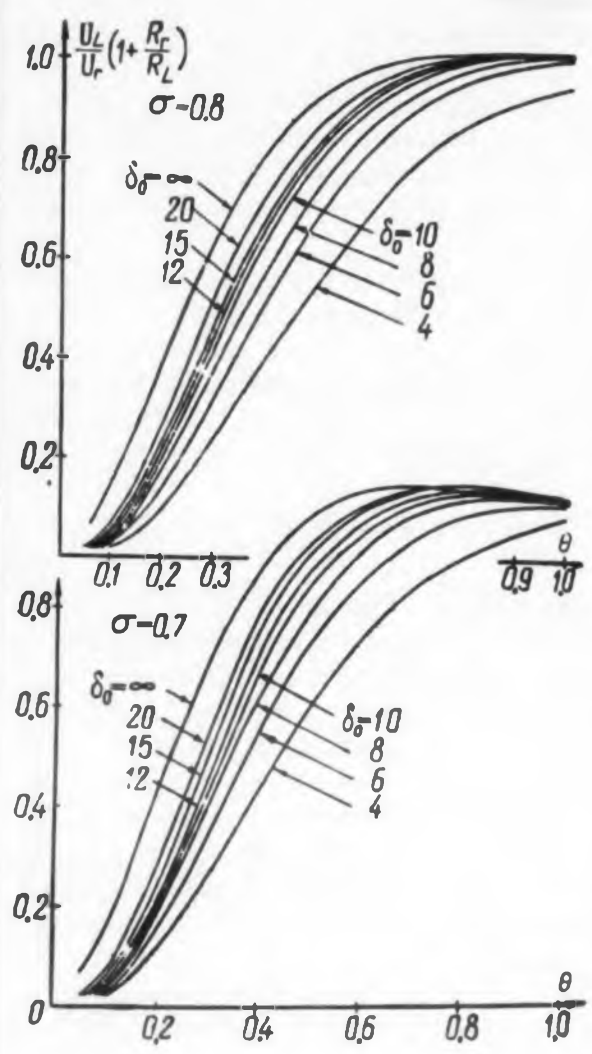
Cambridge 38, Massachusetts

SEE US

AT THE IRE SHOW

BOOTHS 3219 & 3221

CIRCLE 778 ON READER-SERVICE CARD



unit step input, but for an input pulse with a finite rise time. With accuracy sufficient for practical calculations, the front of the input pulse τ_{fr} can be represented by an exponential function $U = U_m(1 - e^{-\delta t})$.

If the front duration is estimated between the levels (0 — 0.9) U_m, then $\delta = 2.3/\tau_{fr}$; for (0.1 — 0.9) $U_m\delta = 2.2/\tau_{fr}$, while for (0.05 — 0.95) $U_m\delta = 2.94/\tau_{fr}$. When a voltage varying in accordance with this relation is applied to the equivalent circuit, the wave form of the output can be determined from the formula:

$$U_L(\Theta) = \frac{U_g R_L}{R_L + R_g} \Bigg\{ 1 - \frac{e^{-\sigma 2\pi\Theta}}{\delta_0{}^2 - 4\pi\sigma\delta_0 + 4\pi^2}$$

$$\Bigg[\left(\frac{\sigma}{\nu} \sin 2\pi\nu\Theta + \cos 2\pi\nu\Theta \right) (\delta_0{}^2 - 4\pi\sigma\delta_2)$$

$$+ \frac{2\pi\delta_0}{\nu} \sin 2\pi\nu\Theta + 4\pi^2 e^{-\Theta(\delta_0 - 2\pi\sigma)} \Bigg] \Bigg\}, \qquad (2$$

or else it is possible to plot the dependence of the duration of the output-pulse front Θ_{fr} (in relative units) on δ_0 for various values of σ. Such a plot is shown in Fig. 3 for $\sigma = 0.7$.

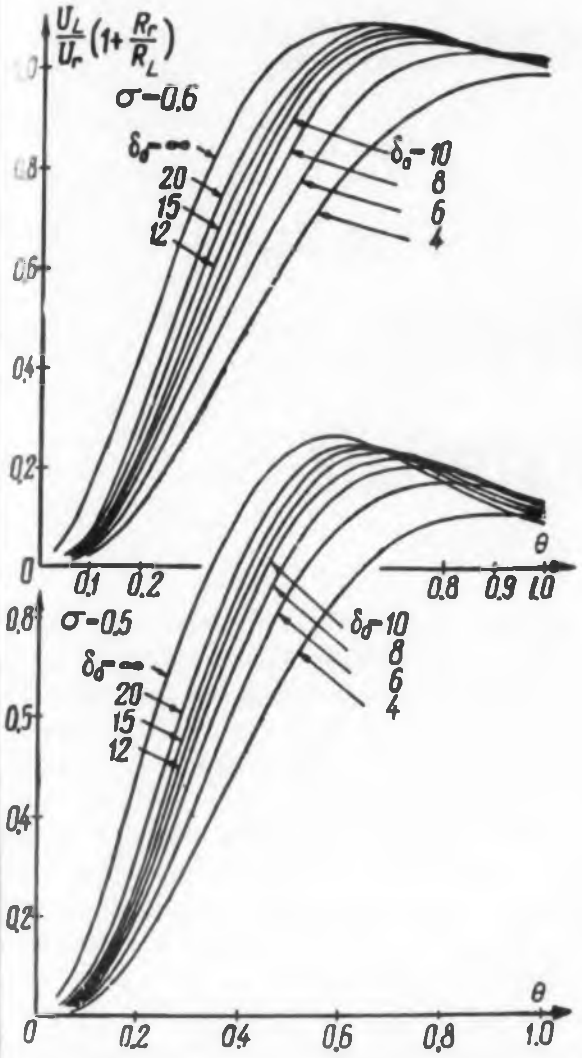


Fig. 2. (Above and opp. page) Pulse transformer output voltage for various values of σ and δ₀.

It is difficult to recommend a design procedure that determines uniquely the optimum value of σ as a function of the rate of rise of the front of the input pulse. To do this would require substantial modification and complication of the methods used for pulse transformer design. This is because the requirements that are made on the front of the output pulse are not unique, but must be reconciled with requirements concerning the voltage droop on the flat part of the pulse, losses, transformer size, etc. In the present article, therefore, the determination of the front duration and of the voltage overshoot are limited to a verification based on the usual graphical calculation of the value of σ. This calculation takes into account the finite rise time of the input-pulse front, and chooses σ so that it satisfies the requirements imposed on the output-pulse front.

A computation of the transformer output voltage waveform, taking into account the finite rise time of the input pulse front, gave good agreement with experimental observation.

This article is abstracted from Effect of Rise Time of the Input-Pulse Front in Pulse Transformers by L. Z. Gololitsyn in Radiotekhnika, *Vol. 14, No. 11, 1959, pp. 52-55.*

E. Brenner

Microwave Drying of Dielectric Materials

DIELECTRIC strips and foils, such as printed or impregnated paper or fabric, can be efficiently dried by microwave frequencies. To avoid exceeding the dielectric strength of the material, the strip is drawn through a meandering waveguide arrangement, shown in Fig. 1. The material moves so that its driest portion passes over the input section of the guide and its wettest portion enters at the load end, where the field is weakest. Because of the variation of dielectric constant with drying, the power absorption, at a frequency of 2.4 kmc, for example, per section of waveguide, is approximately constant.

The slot in the waveguide for the dominant mode (H_{10} mode) is cut at the midpoint of the larger dimension of the rectangular guide, exactly as in a "slotted" section. When the moisture content of the material is large enough to absorb all the microwave power, the waveguide arrangement can be terminated in a short-circuit. Efficiency as a function of moisture content is shown in Fig. 2 for the eight section arrangement of Fig. 1. Moisture content as a function of number of waveguide sections is shown in Fig. 3, with fabric speed as a parameter.

Abstracted from an article by W. Schmidt, Elektronische Rundschau, *Vol. 13, No. 10, October 1959, pp 359-361.*

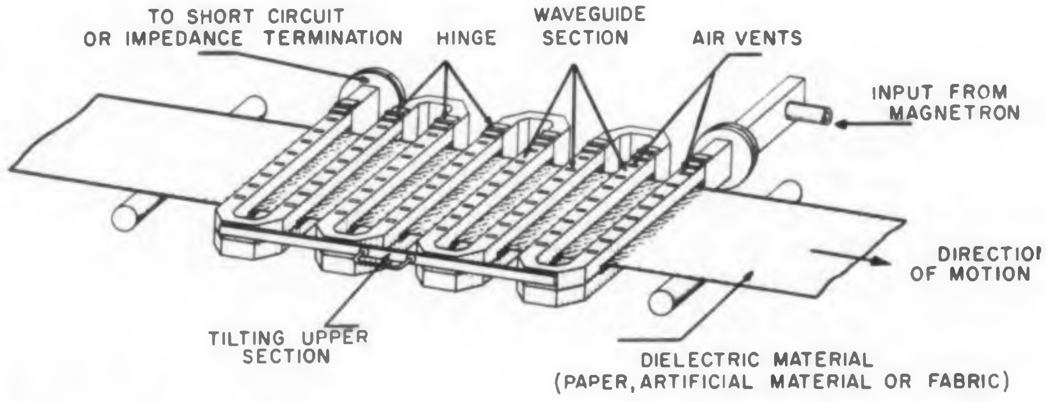


Fig. 1. The dielectric material is drawn through a meandering waveguide system, absorbing varying amounts of microwave power.

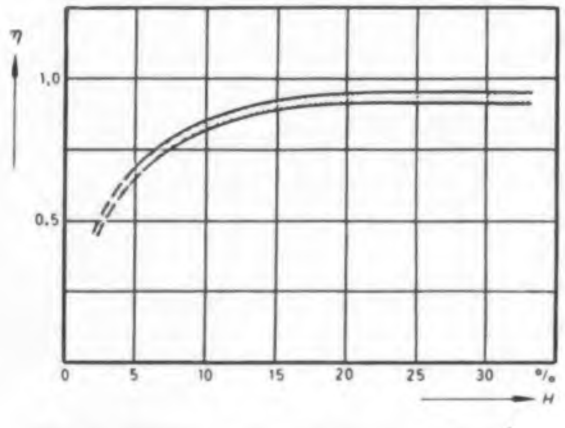


Fig. 2. Efficiency, η, as a function of moisture content, H, for a cotton strip 500 mm x 0.5 mm.

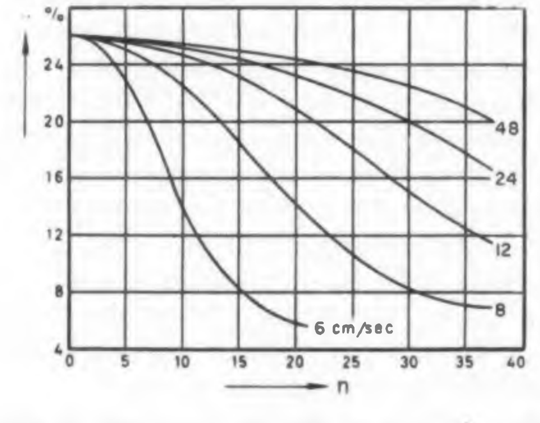


Fig. 3. Moisture content H, as a function of number of sections n, with pull-through speed as a parameter. The width of the material was 500 mm; microwave power input, 2.5 kw.

Testing Linear Low-Pass Networks

E. Brenner

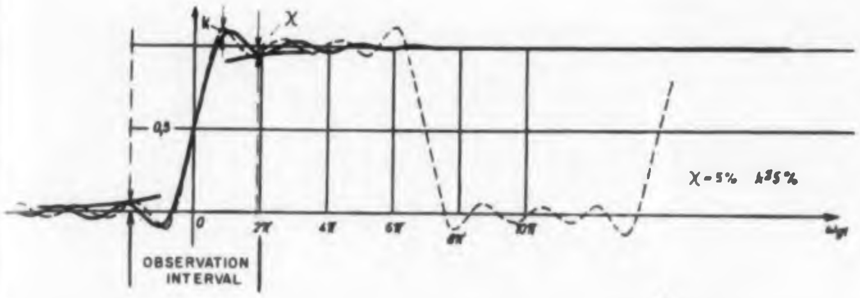


Fig. 1a. Step-response (solid line) and square-wave response of an ideal low-pass filter.

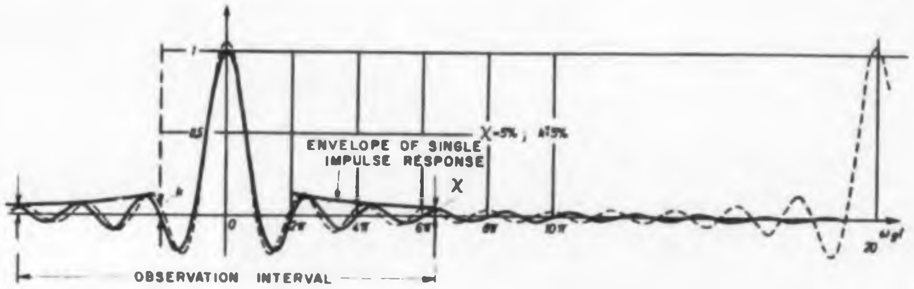


Fig. 1b. Response to impulse and to impulse train (dotted) of an ideal low-pass filter.

SQUARE WAVES or periodic pulses are commonly used laboratory signals for examining network behavior. To determine the response of the network to a single pulse or step, the repetition rate of the periodic signal must be low enough so that the observable effect of the preceding pulse is negligible. Using an "ideal" low-pass filter as a model (constant gain and constant time delay in the passband, infinite attenuation above the cut-off frequency), the response to a symmetrical square wave compared to the step response is shown in Fig. 1a. The response to a periodic impulse train compared to the single impulse response is shown in Fig. 1b. Using analytical results for the ideal filter, numerical criteria relating certain error parameters to the repetition frequency can be established. Also, it can be shown, both analytically and experimentally, that these criteria are applicable to physically realizable filter networks with negligible error.

To compare square wave with step response, the quarter cycle of the waveform, which includes the rise of the leading edge, is observed, Fig. 1a. The difference between the envelope, along which the step response approaches steady state, and the steady state value is denoted by x. The difference between step and square wave response is measured by the corresponding maximum fractional envelope difference, k. If $k \leqq x$ then the repetition frequency f is related to the cut-off frequency f_g by the approximate relationship $f \approx \pi\, k_{max} f_g$

The rise-time with periodic square waves, T_R, is related to the rise time with a step input, T_{RO}, by the approximate formula

$$T_R = T_{RO} \frac{f_g}{f_g + f}$$

When narrow pulses are used to test the network, the result of the impulse calculation is applicable. In this case, x is defined as the fraction of peak pulse output to which the envelope has decayed with an impulse input, and k is the difference between x and the envelope decay with a periodic input. The observation time is half the repetition period. Denoting by n the ratio of repetition frequency to cut-off frequency, the maximum error, k, is shown as a function of $2\,\pi\, f_g t$, with n as a parameter in Fig. 2. For $k \leqq x$ the repetition frequency is related to cut-off frequency f_g by the approximate formula $f \approx 2 k_{max} f_g$

Abstracted from an article by R. Elsner and K. H. Steiner, Nachrichtentechnische Zeitschrift, *Vol. 12, No. 12, December 1959, pp 618-624.*

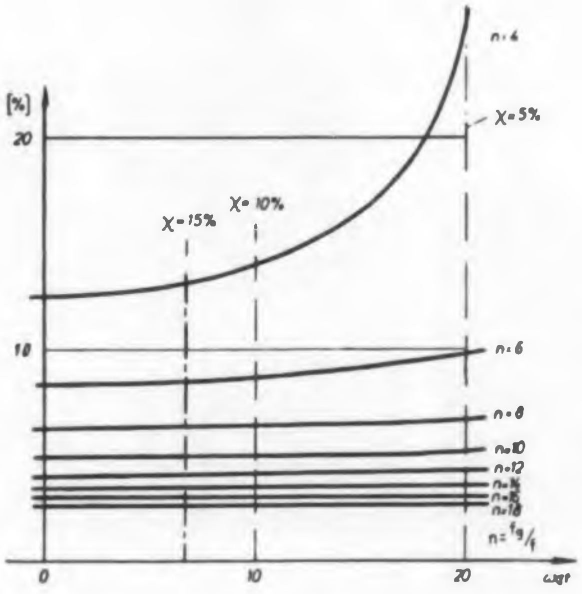
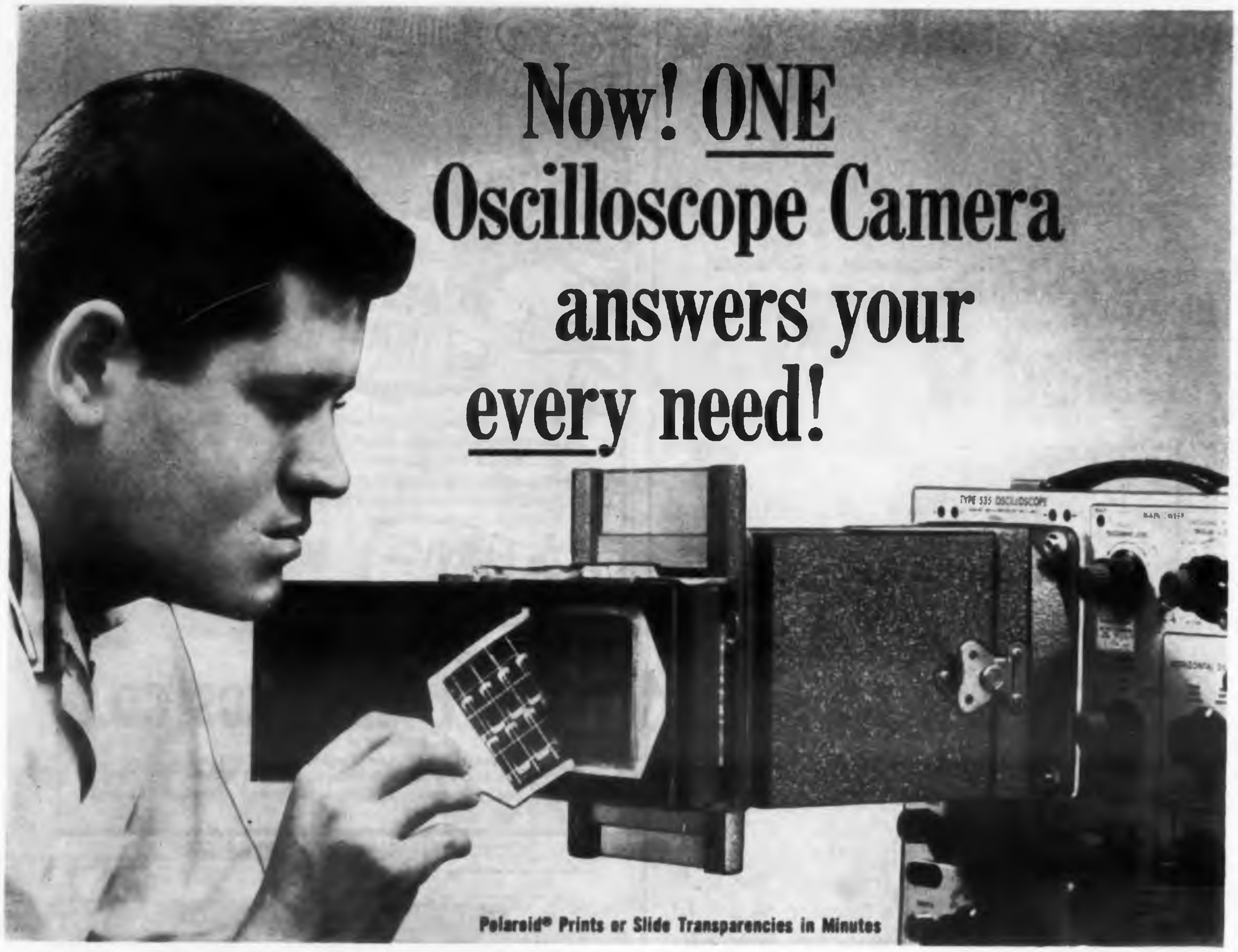


Fig. 2. Maximum envelope differential between the response to a single impulse and to periodic impulses of an ideal low-pass filter.



NEW Beattie "Minute Man" Oscillotron*

Whatever your requirements in oscilloscope photography, the versatile new Beattie "Minute Man" Oscillotron can do the job superbly well. An entirely new concept in simplified design, it is a light, compact, precision instrument built for rigorous duty.

Equipped with large Polaroid® Land back for 60 sec. prints or slide transparencies. Object to image ratio - 1 to 0.9. Records up to 9 traces on a single frame.

75mm f/2.8 Wollensak lens in Alphax #2 shutter. Precise, split-second focusing. Modular design permits instant conversion for a wide range of instrumentation photography. A truly fine camera at a remarkably low price. Write for complete information.

MAXIMUM VERSATILITY WITH THESE ACCESSORIES:

- *Binocular viewing hood*
- *Data card to record in frame*
- *Data chamber with watch, platen, and counter*
- *75mm f/1.9 lens (standard or flat-field)*
- *Positive electric remote shutter control*
- *35mm camera*
- *35mm pulse or continuous motion magazines*

*Trade Mark

Swing out, lift off camera for easy accessibility. Direct-view hood is one of many accessories.

Only $250 BASIC CAMERA AS SHOWN IN TOP PHOTO

"Polaroid" ® by Polaroid Corp.

BEATTIE-COLEMAN inc.

1000 North Olive Street, Anaheim, California
Branch: 437 Fifth Avenue, New York, N. Y.

See us in Space 3823 at the I.R.E. Show

CIRCLE 784 ON READER-SERVICE CARD

ELECTRONIC DESIGN

DIGEST

of recent papers and literature

Spectrum Analyzer Photos Measure AF Distortions

AUDIO-FREQUENCY distortion measurements can be made accurately and rapidly with an automatically scanning audio-frequency analyzer.

The crt photographs shown were taken on a Panoramic Sonic Spectrum Analyzer, model LP-1a. They illustrate the display methods this type of analyzer uses when making certain audio frequency measurements.

Digested from The Panoramic Analyzer, Vol. 1 No. 5, Techniques of Swept Audio Measurements, *Panoramic Radio Products, Inc., Mount Vernon,* N.Y.

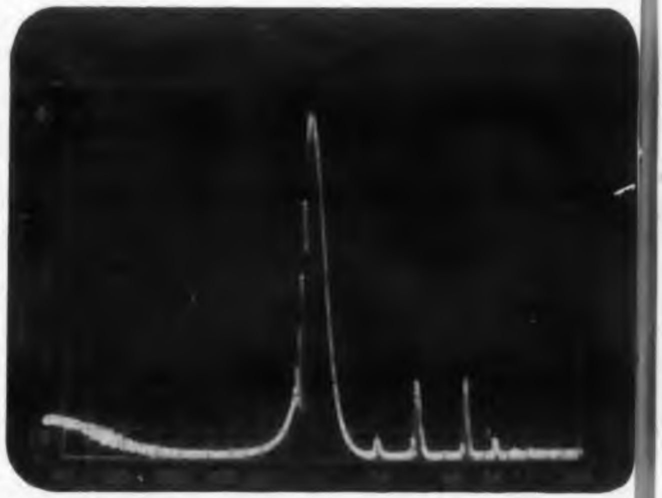


Fig. 1a. A power amplifier was driven almost to its clipping level at 1 kc. Visible are the 2nd harmonic at 2 kc at —40 db, or 1 per cent distortion, and the 3rd and 5th harmonics at —31 db, or 3 per cent distortion. Several higher order odd harmonics are also visible at very low amplitude levels.

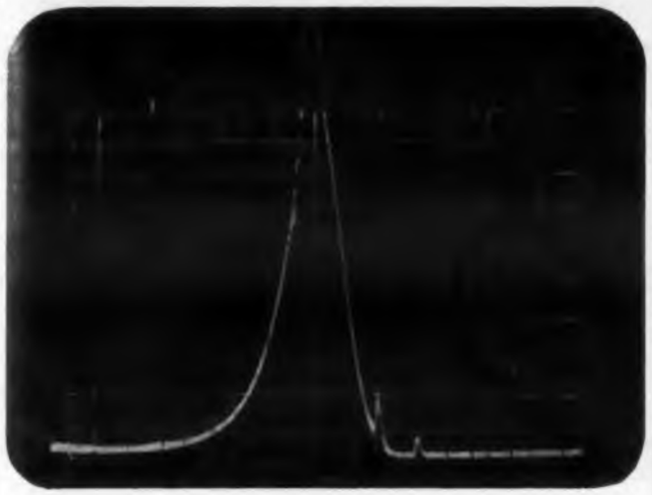


Fig. 1b. The amplifier was driven well below its clipping level. The fundamental tone was deflected 20 db over full scale to show the low-level harmonics. Visible are the 2nd harmonic at —52 db, or 0.25 per cent distortion and the 3rd harmonic at —60 db, or 0.1 per cent distortion.

Intermodulation Distortion (IM)

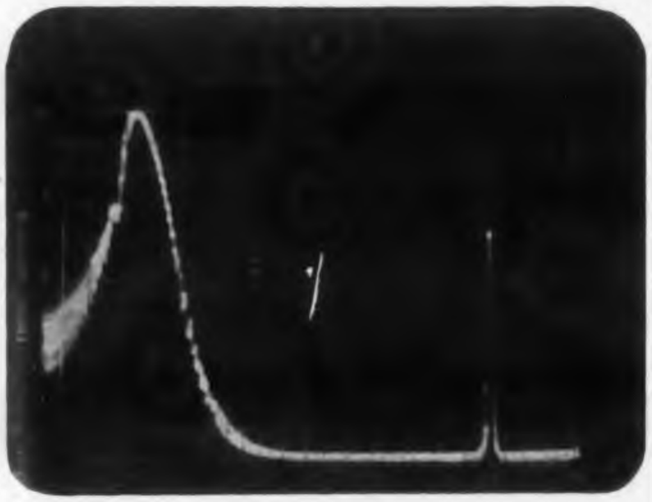


Fig. 2a. A signal consisting of a low (100 cps) and high (7 kc) audio frequency signal in a 4:1 amplitude ratio (12 db) was fed into the power amplifier. The output is pictured on the analyzer's 20-kc logarithmic sweep.

DOW *Now in magnesium and aluminum*

400-TON PRESS draws end pieces of magnesium transmitter housing for missile ground support electronic system. Heated dies make possible one-step draws.

The electronic transmitter housing shown in various stages of production on this page is a good example of the type of work carried on at Dow's Bay City fabrication plant. It is a large and complex assembly which is produced in quantity, involves many operations, and must conform to extremely high standards.

Large or small jobs. The Bay City plant is a large, well equipped production facility set up to handle large or small jobs, and plenty of both. Its activities encompass every phase of fabrication—deep drawing, bending, spinning, stamping, piercing, machining, arc and spot welding, assembling, chemical treating and painting. The facilities are government certified.

Engineering and quality control. Dow engineers working closely with the customer are frequently able to suggest design modifications which cut costs and/or meet application requirements better. A quality control team using modern methods and equipment assures that high standards of craftsmanship are rigidly maintained.

Many "firsts." The Bay City fabrication plant has pioneered many developments in the production of magnesium parts and products. They were first to hot draw the lightest structural metal, and first to spot weld and automatically weld it. They have also been a leader in the production use of chemical treatments and finishes for magnesium.

Whatever your requirements, if they involve magnesium or aluminum fabricated parts or assemblies, it will pay you to make Dow your supplier.

For more information contact your Dow Sales Office or write today for an illustrated brochure discussing Dow fabrication services. THE DOW METAL PRODUCTS COMPANY, Midland, Michigan. Merchandising Department 1010BC3-16

ARE YOU USING DOW'S EXTENSIVE FABRICATION FACILITIES?

Capacity and outstanding capabilities now available for both magnesium and aluminum fabrication, finishing and assembly.

"WRAPPER," or shell of housing is roll-formed of magnesium sheet.

AUTOMATIC ARC WELDER, using tungsten-inert gas process, joins end to wrapper.

ASSEMBLY involves attachment of doors, hardware, components using riveting, bolting.

DOW THE DOW METAL PRODUCTS COMPANY

Division of The Dow Chemical Company

CIRCLE 785 ON READER-SERVICE CARD

CECO

Low Noise

VHF and UHF

Amplifiers and Preamplifiers
SERIES 1000

For application as receiver preamplifiers or wide band i. f. amplifiers . . . in scatter communications systems, laboratory, or nuclear research. Eight standard models cover VHF and UHF to 900 mc. High gain, low noise. Special pass bands available.

Advanced techniques permit modification of standard units at minimum cost.

Write for complete details:

COMMUNITY ENGINEERING CORPORATION
P. O. BOX 824 STATE COLLEGE, PA.
CIRCLE 786 ON READER-SERVICE CARD

send for this
FREE
EICO
Electronics
Catalog

you save 50%
on Top-Quality
Test Instruments
Hi-Fi • Ham Gear
KITS AND
ASSEMBLED
Ready-to-use
for professional
and home use

TEST INSTRUMENTS
battery eliminators
battery testers
bridges
decade boxes
electronic switch
flyback tester
oscilloscopes
probes
signal and
sweep generators
tube testers
transistor tester
vacuum tube
voltmeters
volt-ohm-
milliammeters

HI-FI
stereo and monaural
tuners
preamplifiers
power amplifiers
integrated amplifiers
speaker systems

HAM GEAR
cw transmitter
modulator-driver
grid dip meter

OVER 1 MILLION
EICO instruments in
use throughout
the world.

LIFETIME service and calabration guarantee.
IN STOCK at your neighborhood EICO dealer.
Send now for FREE catalog ED-3

EICO 33-00 N. Blvd., L. I. C. 1, N. Y.
. . . praised by the experts
as BEST BUYS IN ELECTRONICS

SEE YOU AT IRE BOOTH 3505
CIRCLE 787 ON READER-SERVICE CARD

DIGEST

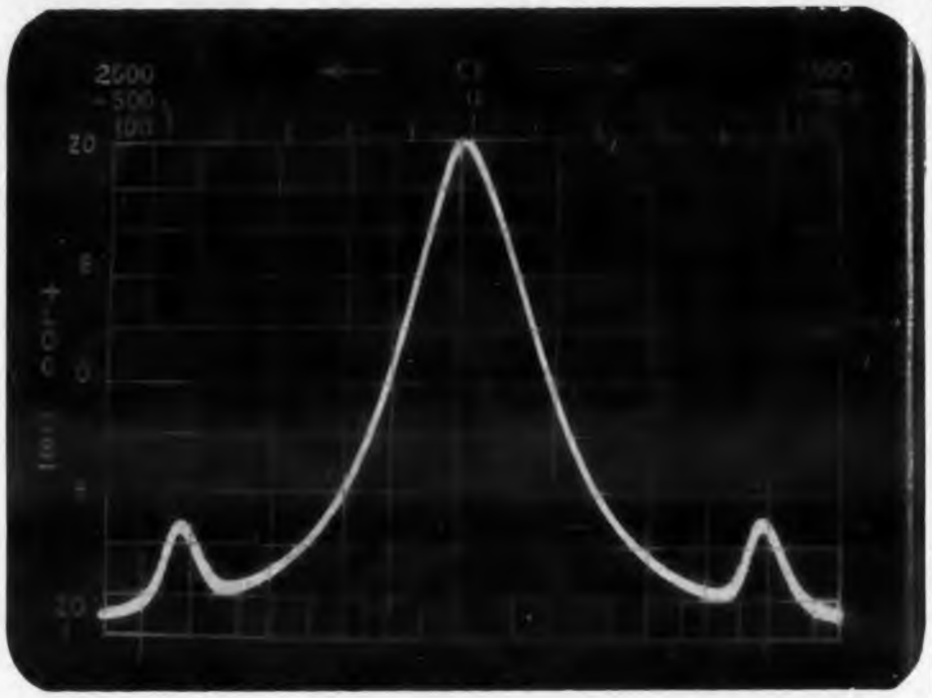


Fig. 2b. Using the same test frequencies as in Fig. 2a, the analyzer was set for a 200 cps linear-sweep to bring the 7-kc carrier to full scale deflection. Sidebands now appear at —31 db or 2.8 per cent of the carrier level. Since the ratio of sideband to carrier amplitude is half the modulation percentage, the IM distortion is 5.6 per cent.

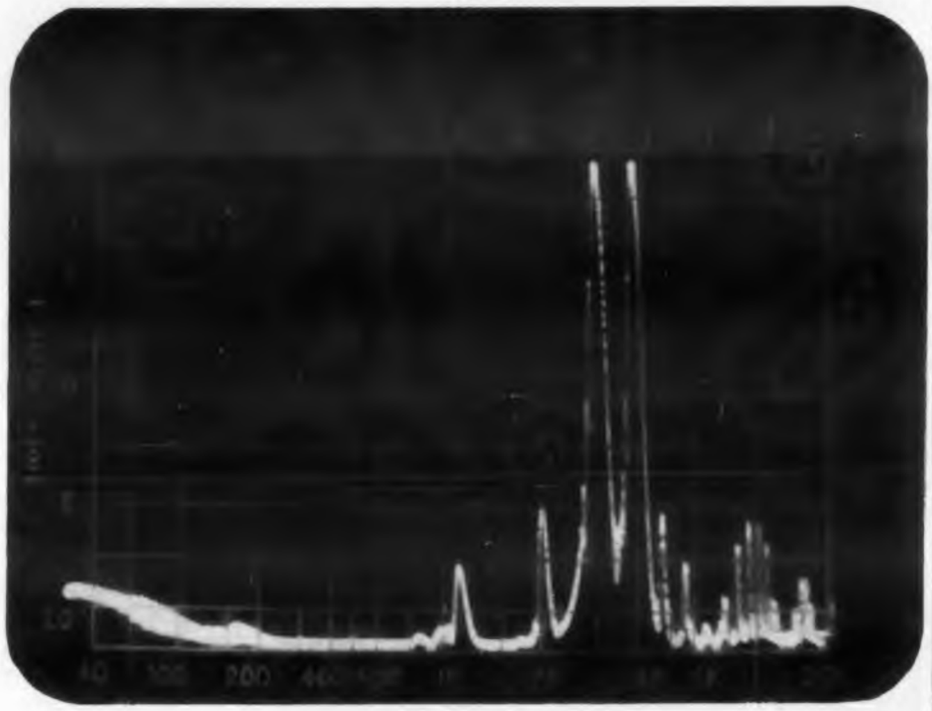


Fig. 2c. Two equal amplitude signals—one at 3 kc, the other at 4 kc—were passed through a power amplifier. The difference tone near 1 kc is clearly visible some 34 db below the two-tone level. Also visible are third order distortions near 2 kc and 5 kc, as well as test frequency harmonics and various harmonic cross-products.

Loudspeaker Response Tracing

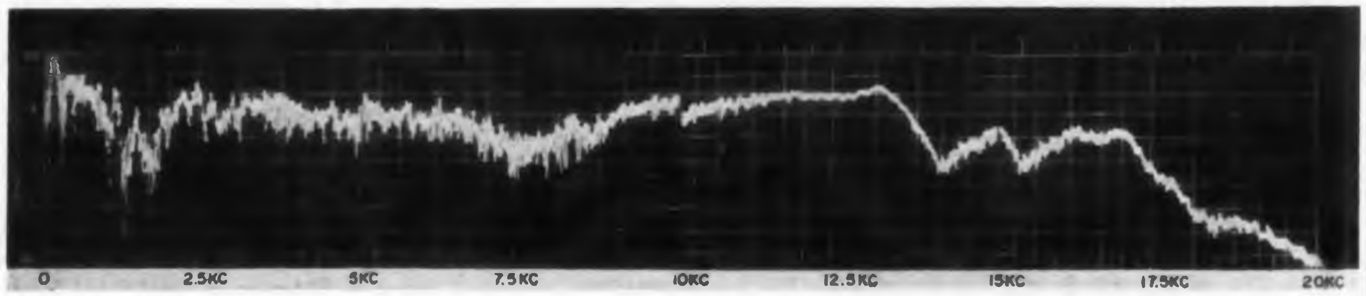


Fig. 3a. A composite of four screen photos show the 20-20,000-cps response of a speaker system. The analyzer was set at a 5-kc linear-sweep width, at center frequencies of 2.5 kc, 7.5 kc, 12.5 kc and 17.5 kc. A Panoramic Triangular Wave Generator produced a sweep duration of 10 sec for each 5000 cycle segment. Ambient noise is seen to roughen the trace.

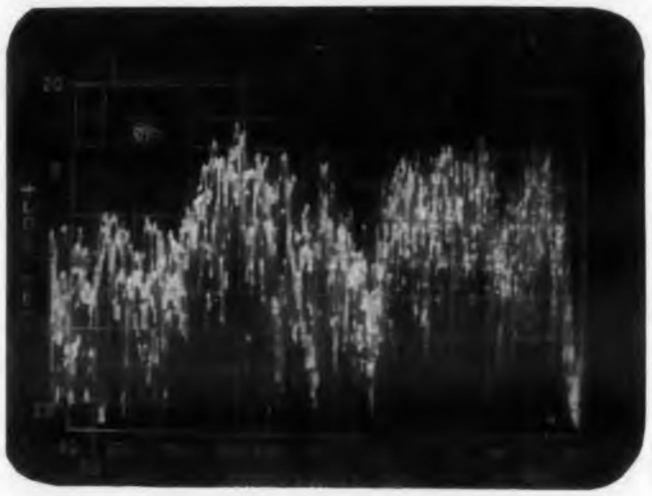


Fig. 3b. Loudspeaker frequency response can also be measured with a white noise test signal. In order to average out the random amplitude variations of the noise signal, the photograph exposure covered about 15 sweeps. It is seen that the single line displays obtained in the sweep frequency test are much easier to read and interpret than a noise spectrum analysis.

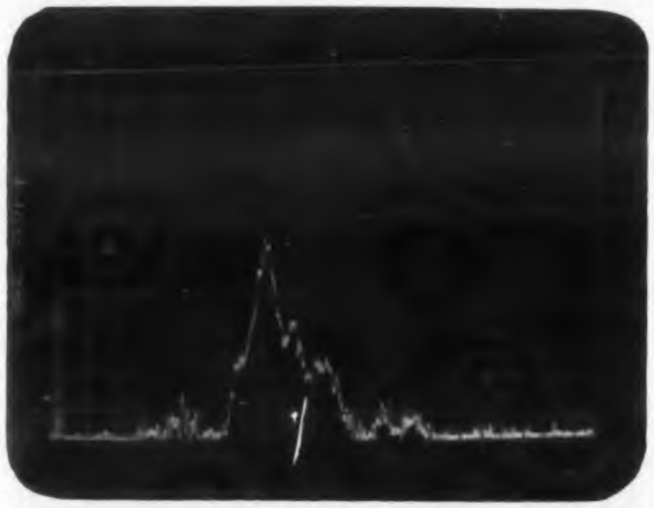


Fig. 3c. The IM distortion of a speaker for two equal amplitude test tones is plotted here versus the test-tone frequency. The test tones were set for a 90-cps frequency difference and were swept synchronously through the audio spectrum. By discretely varying the difference frequency, the distortion properties of the speaker over its bandwidth can be investigated.

My name is Paul M. Platzman,

I pioneered the ultrasonic industry. Two well known ultrasonic companies were founded by me. Now, I have created a new organization, Ultrasonic Industries, Inc., based on a revolutionary approach to mass producing and selling ultrasonic equipment. No middleman's profit in this factory — direct-to-you deal.

Tremendous savings are passed on to you the customer bringing formerly high-priced ultrasonic cleaners within the range of everybody's budget. My products stand out because of their distinctive appearance, unbelievably low money-back-guaranteed prices—free five year service contract, and consistent trouble free performance under the most gruelling conditions. This is possible because my DiSONtegrator generators and transducers incorporate the latest advances in ultrasonic technology.

$99.95

Including tank, connecting cable and instruction manual (export model: 220V — 50 cycles $7.50 extra)

DiSONTEGRATOR®
SYSTEM FORTY
ULTRASONIC CLEANER

The lowest priced ultrasonic cleaner ever sold! **Buy ONE or 100 and Save!**

The DiSONtegrator System Forty ULTRASONIC CLEANER is attractively styled, ruggedly-built, and work-tested to give a lifetime of trouble-free service.

The DiSONtegrator Features:
Simplified one knob control for easy operation. High Frequency sound waves disintegrate harmful soils and contaminants in seconds.
Saves time and labor, boosts production rate, improves product. You can replace hazardous chemicals with safe solvents and even water.

The DiSONtegrator works FAST
In **SECONDS** you can disintegrate soils on: radioactive lab apparatus; glassware; medical instruments; test tubes, syringes, hypodermic needles; dental instruments, drills, burrs, false teeth, bridges; fossils and fossil foraminifera; electronic components, semi-conductors, crystals, switches, precision potentiometers; optical parts, lenses, plastic contact lenses, eyeglasses; timing mechanisms; small gear trains; miniature printed circuit boards; and hundreds of other items.

In seconds you can remove:
rust, oxides, shop dirt, dust, lint, preservatives, finger prints, machining chips, extrusion lubricants, paraffin, wax, paint, varnish, lacquer, plastic residue, resists, silicones, greases cooked food residue, blood, plaster of paris, lapping compounds, carbon, radioactive particles, polishing compounds, shale, diatomite, volcanic tuffs, clay and sand, graphite, starches, cutting oils, heat treat scale, color stains, foundry sand, abrasives, quenching oil, salts, pitch, asphalt, tar, inks, adhesives, jewelers rouge, tripoli, resin flux, acid flux, many others.

The DiSONtegrator is VERSATILE
In addition to super speed, surgical precision cleaning it can be used to: brighten, quench, degrease, impregnate, decontaminate, pickle, etch, dip coat, emulsify, degas liquids, anodize, dye, mix, accelerate reactions.

Ultrasonic cleaners are widely used
in production lines, maintenance departments and laboratories. You should have at least one DiSONtegrator if your field is Electronic, Optical, Glass, Clinical, Biological, Textile, Oil, Food, Paper, Dental, Plastic, Drug, Rubber, Wood, Chemical, Isotope, Geological, Agronomical, Metallurgical, Anthropological, Paleontological, Petrochemical, Ceramics, Dairy, Brewery, Beverage, Confectionery, Laboratories, Photographic, Paint, Bottling, Cosmetic, Pharmaceutical, Metal Working, Metal Finishing, Die-Casting, Foundry, Plating, Metal Treating, Automotive, Aircraft, Horological, Jewelry, Medical, Marine, Mining, Utilities, Power Plants, Instrumentation.

ultrasonic industries INC.
141 ALBERTSON AVENUE · ALBERTSON, L. I., N. Y.
Pioneer 1-4333

INTRODUCTORY OFFER
Money Refunded (less shipping charges) if not completely satisfied.

Guarantee
The DiSONtegrator you have just received is the finest ultrasonic machine made. It has passed a rigid inspection and found to be in perfect condition. Read your instruction manual carefully. Properly handled, this equipment will exceed your expectations and render long service.
A free 5 year service policy is included with this purchase. No charge for replacement parts first two years. Tubes carry 90 day guarantee. Service and parts required after the expiration of the guarantee will be furnished at prevailing factory prices.

5-DAY TRIAL
We will pay all shipping charges to any point within the continental limits of the United States (not including Alaska and Hawaii), if you enclose check with order.

UNPRECEDENTED FREE 5 YEAR SERVICE CONTRACT
The **DiSONtegrator — System Forty** is available from stock for immediate delivery in unlimited quantities.

SPECIFICATIONS
GENERATOR INPUT: 117 V, 60 cycle — **GENERATOR OUTPUT**: 40 W, 90 KC
DIMENSIONS: GENERATOR: 10" L x 7" W x 5¾" H
Tank (overall): 6¼" L x 7" W x 6½" H
Tank (inside): 5¼" x 5¾" W x 4" D
Tank (capacity): 0.5 gal.

FOR THE FIRST TIME – you have a choice of 6 beautiful decorator colors to harmonize with your office or laboratory decor: Ivory, Wheat yellow, Turquoise, Desert sand, Pale green and Soft gray. Please specify color when ordering.

ORDER NOW

TO: Ultrasonic Industries, Inc., Dept. 5-ED-4
141 Albertson Avenue, Albertson, L. I., N. Y.

Gentlemen: Please ship ______ DiSONtegrator® System Forty Unit(s) @ $99.95ea.: ☐ Ivory ☐ Wheat yellow ☐ Turquoise ☐ Desert sand ☐ Pale green ☐ Soft gray

to: ______________________

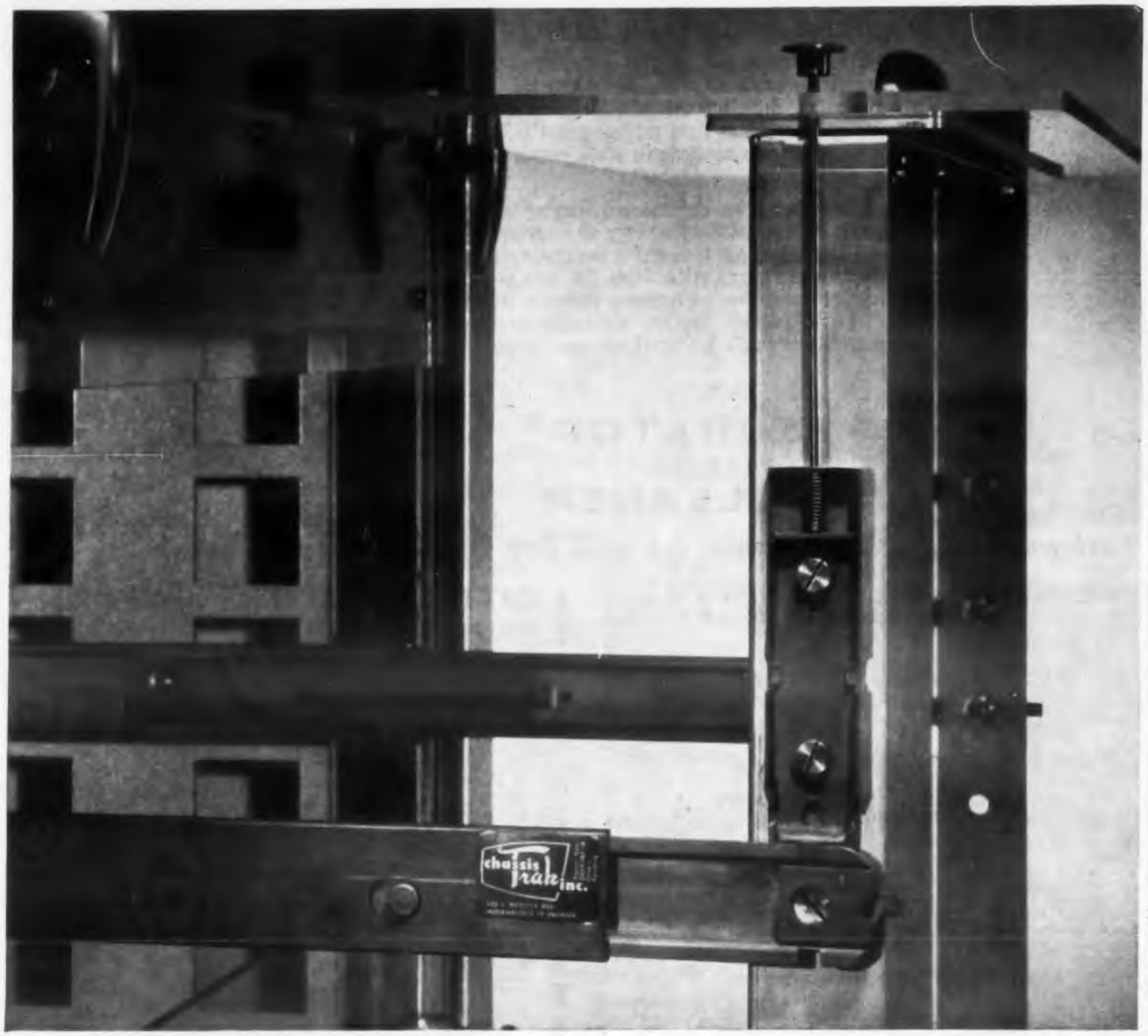
____

____

I understand that my money will be refunded if not completely satisfied after 5 day trial.

☐ check enclosed (freight prepaid) ☐ C.O.D.
☐ bill me (rated firms only) ☐ Please put us on your mailing list

CIRCLE 788 ON READER-SERVICE CARD



From CHASSIS-TRAK—*New Feather-Light Detent Slide!*

Model C-300 Detent locks in three service positions—90° up, horizontal, 90° down

Chassis-Trak continues to set the pace in slide design with the new Model C-300 Detent. Never before has a tilt-lock slide come in such a small package, yet despite its space-saving size — 1¾" high, 3/16" wide — the Model C-300 Detent will support chassis loads up to 50 lbs. Not the least of the new slide's attractive features is its low price — lowest of any detent slide on the market.

Made of hard, cold-rolled steel, each slide is cadmium plated and then coated with Poxylube 75, a bonded film formulation of molybdenum disulfide, which provides permanent dry lubrication. Solid bearings on all surfaces afford high resistance to shock and vibration.

Model C-300 Detent Slides are available in seven lengths — 12 to 24 in. — and are designed for mounting electronic equipment in any standard rack or cabinet. Like all Chassis-Trak Slides, they are easy to install and smooth and trouble-free in operation.

Be sure to see this new slide demonstrated at the IRE Show — Chassis-Trak Booth 4001. You'll be impressed with its performance.

IRE SHOW, BOOTH 4001

chassis Trak inc.

For further information contact:

525 SOUTH WEBSTER, INDIANAPOLIS 19, INDIANA

CIRCLE 789 ON READER-SERVICE CARD

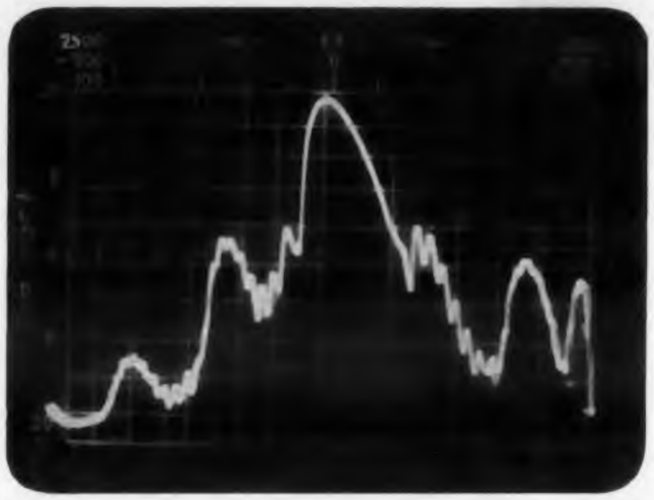


Fig. 3d. Speaker "Doppler distortion" is demonstrated when a speaker is driven with two, very unequal amplitude tones. Here, a 1000-cps tone was mixed with a very large amplitude 45-cps signal. The analyzer was centered at 1000 cps with a 200-cps sweep width and shows ±45 and ±90 cps sidebands of 1 kc. The fact that the 1090-cps sideband is greater in amplitude than the 910-cps sideband indicates the presence of combined amplitude and frequency modulation in the output signal.

Tape Recorder and Phono-Cartridge Testing

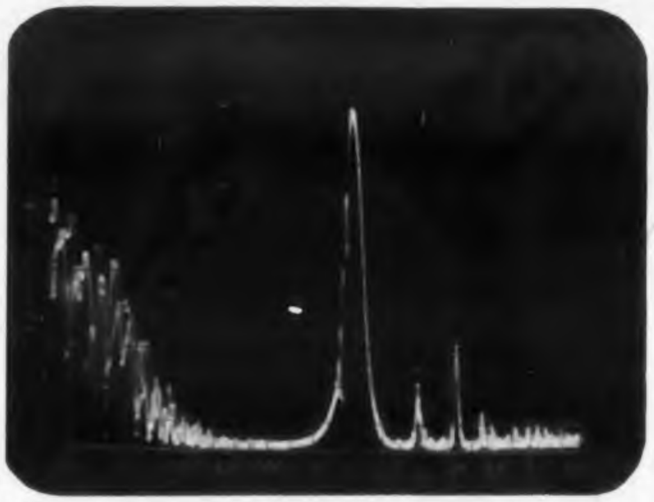


Fig. 4a. Evaluation of a phono-cartridge was made here with a single frequency, 1.5-kc test recording. Visible are the fundamental and harmonic distortion components. However the inherent distortion of the record is not distinguished from that of the pickup.

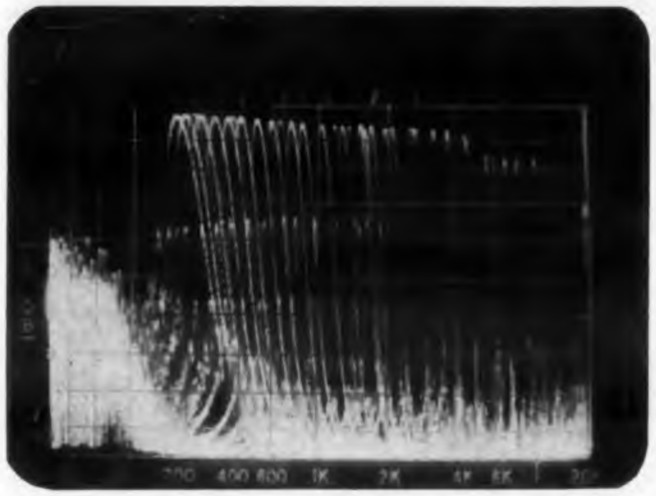


Fig. 4b. An analysis of a phono-frequency test record was made in this display. The sweep rate of the analyzer was set at 1 cps through its frequency band. A hummy test set up can obscure the display as is apparent for frequencies below about 200 cps.

Fig. 4c. Tre frequency responses of a professional quality tape recorder was displayed using a sweep frequency recording. When the recording reaches its upper frequency limit, there is a "fly-back" period and the frequency returns to its lower frequency limit. To re-establish the sweep frequency calibration, a synchronizing pulse is superimposed on the high frequency end of the recording. This pulse is visible at the extreme right of the display.

4 reasons why you should buy Hughes high voltage silicon cartridge rectifiers

To meet your requirements for IN1730-34, IN2382-85, IN596-98 and IN1406-13 rectifiers... Hughes offers you a universal series with the following advantages over competitive devices:

1 **Better High Altitude Performance—** Since the case is insulated and provides a long leakage path between leads, the probability of flashover or corona at high altitudes is reduced.

2 **Improved Circuit Performance—** Fewer diodes are required in each unit to obtain the PIV ratings...thereby lowering losses, which in turn, provide better voltage regulation and higher efficiencies.

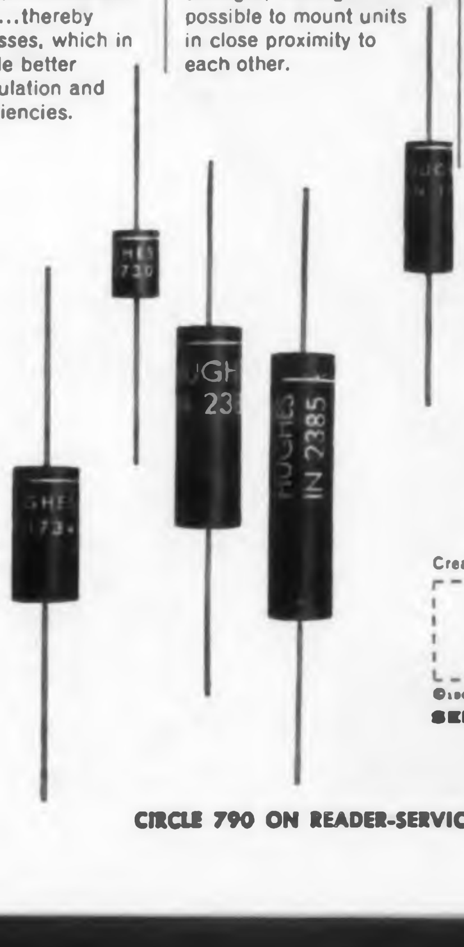
3 **Savings in Space.** The case material is a plastic of high dielectric strength, making it possible to mount units in close proximity to each other.

4 **Greater Dependability—**These assemblies utilize series strings of Hughes hermetically sealed glass diodes...packaged in a non-combustible cartridge. All internal connections are welded together to insure shock and vibration resistance.

These standard Hughes units are available in voltage ratings from 600 to 10,000 volts. In addition, Hughes offers you many custom assemblies designed to meet your special requirements.

ORDER TODAY! To obtain delivery of Hughes Cartridge Rectifiers just call or write the Hughes Semiconductor Sales Office or Distributor nearest you. Or, for a complete Cartridge Rectifier data sheet (Number: D.S. 82) please write Hughes, Semiconductor Division, Marketing Department, Newport Beach, California.

For export write: Hughes International, Culver City, Calif.



Creating a new world with ELECTRONICS

HUGHES

©1960 HUGHES AIRCRAFT COMPANY
SEMICONDUCTOR DIVISION

CIRCLE 790 ON READER-SERVICE CARD

ELECTRONIC DESIGN

DIGEST

of recent papers and literature

Designing With Phototransistors

PHOTOTRANSISTORS can be used in a wide variety of circuits where light is to activate electronic equipment. Four quantities are usually of interest to the designer working with these light sensitive devices. These are the phototransistor's:

1. Light sensitivity
2. Chopped light frequency response
3. Photo-spectral response
4. Noise response.

Light Sensitivity

The light sensitivity of a phototransistor is specified in microamperes per ft-c and can be measured with the circuit shown in Fig. 1. The light source is a 40-w, inside-frosted, incandescent lamp (GE type 40W A19), operated at a rated 120 v. This lamp emits 475 lumens and is equivalent to 33.4 cp. The chopped light sensitivity is given by:

$$S = \frac{2\ V_C}{F_C\ R_L}$$

where S is the sensitivity in microamperes per ft-c, R_L is the collector load resistance, F_C is in ft-c, V_C is the meter reading in millivolts. Note that $2V_C$ converts the rms value of the square wave to peak to peak voltage.

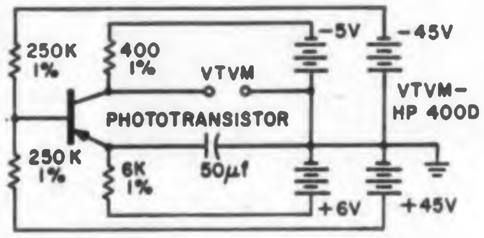


Fig. 1. Circuit for measuring chopped light sensitivity of a phototransistor.

Junction sensitivity is measured in the same fashion except that the base is bypassed to ground and the emitter bypass capacitor is omitted.

For convenience, an incandescent lamp was used in measuring the "apparent" sensitivity of the phototransistor. It should be noted that the emission spectrum of this light source is not uniform over the acceptance band of germanium.

Chopped Light Frequency Response

When used in circuitry similar to that in which current sensitivity is measured (open base and shorted output), the response will be three db down at F_{ae} or F_{ab}/h_{fe}. The condition described here is one closely approximated by a phototransistor followed by a transistor amplifier, with low impedance input. Flat response can be expected to about 15 kc with fall-off beyond 20 kc at the rate of six db per octave.

Photo-Spectral Response

The response of a photo-conductor to light excitation to a first order approximation is a function of the following considerations:

1) n_c, the number of conductive pairs which is proportional to n, the number of photons with energy greater than the threshold energy (that is, the energy gap between the valence and the conduction bands).

2) $n = \frac{I}{h\gamma}$, where I is the light energy, h is Planck's constant, γ = frequency (cps)

$$n_c \approx \frac{I}{h\gamma} = \frac{I}{k}\lambda, \text{ where } \lambda \text{ is wavelength.}$$

To describe the functional dependence of n_c on wavelength and light intensity, we must either normalize the intensity or the number of photons while varying the wavelength. These responses are also functions of the absorption and admissive characteristics of the transparent enclosures.

Noise Considerations

It is convenient to think of phototransistor noise in terms of equivalent illumination, for example, the amount of masking light signal. This signal may be calculated from the noise figure of the transistor and referred back to the base as equivalent illumination. The rms noise voltage reference is 0.05 μv for a 100-cycle bandwidth and an assumed input resistance, R, of 1500 ohms. The noise voltage:

$$e_n = \sqrt{4KTBR}$$

where K is Boltzman's constant, B is the bandwidth in cycles/sec, T is the temperature in degrees Kelvin, R is the input resistance.

A transistor exhibiting a noise figure of 12 db (taken at 1000 cycles with a 100-cycle bandwidth) would have a noise voltage $e_n = 0.2$ μv referred to its base. This is equivalent to a base current of e_n/R or 1.33×10^{-4} μa.

The amount of light required to produce an equal base current would then be determined by dividing this current by the junction light sensitivity.

$$\frac{i_b \text{ (Noise base current) in } \mu a \text{ (rms)}}{\text{Junction sensitivity in } \mu a/F_C \text{ (rms)}}$$

A typical value of junction sensitivity is 0.12 $\mu a/F_C$. In rms terms this is:

$$\frac{0.12}{2\sqrt{2}} \mu a/F_c = 0.043 \mu a/F_c$$

The equivalent noise illumination I_{eq} is:

$$I_{eq} = \frac{1.33 \times 10^{-4} \mu a}{0.043 \mu a/F_c} = 3 \times 10^{-3} \text{ ft-c}$$

Similarly this same transistor operating with a one cycle bandwidth would have an equivalent noise illumination of 3×10^{-4} ft-c.

Circuit Applications

Phototransistors have sometimes been called "light tetrodes" because carriers may be injected into the base by (1) signal voltage applied to the base lead as with any other transistor, or (2) by light energy falling on the base. The two conditions may exist together or separately.

In order that the phototransistor be utilized in its most sensitive configuration the base should be open-circuited or as close to this condition as possible. Fig. 2 shows the effect of an external base resistance, such as a bias network, on the short circuit light sensitivity.

It must be noted that the open base condition

A GOOD RUN FOR YOUR MONEY—

New "SCOTCH" BRAND Heavy Duty Tapes offer exceptional life, low rub-off, good resolution

HAVE PROBLEMS OF TAPE-LIFE, rub-off and resolution? To cure your headaches in applications that subject magnetic tape to high speeds, pressures, temperatures and low humidity, "SCOTCH" BRAND now prescribes two new tapes—Heavy Duty Tapes 198 and 199. They offer plus-performance in a wide variety of temperature and humidity conditions.

Take the matter of wear, for instance. Field tests show that "SCOTCH" BRAND Heavy Duty Tapes wear five times longer than standard tapes—yet they maintain good resolution and freedom from drop-outs over this long haul. Two factors are decisive in this performance—resistance to rub-off and resistance to high temperatures.

Ordinary tapes age fast if the temperature climbs or the relative humidity drops sharply. The binder softens, allowing the oxides to rub off on those costly and sensitive heads.. Further, as an electrostatic charge builds with each pass, stray contaminants are attracted to the tape—and the tape starts to cling to the equipment. In each case—your drop-out count mounts.

Not so with "SCOTCH" BRAND Heavy Duty Tapes. They boast an extra tough binder system similar to that used in "SCOTCH" BRAND Video Tape, which after two years is still the only video tape in commercial use. The heavy duty binder system anchors the oxides firmly to the polyester base in a way that resists very high temperatures—minimizing rub-off. Moreover, Heavy Duty Tapes have a conductivity nearly 1000 times greater than conventional tapes, allowing static charge to drain off. Result? Clean, smooth runs with good resolution—a good run for your money.

Performance of this kind is easy to promise—much harder to deliver. And only experienced "SCOTCH" BRAND technology has such a record of delivering the right tape for every application in data acquisition, reduction or control programming.

Check all the tapes in the "SCOTCH" BRAND line. High Resolution Tapes 158 and 159 pack more bits per inch, offer extra play time. High Output Tape 128 gives top output in low frequencies, even in temperature extremes. Sandwich Tapes 188 and 189 drastically cut head-wear, eliminate oxide rub-off, and wear 10 times longer than ordinary tapes. Standard Tapes 108 and 109 remain the standard of instrumentation.

Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details consult him or write Magnetic Products Div., 3M Co., St. Paul 6, Minn.

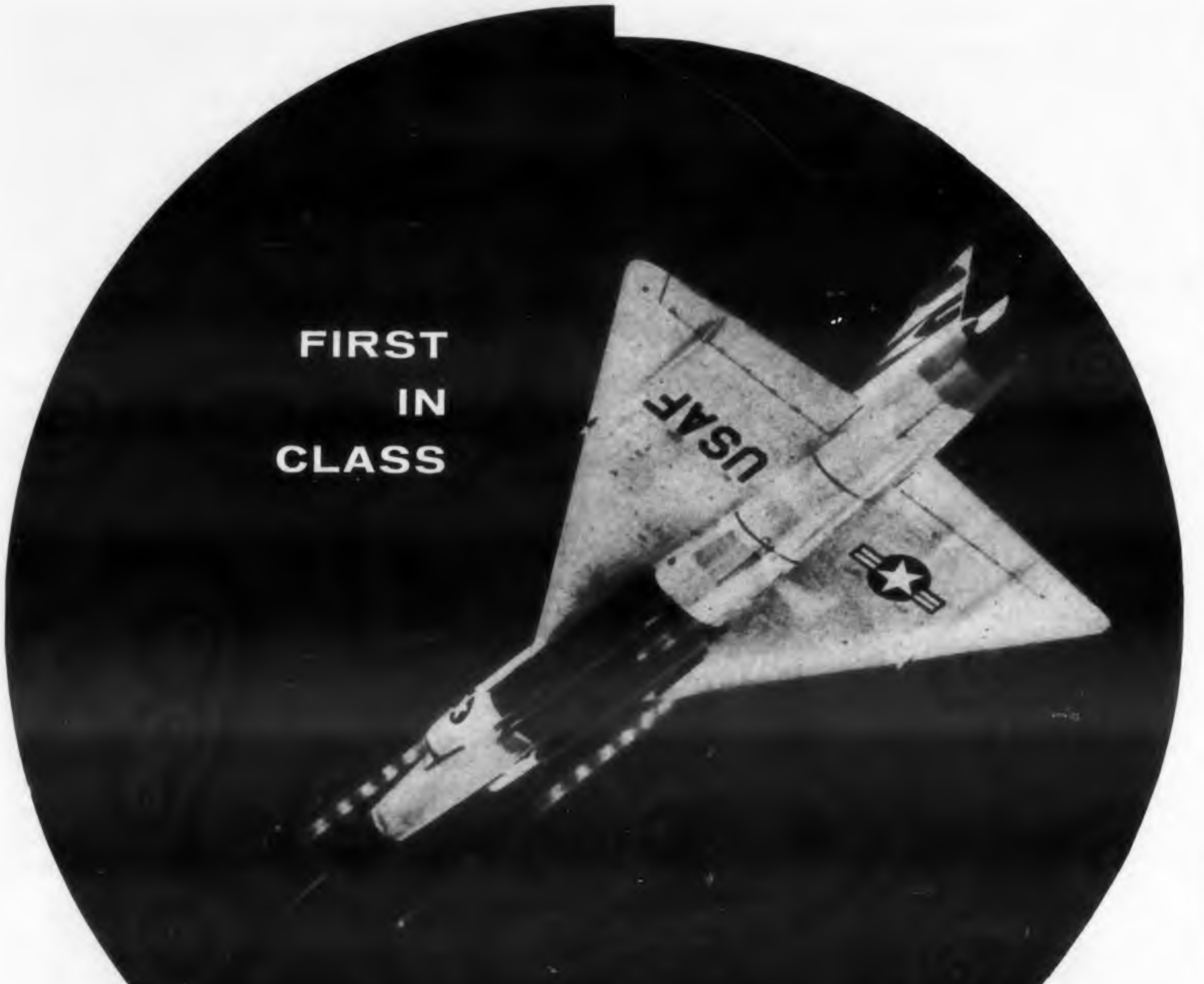
© 1960 3M Company

"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesota. Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontario.

SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW
3M

CIRCLE 792 ON READER-SERVICE CARD



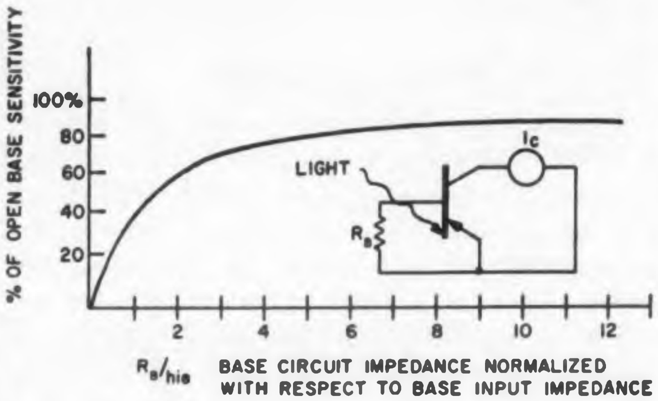


Fig. 2. Light sensitivity as a function of base circuit impedance. The base circuit impedance has been normalized with respect to base input impedance.

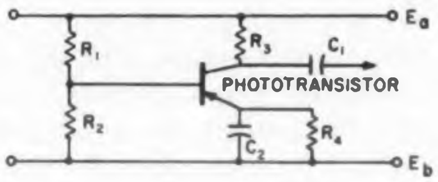


Fig. 3. Phototransistor chopped light transducer suitable for translating varying light into equivalent electrical signals.

is temperature-unstable and the same care must be taken in the biasing of the stage as with other types of transistor amplifiers. Proper operation is a compromise, therefore, between sensitivity and stability. Circuit applications may be divided into two groups. The first group translates varying light, or pulses of light, into equivalent electrical signals. The second group activates switches according to the presence or absence of light. An example of the first group of circuits is shown in Fig. 3. The accompanying table lists practical circuit parameters for amplifier loads of:

a) High input impedance
b) Moderate input impedance
c) Low input impedance.

Fig. 4 is an example of a circuit which when it is activated by light turns a normally on relay off.

Parameters for the

Load	R_1	R_2	R_3	R_4
a)	250K/1%	250K/1%	170K/	K/1%
b)	[25K	25K	25K	36K
c)	24K	12K	8.2K	.2K

*Frequency Range - 400-1000 cps.

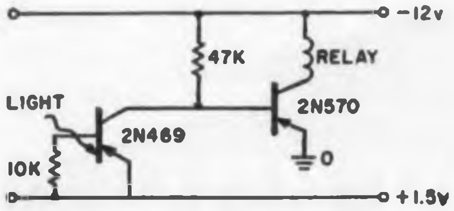


Fig. 4. Phototransistor circuit designed to turn a normally activated relay off.

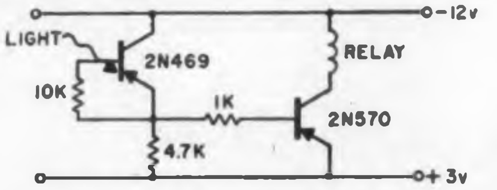


Fig. 5. Phototransistor circuit designed to turn a normally off relay on.

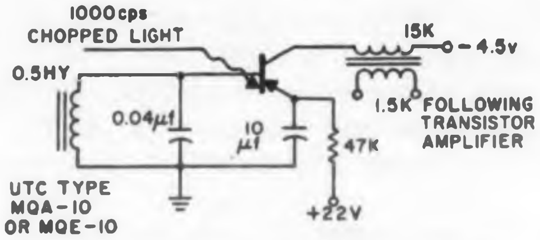


Fig. 6. Phototransistor circuit designed to operate in the presence of high ambient light from a 1000-cps chopped light source.

Fig. 5 turns a normally off relay on.

Where operation in the presence of high ambient light is required, the circuit of Fig. 6 is useful, especially in the single frequency case.

High resistance in the emitter circuit degenerates response to unvarying ambient light. The tuned circuit in the base degenerates response at frequencies other than that to which it is tuned. The capacitor would be omitted for operation over a wide frequency band.

Low collector circuit resistance will reduce the possibility of the transistor going into saturation although care must be taken that dissipation will be within safe limits.

Digested from PNP Phototransistors, *Brochure G-190, published by General Transistor Corp., Jamaica, N.Y.*

the Circuit of Fig. 3

R_3	R_4	C_1	C_2*	E_a	E_b
70K/	K/1%	.02 µf	50 µf	0V	+150V
25K	36K	5.0 µf	50 µf	−25V	0V
8.2K	.2K	5.0 µf	50 µf	−12V	0V

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.

Investigate their outstanding operating characteristics for use in *your* products. Write, stating requirements, to The Gamewell Company, 1399A Chestnut St., Upper Falls 64, Massachusetts.

GAMEWELL SG-270
Precision Rotary Switch

Gamewell®

PRECISION POTENTIOMETERS

"INTEGRALS OF
HIGH PERFORMANCE"

CIRCLE 794 ON READER-SERVICE CARD

Need a Miniature Printed Circuit Switch?

S30-42B SERIES

- Gold flash and other special contact material for low voltage applications
- Positive overtravel stop
- Special terminals for easy printed circuit insertion
- Small size (1/4" x 1/2" x 1")
- Over 50 actuator variations including cam followers
- Rated: 10 amps/125 V a-c
  5 amps/250 V a-c
  1/3 hp/125/250 V a-c

CALL OR WRITE

CHERRY ELECTRICAL PRODUCTS CORP.
1646 Deerfield Rd., Highland Park, Ill.
Phone: Idlewood 2-8182

CIRCLE 795 ON READER-SERVICE CARD

MOXNESS

. . . Logical Source for Precision Silicone and Fluorocarbon Products

PRECISION MOLDING Rubber and Plastics
Simple or complex, Moxness has complete, modern mass-production facilities, including die-making, to give fast delivery on the rubber and plastic components you specify.

PRECISION BONDING
Specialists in rubber-to-metal bonding to meet exacting specifications and production requirements. Inserts may be furnished by the customer or produced in our plant.

PRECISION EXTRUDING
Special equipment and an exclusive process developed by Moxness are two reasons why you will pay *less* for quality extrusions when you order from Moxness.

PRECISION MOX-TAPE®
NEW Guide Line Triangular MOX-TAPE provides homogeneous void-free insulation for motors (class H and B) with a single wrap. *Cuts* taping time 50 to 60%.

Write for the Moxness Story
MOXNESS PRODUCTS, INC.
1919 Indiana St. • Racine, Wisconsin
Subs. Nat'l Rivet and Mfg. Co.

MOXNESS

CIRCLE 796 ON READER-SERVICE CARD

REPORT BRIEFS

Antenna System for Very Low Radio Frequencies

The theoretical antenna problem was solved using a normal mode expansion of the current distribution. A matrix method was developed to compute the current distribution of a thin, linear antenna loaded with lumped-circuit elements. A digital computer was used to solve the matrix equations. Results were obtained for a full-wave linear antenna symmetrically loaded with real impedances Z_o one half wavelength apart. Current distributions, feedpoint impedances, radiation patterns, etc., are presented as functions of Z_o. Results of the idealized problem are applied to the power-line antenna. The matrix method can also be extended to the general linear antenna with any type of loading or feeding. System components and performance of the Dinkey Creek power-line antenna are described. The problem of interference with nearby audio-frequency communication systems is examined. *A New Transmitting Antenna System for Very Low Radio Frequencies, Willard Van Tuyl Rusch, California Institute of Technology, Pasadena, Calif., June 26, 1959, 167 pp, Microfilm $7.80, Photocopy $25.80. Order PB 142988 from Library of Congress, Washington 25, D. C.*

Ultra-High Temperature Resistors

This report covers the development of a suitable design for a one watt resistor capable of operation at temperatures from —65 deg C to +500 deg C in nuclear radiation environments for extended periods of time. The work was devoted to refining the electrical properties and design of the resistor. It was demonstrated that high alumina ceramics were necessary to minimize large non-uniform resistance changes occurring over uniform temperature increments to +500 deg C. A number of terminal material compositions were examined for applicability in ultra-high temperature operation. Investigation of various metal oxide films revealed that a 7.5 per cent Sb_2O_4: 92.5 percent SnO_2 composition possessed a near zero temperature coefficient of resistance over broad temperature range and the most desirable electrical characteristics. A suitable insulating coating, composed of flame deposited aluminum oxide, was utilized in this application without undesirable effects on resistor properties. Radiation tests were made on a variety of modified tin oxide resistors at +500 deg C for 1500 hours under high intensity nuclear radiation. *Resistors, Fixed, Ultra-High Temperature, Radiation Resistant, David R. Sivertsen, P. R. Mallory and Co., Inc., Indianapolis, Ind., July, 1959, 47 pp, $1.25. Order PB 161081 from OTS, Washington 25, D.C.*

PHAZOR PAT PEND

PHASE METER

MODEL 200AB

PRICE $449^00

- 2° absolute accuracy
- Readings not affected by noise and harmonics
- Frequency range 15 CPS — 30KC
- Accuracy to .01 degree with simple circuit techniques
- High sensitivity on input & reference channels
- Can measure in-phase & quadrature voltage component

For further information contact your nearest representative or write for brochure

ITECO INDUSTRIAL TEST EQUIPMENT CO.
55 E. 11th ST. · NEW YORK 3 · GR 3-4684

VISIT BOOTH #3513, I.R.E. SHOW, NEW YORK COLISEUM
CIRCLE 797 ON READER-SERVICE CARD

FREE! BOOKLET AND SAMPLES

LEARN HOW FASTEX® Plasti-Rivets® CUT ASSEMBLY COSTS!

These ingenious new plastic fastenings drive from one side—simplify blind fastening problems—resist vibration loosening and corrosion. Available in a wide variety of thermo-plastic materials, in a wide choice of colors, sizes and standard or special types.

Send for FREE Testing Samples to-day!

itw FASTEX

195 Algonquin Road, Des Plaines, Illinois
In Canada: SHAKEPROOF-FASTEX,
Division of Canada Illinois Tools Ltd., Toronto, Ont
A DIVISION OF ILLINOIS TOOL WORKS

CIRCLE 798 ON READER-SERVICE CARD

CIRCLE 799 ON READER-SERVICE CARD ➤

Microelectronics

Two techniques have been developed for constructing microelectronic transistorized modules. The first uses etched wiring boards and standard subminiature components. The second technique gives a greater than ten to one volume reduction over the first by incorporating an uncased transistor directly into a printed circuit ceramic plate. The degree of reduction is such that optical aids must be used in constructing and inspecting the circuitry. A new term, microelectronics, has been selected to embrace the latter technique as well as related efforts in system design, power supplies, etc. *Microelectronics: An Introduction And A Status Report, T. A. Prugh, Diamond Ordnance Fuze Laboratories, Washington, D.C., Nov. 1, 1957, 11 pp, Microfilm $2.40, Photocopy $3.30. Order PB 143566 from Library of Congress, Washington 25, D.C.*

Narrow-Band Amplifiers

A method for the design of multi-stage, narrow-band amplifiers employing general active two-port devices as amplifying elements is presented. The stability of the amplifier is controlled by means of its input and output conductance levels, rather than by neutralization. The main characteristic of this paper is a theoretical exposition of the functional dependence of the transducer gain of a multi-stage, narrow-band, iterative amplifier upon its interstage network, and upon the input and output terminations. A complete analysis of the transducer gain of the amplifier is included. *Multi-Stage, Narrow-Band Amplifiers Employing Non-Unilateral Electron Devices, M. Lim, Stanford Electronics Laboratories, Stanford University, Palo Alto, Calif., Feb. 11, 1958, 121 pp, Microfilm $6.30, Photocopy $19.80. Order PB 138708 from Library of Congress, Washington 25, D.C.*

Miniaturized Trimmer Capacitors

The objective of this study was to develop a highly stable, miniaturized line of trimmer capacitors to replace the variety of existing types. These capacitors were to exhibit good temperature and mechanical stability, and a high order of ruggedness and reliability under the environmental conditions encountered by military communications equipment. This report is a condensation of the three previous reports. It contains the results of the samples tested, the results of the dielectric material survey, and the recommended designs for the ten capacitors as requested in the contractual requirements. *High Stability Miniaturized Trimmer Capacitors, C. W. Everhart and B. L. Borman, P. R. Mallory and Co., Indianapolis, Ind., Oct. 15, 1955-Oct. 15, 1956, 76 pp, Microfilm $4.50, Photocopy $12.30. Order PB 143301 from Library of Congress, Washington 25, D.C.*

◄ CIRCLE 799 ON READER-SERVICE CARD

BENDIX-PACIFIC
in Southern California
needs **ENGINEERS** *with*
DOCTORS'- MASTERS'- BACHELORS'
DEGREES
for electrical, mechanical and systems work in fields of
Instrumentation — Telemetry
Anti-Submarine Detection   Systems/Operations Research
Missile and Aircraft Fluid Controls.

Please send resume to W. C. WALKER,
ENGINEERING EMPLOYMENT MANAGER

Other High-Level Electronic
Engineering Positions Available

Bendix-Pacific
DIVISION OF BENDIX AVIATION CORPORATION
NORTH HOLLYWOOD, CALIFORNIA

CIRCLE 926 ON CAREER INQUIRY FORM, p. 317

newton digital shaft pulser

REMOTE POSITIONING OF SHAFTS ***of counters, switches, indicators, etc., for more effective, versatile equipment.***

The NEWTON DIGITAL SHAFT PULSER is a bi-directional stepping motor with high output torque of approximately one inch pound at 6° output. It operates at a maximum of 40 steps per second; is equipped with a precision detent.

The motor can be easily mounted in any position and is versatile in output increments. It includes 36°, 6°, 5°, 4°, 3°, 2°, 1°, 2/3°, 1/2°, and 1/3° output per step. Special output steps can be ordered.

Approximately a 10 millisecond pulse at 15 watts will produce the rated torque. The 13-ounce NEWTON PULSER is available in a wide range of operating voltages and is designed to meet strict military specifications.

Write today for complete details

THE NEWTON COMPANY *MANCHESTER, CONNECTICUT*

Another achievement in operational digital by NEWTON

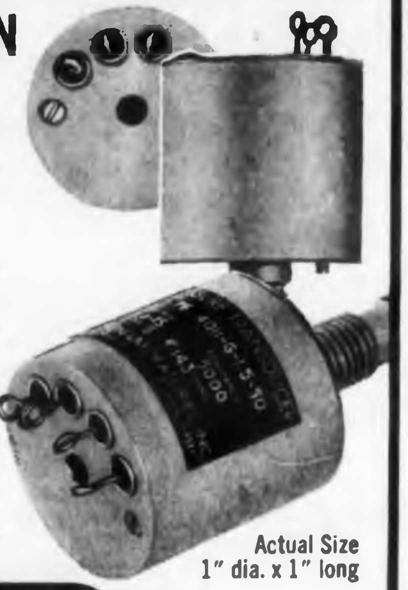
CIRCLE 841 ON READER-SERVICE CARD

NEW CMC
UNIVERSAL
Counter Timer

CMC's new Model 226B Universal Counter Timer has a functional panel layout that is human engineered to eliminate costly "cockpit" trouble. Inside, modular construction is used throughout to simplify maintenance and reduce weight. Circuitwise, 9 tubes have been eliminated lowering power drain, operating temperature and increasing reliability.

Direct reading, the 226B measures frequency from 0 to 1.2 mc, time interval from 1 microsecond to 1 million seconds and period from 0 microsecond to 1 million seconds. Accuracy is ± 1 count ± stability. Stability is 2 parts in 10^7 with an option to 5 parts in 10^8. Sensitivity is 0.1 volt rms over entire range. Oscilloscope marker signals simplify start and stop trigger level adjustment for TIM of complex wave forms. Unit will drive the CMC fast digital printer and most other types of printers and data handling equipment. Price fob Sylmar, California: 1 mc Model 226B-$1175.00; 220 kc Model 225C-$900.00. For 4-page bulletin giving complete technical specifications, contact your nearby CMC representative or write directly to **Computer Measurement Company, 12970 Bradley Ave., Sylmar, California, Dept. 19-3.**

CIRCLE 842 ON READER-SERVICE CARD


LIGHT WEIGHT ONE OUNCE MAX.
SMALL SIZE ONE CUBIC INCH MAX.
MINIATURE PRESSURE TRANSDUCER
FROM COLVIN

High vibration performance
±35G to 5,000 cps
Pressure ranges
Absolute, differential and gage pressures
0-3 to 0-400 psi
Differential pressures
±3 to ±200 psi
Standard Nominal Potentiometer Resistances
400 to 10,000 ohms
Electrical Connection
Pigmy receptacle or soldering terminals
Mounting
Flange or bulkhead

Actual Size
1" dia. x 1" long

COLVIN
LABORATORIES, INC.
364 Glenwood Avenue East Orange, N. J.

Write for complete information.

CIRCLE 843 ON READER-SERVICE CARD


FREE
416-PAGE
PIC MASTER CATALOG #21
Lists over 12,000
PRECISION INSTRUMENT PARTS
and ASSOCIATED COMPONENTS
Available From STOCK!

Completely illustrated with detailed drawings specifications and prices

GEARS • SHAFTS • COLLARS • CLUTCHES • BEARINGS • COUPLINGS • DIFFERENTIALS • SPEED REDUCERS and many other Precision Engineered Parts & Components.

Send for your FREE copy today.

PIC DESIGN CORP.
Subsidiary of BENRUS WATCH COMPANY, Inc.
477 Atlantic Ave., East Rockaway, L. I., N. Y.

CIRCLE 844 ON READER-SERVICE CARD

REPORT BRIEFS

Parametric Amplification

The performance of varactor amplifiers may be enhanced for some purposes by using diodes with special nonlinear characteristics. By approximating a step in the impurity density distribution, a junction diode with an abrupt change in slope in its capacitance reverse bias characteristic may be fabricated. This change in slope enables a parametric amplifier employing such diodes to exhibit great sensitivity at that operating point while maintaining stability. Design criteria for such a diode are reviewed; design theory is presented. Fabrication techniques and problems are discussed. The results of preliminary measurements on an experimental unit are presented. *Study of Parametric Amplification, G. C. Gerhard, Ohio State University Research Foundation, Columbus, June 1959, 20 pp., Microfilm $2.40, Photocopy $3.30. Order PB 143192 from Library of Congress, Washington 25, D. C.*

Processing Taped Data

This report describes Telemag, a system which is used to process test data which may have been recorded on magnetic tape in the test vehicle, telemetered to a ground station or the Telemag and recorded, or telemetered and fed directly to Telemag. The report also presents a brief review of some telemetry and magnetic tape data recording techniques. The last two chapters deal respectively with the actions to be taken to best utilize Telemag and plans for expanding its facilities and functions. *Telemag—A System For Processing Test Data Recorded On Magnetic Tape, James L. Blilie, Air Proving Ground Center, Elgin AFB, Fla., June 1959, 77 pp, Microfilm $4.50, Photocopy $12.30. Order PB 143290 from Library of Congress, Washington 25, D.C.*

Fourier Coefficients

Programmed computation of periodic Fourier coefficients in connection with the tabulation of $C_n(m)$ yields any desired number of Fourier coefficients. This new method is thus superior to other computational methods and schemes that *a priori* limit the number of obtainable coefficients. Fourier coefficients of specially selected orders can be obtained in a few steps, without the necessity of computing the entire sequence of coefficients. The method can be programmed for desk calculating machines as well as for computers. *A Method For Numerical Evaluation Of The Coefficients of Fourier Series, Kurt H. Haase, Air Force Cambridge Research Center, Bedford, Mass., June 1959, 38 pp, Microfilm $3.00, Photocopy $6.30. Order PB 143492 from Library of Congress, Washington 25, D.C.*


NEW FROM NARDA

Model
10001
$4700.

High Power
MICROWAVE MODULATOR
accepts over 40 magnetrons!

Here's the first of a series of new products from Narda's recently-established High Power Electronics Division! A high power Microwave Modulator that permits installation inside the unit of any of more than 40 magnetrons! Complete, compact and self-contained, it accepts magnetrons covering 3,200 mc to 35,000 mc, with peak outputs from 6 KW to 120 KW. Model 10001 features a completely interlocked circuit, with all high voltage leads and connections internal, for maximum safety; solid state high voltage bridge rectifiers for longer life and reduced heat output (prolonging life of other components, too); and built-in meters and viewing connectors for all principal parameters.

Other features are shown below. For complete specs and a list of at least 40 magnetrons suitable for use with the 10001, write Narda's High Power Electronics Division (HPED) at Dept. ED-7.

SPECIFICATIONS

High voltage supply: Continuously variable from 0 to 4 KV at 100 ma; **Pulse power:** 18 KV at 20 amps max.; **Magnetron filament supply:** Cont. variable from 0 to 13 volts at 3 A; **Rep. rate generator range:** Cont. variable from 180 to 3000 pps; **Pulse width:** 1 microsecond at 70% points, rise time 0.15 microseconds, max. slope 5% (other pulse widths available); **Size:** 38" h. 22" w, 18" d. **Weight:** 150 lbs.

Complete 1959 catalog available on request.

the narda microwave corporation
HIGH POWER ELECTRONICS DIVISION
118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

CIRCLE 845 ON READER-SERVICE CARD

Microwave Transistors

Wafer-type depletion layer devices have been fabricated in order to investigate injection into the depletion layer. A theoretical analysis of both high- and low-frequency operation has been initiated to determine the feasibility of a depletion layer transistor as a high-frequency device. Results indicate that the fabrication problems will be the principal barrier to the development of a feasible device. The results of a study concerning the fabrication and evaluation of bar-type, wafer-channel, and surface-barrier analog devices indicate that the surface-barrier device has the most favorable and reproducible characteristics, and is the easiest to fabricate. A theoretical analysis has also been initiated to determine the feasibility of the analog transistor for high-frequency application. Early results indicate that the field-effect unipolar device is extremely flexible. *Research and Experimental Work On Microwave Transistors, R. L. Goldman, Philco Corp., Philadelphia, Pa., Apr. 15-July 15, 1958, 30 pp, Microfilm $2.70, Photocopy $4.80. Order PB 139065 from Library of Congress, Washington 25, D.C.*

TRADIC Computer Research

This report summarizes the program for the development of solid-state technology for airborne weapons-control computers. Among the major items covered are: encoding and decoding techniques; two forms of non-destructive program storage; a wide temperature range magnetic core memory system; silicon direct coupled transistor logic; organization of a computer as an aid in trouble location; and programming techniques for the protection of stored constants and error correction in the weapons-control computer. *TRADIC Computer Research (Second Stage), J. A. Githens and M. J. Gilmartin, Bell Telephone Laboratories, Inc., New York, N.Y., Dec. 1, 1958, 398 pp, Microfilm $11.10, Photocopy $60.60. Order PB 143648 from Library of Congress, Washington 25, D.C.*

Semiconductor Device Cooling

In addition to an analysis of proper semiconductor cooling techniques, a study has been made of methods of improving fabrication techniques for transistors. The findings, if followed, may enhance the electrical reliability and life-time of semiconductor devices. Also, patent disclosures have been made on a liquid-filled transistor, a Peltier-cooled transistor, and a Peltier-cooled Zener diode. *Study of Methods of Cooling Semiconductor Devices, James P. Welsh, Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y., Dec. 1958-Feb. 1959, 13 pp., Microfilm $2.40, Photocopy $3.30. Order PB 142943 from Library of Congress, Washington 25, D.C.*

STANDARDS AND SPECS

Sherman H. Hubelbank

Activity in Capacitor Standardization is Summarized

There has been a great deal of activity in the field of capacitor standardization recently. MIL-C-11Q15, General Spec for General Purpose Fixed Ceramic-Dielectric Capacitors was revised as issue B. This issue superseded MIL-C-11015A, MIL-C-19321(Ships) and MIL-C-19683(Ships). These capacitors are primarily for use in applications where appreciable variations in capacitance with respect to temperature, voltage, frequency, and life can be tolerated. Also recently issued was MIL-C-21720A(Navy) covering polarized, tantalum, solid electrolytic, and fixed capacitors. These capacitors are intended for use in low-voltage applications where stability, size, and shelf life are important factors. Polarized tantalum electrolytic fixed capacitors primarily designed for filter, bypass and coupler use with a high degree of reliability are covered by RS-228 (October 1959) released by the Electronic Industries Association, 11 W. 42 St., New York 36, N.Y.; price $1.65.

The general spec covering fixed mica-dielectric capacitors was revised by amendment 1, MIL-C-5B (8 October 1959). In addition, 13-detail spec requirements were revised. MIL-C-20 was revised as issue C. This is a spec covering temperature compensating fixed ceramic dielectric capacitors. Four new disk styles of capacitors were added by this revision.

Plastic Jacket

The use of flexible polyamide (nylon) molding plastic for jacketing is established by this spec. This material is specified for use in applications requiring high strength and flexibility. MIL-M-22096, Molding Plastic, Polyamide (Nylon), Flexible.

Test Procedure For Magnetic Amplifiers Proposed

AIEE has released a proposed test procedure for magnetic amplifiers. Covered in this publication are general considerations, voltage amplification, current amplification, power amplification, response, and figure of merit. Copies of AIEE No. 433 (November 1959) are available from the American Institute of Electrical Engineers, 33 W. 39 St., New York 18, N.Y.

New Navy Spec Covers Variable, Rectlinear Resistor

The Navy has released a new spec covering a type of variable, rectilinear, miniature resistor whose contact bears uniformly over the surface of the entire resistive element. The contact is positioned by means of a multi-turn, lead-screw actuator. These resistors have a resistance tolerance of ±5% and ±10%. The wattage ratings are based on full-load operation of the resistors at 70 C, and are applicable only when the maximum resistance is engaged in the circuit. When only a portion of the resistance is engaged, the wattage rating is reduced in approximately the same proportion as the resistance. MIL-R-2209(NAVY), Resistors, Variable, Rectilinear (Miniature).

Spec Covering Resistor Color Codes Is Revised

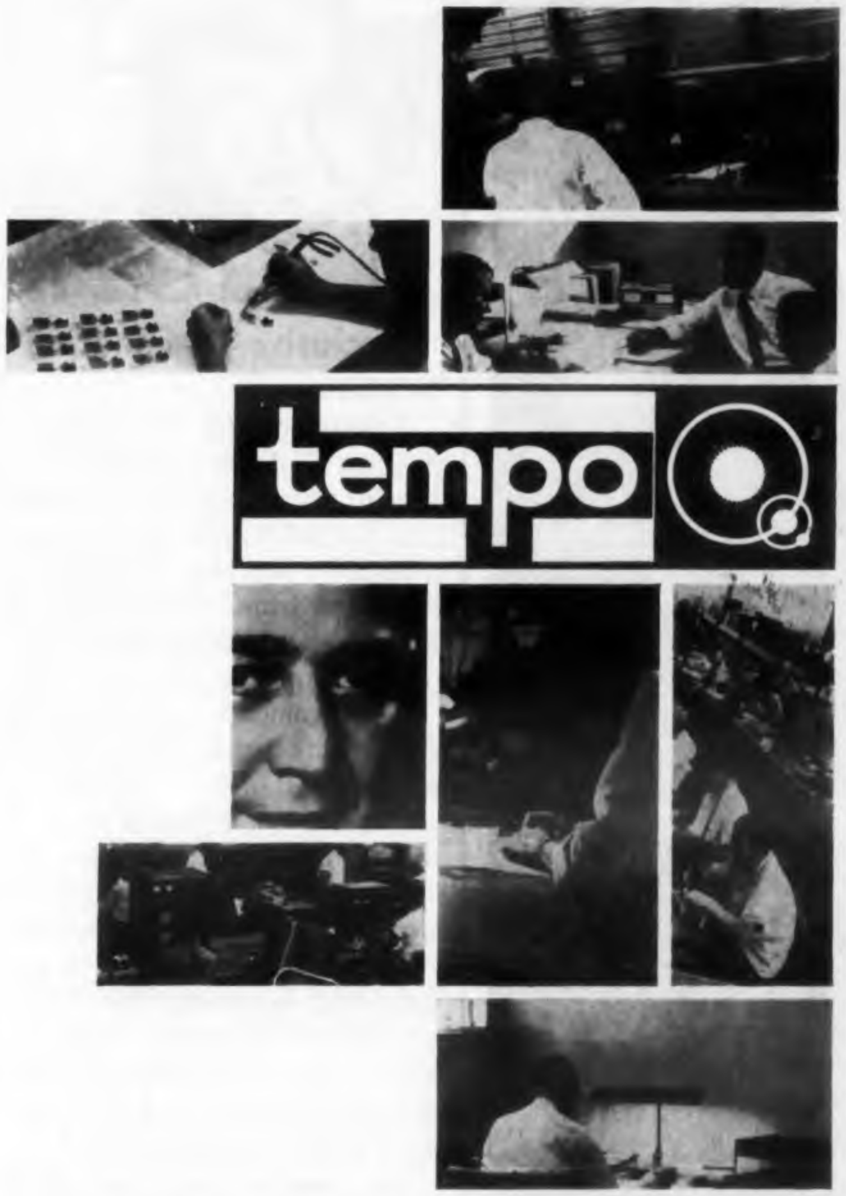
The latest revision to MIL-STD-221A has deleted the color coding for composition-type radial-lead resistors. The ±20% tolerance has been deleted from the color code. Standard MIL-STD-174 is referenced for standard colors instead of MIL-STD-104. The requirements in the conflict of colors paragraph has been relaxed by allowing either the resistor body or the band colors to be differentiated by shade or gloss. MIL-STD-221A (1 December 1959), Color Code for Resistors.

Liquid Soldering Flux

This spec covers a non-corrosive rosin-base flux for application as a liquid external to the solid solder. The flux is for primary use in the preparation of solder joints for electric and electronic circuits. The spec does not cover soldering processes, nor materials used in the soldering of mechanical joints that do not also serve within electric and electronic circuits. MIL-F-14256A, Flux, Soldering, Liquid (Rosin Base).

Interchangeable Parts: Some Necessary Definitions Established

Varying definitions and interpretations relative to interchangeability, substitutability, and replaceability, have adversely affected design, procurement, support, maintenance, and production of equipments according to MIL-STD-447. This standard establishes necessary definitions toward achieving the highest practicable degree of uniformity. An interchangeable item is one that possesses functional and physical characteristics equivalent in performance and durability and capable of exchange without alteration. A substitute item is one that can be replaced only under certain conditions. A replacement part is one that requires alterations. MIL-STD-447, Definitions of Interchangeable, substitute, and Replacement Items.



NOT
NEW,
but...

...proved by millions in use over several years! IERC TR type Heat-dissipating Electron Tube Shields are still the only effective heat-dissipating tube shield designed for retrofitting equipment having JAN bases.

Present TR's are unchanged from the original version introduced — and over the years, nothing has equalled their cooling and retention qualities. The greatly extended tube life and reliability provided by IERC TR's is acknowledged by the entire industry.

IERC's TR's have been right for the job — right from the start. For immediate, increased tube life and reliability — retrofit now with IERC TR Shields.

IERC

Free IERC Tube Shield Guide, listing TR Shields is available by writing Dept. TR for your copy.

International Electronic Research Corporation
145 West Magnolia Boulevard, Burbank, California

CIRCLE 848 ON READER-SERVICE CARD

LETTERS

Exclusive-Or Function Redefined

Dear Sir:

I disagree with the logical definition of an N-input Exclusive-Or function expressed by Mr. Breault and Mr. Morris on pages 174 and 175 of the November 25th issue and also the one expressed by Mr. Maki in "Ideas for Design" of the July 22nd issue. I believe that the output of an Exclusive-Or gate should be true when one and only one input is true.

The common Or-gate is sometimes called Inclusive-Or because it provides an output not only when A or B or C, etc., is true, but also when any combination of inputs is true. Thus it "includes" the redundant functions AB + BC + AC + ABC, etc. In contrast, the counter-adjective "Exclusive" would logically imply the special case when only A or B or C, etc., is true; thus it "excludes" the redundant functions. Only when applied in this manner can the words "inclusive" and "exclusive" have a completely descriptive meaning to a logic designer who may not already be familiar with some arbitrarily chosen set of definitions.

The function for a 3-input Exclusive-Or gate should therefore take the form $A \cdot \overline{B} \cdot \overline{C} + \overline{A} \cdot B \cdot \overline{C} + \overline{A} \cdot \overline{B} \cdot C$, which when expanded to maxterms is $(\overline{A} + \overline{B} + C)\ (\overline{A} + B + \overline{C})\ (A + \overline{B} + \overline{C})\ (A + B + C)\ (A + B + C)$. From the first expression it is easy to see that the function can be true when one, and only one, input is true.

I agree that the circuit of Breault and Morris is very useful for parity checking and as a full adder sum-output, but it should be labeled as something other than Exclusive-Or.

W. H. Ferwalt
Engineer
Engineered Electronics Co.
Santa Ana, Calif.

Current Source Coupling Circuit Modifies Published Design

Dear Sir:

The article by George H. Hall on an "Intercoupling Circuit for Precision Amplifiers" in ELECTRONIC DESIGN, November 25, 1959, was quite interesting. In his list of alternate coupling methods, Mr. Hall mentions "voltage regulator tube" coupling. A similar coupling method utilizes a

ELECTRONIC
HIGH-VACUUM
PUMPS

ULTEVAC®

liters per second
1
5
40
90
180
270
500
1000

THE KEY TO A TRULY CLEAN VACUUM, without fluids or other contaminants, is an UlteVac electronic pump. Can operate unattended for months or years on a sealed system; requires no traps, baffles, or refrigeration. Maintains vacuums of 10^{-9}mm Hg and below; power failure does not harm system since it is sealed after UlteVac starts. Serves as its own vacuum gauge. Operates in any position; no hot filaments, no cooling water.

Series 110
1 l/sec.

Series 327 • 270 l/sec.

ULTEK CORPORATION, only manufacturer devoted exclusively to ion pump technology, offers stock pumps 1 to 1000 liters/second capacity, plus sorption pumps, foreline traps, and SealVac fittings which provide easy-connecting rotatable flanges. Ultek invites comparison of product, service, and delivery time, on either standard or modified pumps and accessories. Literature on request—specify application.

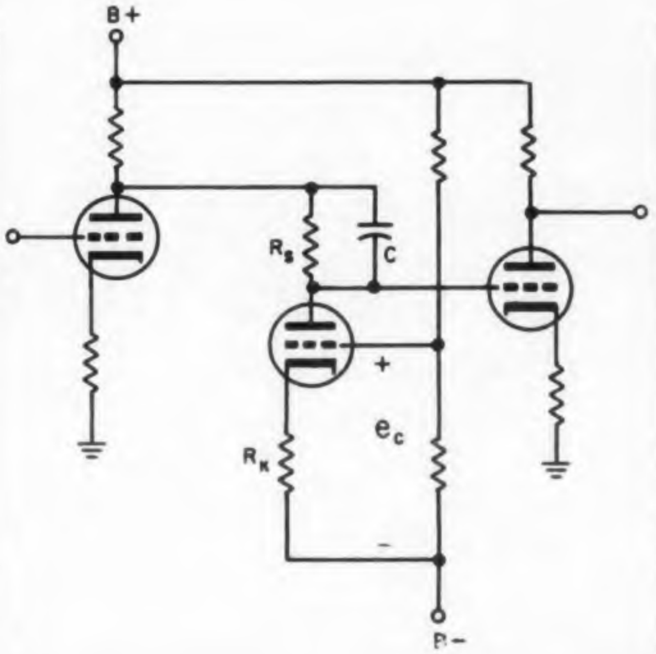
Contact ULTEK, or its exclusive representative, Kinney Mfg. Div. of The New York Air Brake Co. Sales offices in major U.S. cities.

BOOTHS 4309-4311 AT I.R.E.

ULTEK CORP.

920-D Commercial St. • Palo Alto, Calif. • DA 1-4117

CIRCLE 849 ON READER-SERVICE CARD



Current source coupling circuit needs no battery and does not suffer instability from tube aging.

voltage reference diode ("Zener" diode) in place of a voltage regulator tube and does not suffer from the noise problems mentioned by Mr. Hall.

Mr. Hall's circuit exhibits several features which could act as major drawbacks in some applications. One is the need for a battery. Another is the instability of the circuit with respect to tube aging. As the coupling tube ages, that is, as its cathode emission falls, the tube current will change and the coupled voltage will drift. A circuit without these difficulties is shown in the accompanying diagram.

In this circuit the coupling tube is placed in series with a voltage translating resistor R_s and a large cathode resistor R_k. Because of the large cathode resistor, the current through the tube, and therefore the voltage across R_s are held substantially constant regardless of changes in the characteristics of the tube. Voltage variations at one end of R_s are transmitted virtually undiminished to the other end, but with the desired dc translation. The circuit may be thought of incrementally as a voltage divider with a series resistance R_s and a very large shunt resistance equal to $R_k(1+\mu)$. For dc conditions the shunt resistance equals $R_k + R_p$.

Alternately, the tube and cathode resistor may be thought of as a current source of approximately e_cR_k, drawing a constant current through R_s. The grid voltage for the coupling tube is derived from the supply voltages rather than from a battery. Depending on the voltages involved, a negative supply may or may not be needed. The coupling capacitor is used to equalize the transmission at high frequencies. Transmission efficiencies of 99 per cent are easily realizable.

H. T. McAleer
Engineer
General Radio Co.
West Concord, Mass.

DESIGNING YOUR FUTURE

Anyone for Thermo-Tronics?

Arthur F. Dickerson

Product Planning Manager
Receiving Tube Dept.
General Electric Co.
Owensboro, Ky.

The rise of microminiaturization and the growth of electronic systems have kindled an urgent demand for engineers with fresh ideas not only on dissipating heat but on putting it to constructive use.

As electronic units shrink, heat problems for the design engineers expand—especially in systems. Typical of components that create the problems are ones like this printed-circuit transistor (small dot on board upper left), developed by an Army researcher to cut the size of electronic "brains" in military equipment. The transistor it replaces is at right.

IT IS doubtful that the following advertisement would surprise anyone if it appeared in the leading electronics trade journals:

> HELP WANTED: BSE-T (Bachelor of Science in Electronic-Thermodynamics) Preferably with experience in microminiaturization. Salary open.

It is also doubtful that the ad would produce any replies. Although experience with microminiaturization is abundant in the industry, most of it has been obtained the hard way without benefit of formal education in either electronics and thermodynamics. Certainly the academic degree of BSE-T is unfortunately nonexistent. This is not so much a criticism of the state of the electronics art as an observation that a three-credit course in thermodynamics of internal combustion engines (the conventional college dose in thermodynamics) is considerably less than adequate preparation for today's demands on the electronic

TIMM's (Thermionic Integrated Micro Modules) differ from conventional packaging concepts in that they confine heat rather than expel it, and put it to work operating vacuum devices. Designed by General Electric, the units comprise the equivalent of conventional transistors, capacitors and resistors.

equipment designer.

In some ways the belated recognition of the thermodynamic factor in electronics is surprising. The relationship between electron control and heat generation is direct, as every electronics designer discovers at some point in his career, whether he deals with transistors, tubes, magamps or cryotrons. The very act of current control implies the application of energy (through a system of less than 100 per cent efficiency), with the consequent dissipation of power and generation of heat. Even if heat were not generated in the control process, it still would be generated when the controlled electron got where it was going, as well as in the process that got it started in the first place.

If the heat problem seems applicable only to electron tubes, consider the possibilities of a transistor with no power dissipation in the emitter, or a parametric amplifier with a lossless pump circuit, or a cryotron with no heat transfer to the refrigerant. Anyway you view it, heatless electronics is no more probable than perpetual motion, since both depend on a 100 per cent efficient system.

Basic Propositions

Heat in the electronic sense is a matter of degree, and the pertinent question is not "Do we have it?" but "How much?" Invariably the answer is "too much," and the question shifts to "What do we do about it?" At the very least the answer calls for examination of some basic propositions:

1. Heat energy is a systems problem.
2. Heat energy and temperature are two different things.
3. Heat is not all "bad."
4. In microminiaturization the thermal and electronic designs are inseparable.

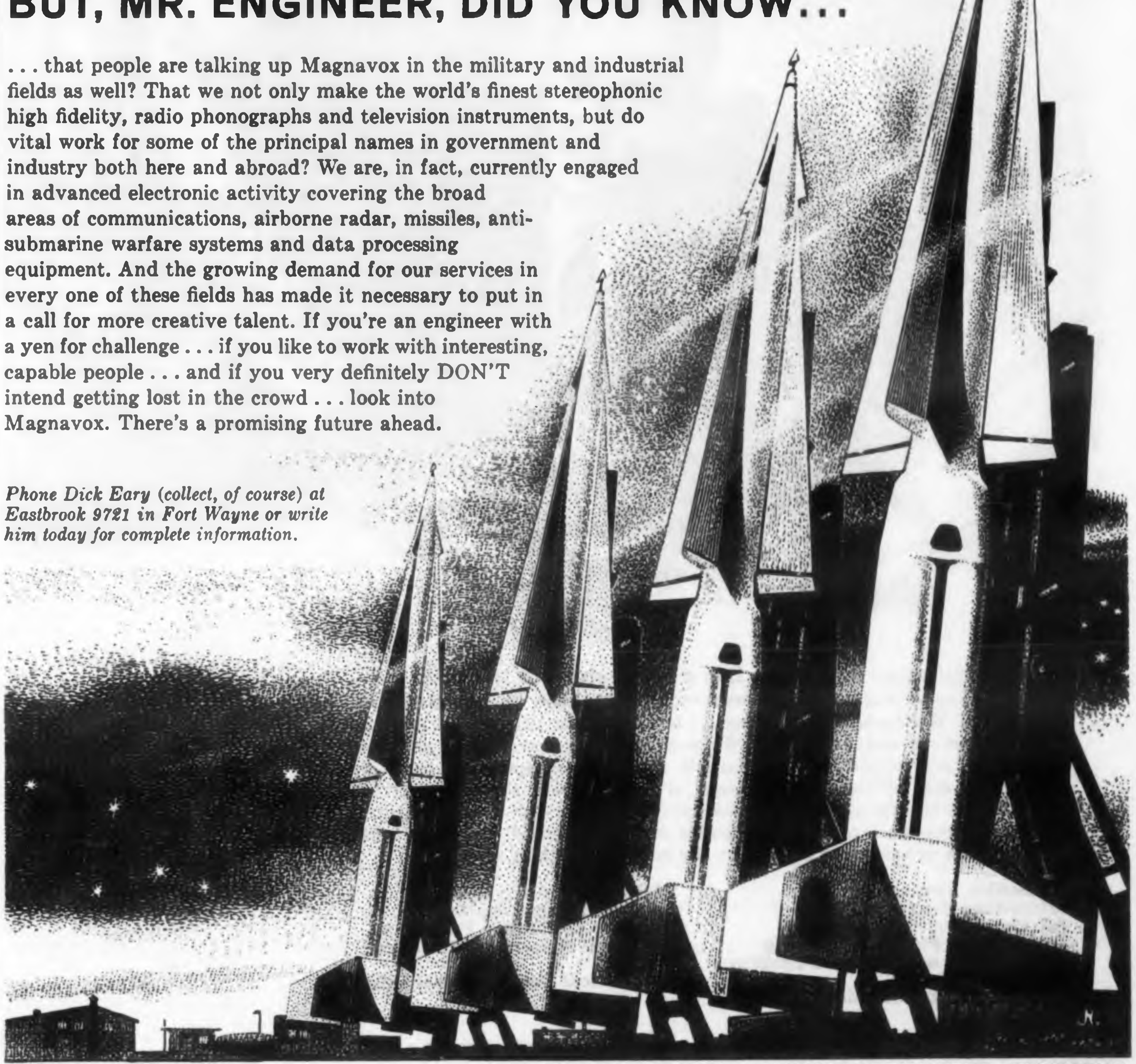
Let us examine these propositions in detail one at a time.

A Systems Problem

First, heat energy is a systems problem. This is an attempt to state that the problems, evaluations and comparisons of heat energy in modern electronic equipment must be dealt with as a systems consideration and evaluated on the basis of the effect on system performance and capability. Let us take a simplified case of equipment *A* and *B*, functionally similar but with these differences:

	A	B
Power Consumption	75 w	35 w
Useful Output	5 w	5 w
Heat Energy Released	70 w	30 w
Max. Rated Internal Temp.	250 C	100 C
Nominal Rise Above Ambient	+100 C	50 C

It is obvious that equipment *B* is more efficient when viewed alone, out of context to the system.

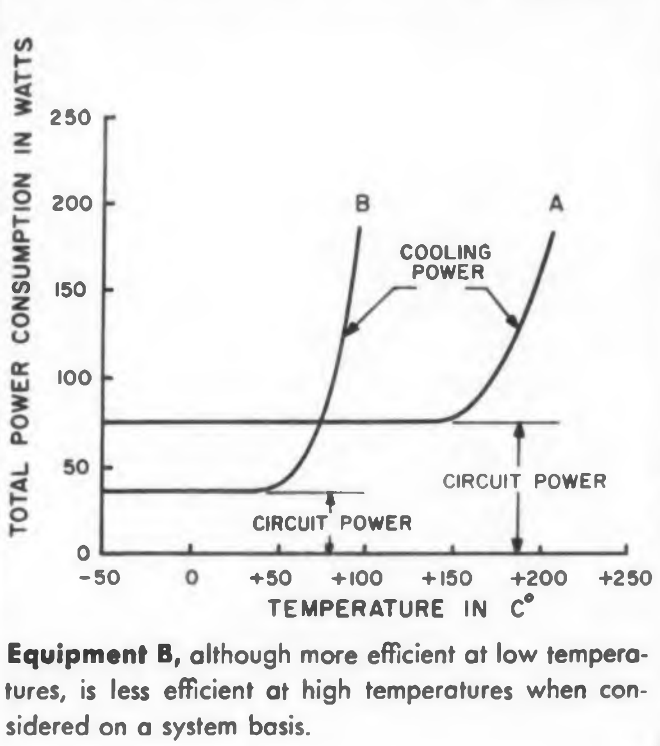


DESIGNING YOUR FUTURE

The pertinent question here is which design is more efficient on a system basis. The answer depends entirely on ambient temperature. Equipment *A* will have to be cooled for ambients above 150 C. As a very rough approximation, at an ambient of 100 C the heat to be removed from B is equal to the total power dissipation. If we assume an electrical refrigeration efficiency of 20 per cent, this becomes 30/0.2 = 150 w.

Under this condition, equipment *B* would consume a total of 185 w on *a system basis,* while equipment *A* consumed 75 w. Consequently for an ambient temperature of 100 C and electrical refrigeration, equipment *A* is more than twice as efficient as *B*, although exactly the reverse is true at an ambient of 50 C.

We can construct a generalized comparison curve (see graph) that illustrates this comparison as a function of ambient temperature. Similar comparison can be made for other system factors, such as weight or volume. In many instances the optimum design for weight will not coincide with the optimum for efficiency or size.



Equipment B, although more efficient at low temperatures, is less efficient at high temperatures when considered on a system basis.

Two Different Things

Second, consider the proposition that heat energy and temperature are two different things. This statement borders on the self-evident; nevertheless it is often overlooked. An illustration is afforded by considering the heat energy above absolute zero in a cubic foot of the North Atlantic Ocean at —2 C, compared with the same volume for colliding gas clouds of Cygnus A, which are estimated to reach a temperature above 1,000,000

Advancement Your Goal? Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—*as confidentially and discreetly as they would do in person.* The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—*the same day the resume is received.*

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. Safeguards include:

- All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN.*
- Your form is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at *ELECTRONIC DESIGN*, and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

ELECTRONIC DESIGN **CAREER INQUIRY SERVICE** USE BEFORE APR. 27, 1960

After completing. mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below. ⑥

(Please print with a soft pencil or type.)

Name ______________________ *Telephone* ______________

Home Address ______________ *City* ____________ *Zone* ______ *State* ____________

Date of Birth ______________ *Place of Birth* ______________ *Citizenship* ____________

Position Desired ____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training ____

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience ____

Professional Societies ____

Published Articles ____

Minimum Salary Requirements (Optional) ____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924
925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949

deg. The Atlantic wins hands down, with a margin of at least 10^{16} over the hot but rarified regions of Cygnus.

Now to put this comparison into terms of an electronic system, we need only observe that "a watt is a watt, is a watt," regardless of the temperature at which it is dissipated. A 1.4-v, 50-ma filament in a vacuum tube consumes 70 mw and operates close to 800 C. In a closed thermal system, such as a satellite or closely packed electronic equipment, the filament represents the same heat energy contribution as 1 ma passing through a 70,000-ohm resistor operating at 50 C or a 70-mw anode dissipation in the tube. To maintain a long-term temperature balance, we must get rid of 70 mw in each case independent of the wide difference in temperature. A drop in the battery cables of 0.1 v at 1 amp would put a greater load on the cooling system than the 800 C filament.

Not Always 'Bad'

Third, let us examine the statement that heat is not always "bad." At least one microminiaturization approach, the General Electric TIMM circuits, is based on the novel idea of constructively using the heat energy released by electronic circuit operation, as opposed to the often costly alternative of getting rid of the heat.

TIMM circuits employ a complete range of electronic components capable of operation at temperatures above 600 C. The equipment is then surrounded with a suitable thermal insulation to retain the heat energy and to raise the internal temperature to the point where usable amounts of thermionic emission can be obtained from prepared surfaces inside the circuit modules. Once started, and with suitable insulation, these circuit modules continue operation self-heated by the dissipation of their circuitry.

This method actually benefits from microminiaturization, as it increases power density and allows more efficient maintenance of the internal temperature. The conservation of heat greatly improves system efficiency.

Inseparable Designs

The fourth statement, that in microminiaturization the thermal and electronic designs are inseparable, is actually a summary conclusion from the preceding statements. The essential advantage of microminiaturization is in the size reduction of large electronic *systems*. To achieve the true advantage, the whole system must be considered in the design. As we saw in the first example, this becomes a thermodynamic electronic design problem in which the two factors are mutually utilized

senior applications engineers

experienced in
SEMICONDUCTOR R&D
for staff level assignments

GROUP HEAD

Senior applications engineer with experience in semiconductors, transistors, diodes, rectifiers, circuit applications and sales engineering. Must be oriented for a responsible managerial position. Ph.D. degree preferred.

STAFF ENGINEERS

Applications engineers with at least five years' experience for senior staff level assignment in semiconductor circuit research and development. Our research project is directed toward development of new uses for existing devices, and creation of circuitry using new devices which will become the building blocks of tomorrow's systems.

These positions were created as a result of the sustained growth of advanced research and development activity at the Semiconductor Division of Hughes Aircraft Company. The recently completed facilities of the Semiconductor Division are located in Newport Beach, California—just south of Los Angeles.

If you meet the requirements for the above positions, or if you are a senior engineer or physicist with experience in the field of semiconductors, we invite your confidential inquiry.

Please contact:

Mr. C. L. M. Blocher
Scientific Staff Representative
HUGHES SEMICONDUCTOR DIVISION
500 Superior Avenue
Newport Beach 3, California

Creating a new world with ELECTRONICS
HUGHES
SEMICONDUCTOR DIVISION

to the optimum to achieve a systems result.

The microminiaturization of large systems inevitably differentiates temperature and heat energy. Although circuit dissipation varies widely, a figure of 1 to 5 mw per component is typical for semiconductor circuitry. With a packing factor of 20,000 components per cubic foot—typical of present printed-board circuitry—this represents a power density of only 20 to 100 w per cubic foot. However, at envisioned packing factors of 1,000,000 components per cubic foot, this figure rises to 1,000 to 5,000 w per cubic foot.

This power density is not frightening for small isolated modules of circuitry, where the edges of the module are exposed directly to a tolerable external environment. However, in large systems, where three-dimensional stacking of modules is necessary, the temperature rise is cumulated at each successive layer. Consequently the innermost module will operate at a much higher temperature than the outermost, although the heat energy released in each may be the same. Thus the design becomes both thermodynamic and electronic as microminiaturization graduates to the large system level, and the designer faces the question of dumping or using the heat dissipated in operation.

It is at this point today that engineering managers feel like crying out:

> HELP WANTED: BSE-T, preferably with experience in microminiaturization. SALARY OPEN

Possible basic courses in this field, as they may appear in college catalogues in the near future are:

Elementary Thermodynamics—Concepts of heat, energy cycles, entropy, enthalpy, and elementary gas thermal properties.

Introduction to Heat Flow—Concepts of heat transmission in passive thermal systems by conduction, convection and radiation with emphasis on simple system analyses.

Advanced Heat Transmission—The analysis and design of complex thermal systems (passive) involving gas, liquid and solid transmission media with simultaneous conduction, convection and radiation effects.

Refrigeration Coolants and Fluid Dynamics—A design course in the application of active thermal systems, including peltier junction cooling, refrigerant cycle, fluid boil-off cooling, and coolant circulation (both gas & fluid).

Thermo-Tronic Systems Synthesis—The analysis and design of systems involving the thermal considerations of the above courses combined with electrical and electronic design courses, or thermotronic system design.

Anyone for thermo-tronics? ■ ■

ENGINEERS:

FACTS WITHOUT FRILLS...

About Job Potentials at Light Military Available to You Now!

Prepared for the engineer who likes to get right down to basics in evaluating a position, LMED's Fact Sheets bring you clearly presented up-to-date unvarnished information about all the aspects of company policies, projects and plans related to your professional future here.

WHETHER OR NOT YOU CONTEMPLATE AN IMMEDIATE CHANGE, these "Engineering Fact Sheets" are a valuable thing to have. Use them as a yardstick to assess your present – or a possible future – association.

Next to your choice of profession, and your choice of a wife – selecting a position with long-range career implications can be the most important decision in your life...

It's A Good Thing To Have Reliable Tools On Hand, To Help Make That Choice a Sound One!

PARTIAL CONTENTS

- Organization
- Size of Staff
- Resources
- Facilities List
- Technical Scope (list of projects)
- Internal Communications and Support
- Benefits (detailed)
- Salary Scale
- Specific Responsibilities of D&D Engineer
- Promotion Plan
- Graduate Program
- In-Plant Courses
- Contacts with Other G.E. Components

SEND FOR THESE "ENGINEERING FACT SHEETS"

Mr. R. Bach / Light Military Electronics Department / General Electric Company / French Road, Utica, New York.
Please send me a set of your "ENGINEERING FACT SHEETS."

NAME________________
HOME ADDRESS________________
CITY________ZONE____STATE____
DEGREE(S)________YEAR(S) RECEIVED____
76-MC

LMED
LIGHT MILITARY ELECTRONICS DEPARTMENT
GENERAL ELECTRIC
FRENCH ROAD, UTICA, NEW YORK
CIRCLE 906 ON CAREER INQUIRY FORM

REWARDING!

A feeling of accomplishment, comfortable salary, security, fine home, prestige in the community. Yes, these are the marks of a successful Motorola engineer in Chicagoland. But, what exactly makes a career at Motorola so rewarding—beyond the ordinary realm of material benefits?

Foremost is opportunity. For here a man is encouraged to use all of his creative talents to their fullest. He works on projects that spark vision, that inspire imagination. He works with men who recognize and respect his abilities . . . a calibre of men that he cannot help but admire.

Yes, a career at Motorola is deeply rewarding. You owe it to yourself to discover *exactly* how much. Simply clip the coupon below.

- Radar transmitters and receivers
- Radar circuit design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using kylstrom, traveling wave tube and backward wave oscillator
- Display and storage devices

2-WAY RADIO COMMUNICATIONS

- VHF & UHF receiver
- Transmitter design and development
- Power supply
- Systems engineering
- Antenna design
- Selective signaling

- Transistor applications
- Crystal engineering
- Sales engineering

- Design of VHF & UHF FM communications in portable or subminiature development
- Microwave field engineers
- Transistor switching circuit design
- Logic circuit design
- T.V. circuit design engineering
- Home radio design
- New product design
- Auto radio design
- Mechanical engineering
- Semi-conductor device development
- Semi-conductor application work

Also Splendid Opportunities in:

Phoenix, Arizona and Riverside, California

Send Complete Resumé to:

MR. L. B. WRENN
Engineering Personnel Mgr.
Dept. B
4501 Augusta Blvd.
Chicago 51, Illinois

EQUAL JOB For All Qualified Applicants OPPORTUNITY

MOTOROLA Inc.

CIRCLE 907 ON CAREER INQUIRY FORM

CAREER OPPORTUNITIES BROCHURES

Sperry Gyroscope Co.

Prepared especially for engineers, Sperry's career brochure is a well-balanced profile of the company's many activities. Illustrations and text cover the types of work done by the various departments under the headings of Research, Development and Production.

Emphasis is placed on the individual's role in the company, and several paragraphs explain what the firm expects from its engineers and scientists. Advantages to the employe are also well covered.

J. W. Dwyer, Employment Manager, Sperry Gyroscope Co., Great Neck, N.Y.

CIRCLE 870 ON READER-SERVICE CARD

Consolidated Controls Corp.

A new booklet describing company facilities and capabilities has just been issued.

The booklet outlines management and engineering policies and production and quality-control techniques used at the firm's Bethel, Conn., and Inglewood, Calif., plants. The company develops and manufactures components and systems for measurement and control of the pressure, temperature, speed, flow, position and level of liquids under conditions encountered in supersonic flight and power reactors.

Charles M. Colt, Consolidated Controls Corp., Dept. ED, Bethel, Conn.

CIRCLE 871 ON READER-SERVICE CARD

LEEDS & NORTHRUP CO.

. . . wants to talk with you about the following technical openings.

APPLICATION ENGINEER

A degree in engineering and 2 to 5 years' experience in measurement and control of steel, glass, cement, chemical or petroleum processes is required.

SALES ENGINEERS

An EE degree with 1 to 3 years' industrial selling experience of instrumentation or electrical equipment is required.

PRODUCT ENGINEERS

A degree in electrical engineering with 2 to 8 years' experience in instrumentation engineering of industrial processes or data handling equipment is required.

TECHNICAL WRITER

Electrical engineering graduate with recent experience in writing of technical instruction manuals.

ASSOCIATE SCIENTIST

MS or PhD in chemistry or chem engr or BS and equivalent training and experience in instrumental methods of analysis and physical chemistry. Good background in fundamentals and mathematics necessary.

ASSOCIATE SCIENTIST

BS in nuclear engineering, physics or electrical engineering. 3 to 5 years' experience in nuclear instrumentation desired. Experience in solid state electronics required.

ASSOCIATE SCIENTIST

MS degree with both chemical engineering and automatic control training. Experience in chemical or petroleum processes with automatic control system design. Computer experience also desirable.

PRODUCT ENGINEER

BS in EE with experience on electromechanical devices and electronic instruments. Facility with feedback amplifiers desirable.

ASSOCIATE SCIENTIST

BS or MS in EE, knowledge of semiconductor and vacuum tube circuitry as applied to instrumentation required. Knowledge of magnetic amplifier circuitry desirable.

MARKET DEVELOPMENT

Field Engineer BS in engineering preferably metallurgical. 3 to 6 years' sales experience in metal working industries. Experience with heat-treating furnaces desirable.

DESIGN ENGINEER

A degree in mechanical engineering with 3 to 4 years' experience in design and application of small mechanisms plus knowledge of manufacturing processes is required.

SEND COMPLETE RESUME TO:

WAYNE L. BESSELMAN

Coordinator of Technical Employment

LEEDS & NORTHRUP CO.
4850 Stenton Ave.
Phila. 44, Pa.

CIRCLE 908 ON CAREER NQUIRY FORM

professional opportunities at Honeywell Aero

FLIGHT CONTROL SYSTEMS: Analytical, systems, and component engineers to work in areas such as advanced flight reference and guidance systems. Positions range from analyzing stability and control problems, systems engineering through design, testing and proof of electrical and mechanical equipment—including flight test and production test.

GROUND SUPPORT: Electrical Engineers to design equipment for testing complex electronic systems, preferably with experience in digital techniques, solid state circuitry, and logic circuit design as applied to automatic checkout systems.

EVALUATION: Graduate engineers with electronic background desiring opportunity in development, qualification and reliability testing. Must have ability to design and develop specialized equipment which can duplicate environmental conditions encountered by advanced projects. Assignment in this work leads directly to a career in design, research or advanced system development.

ADVANCED GYRO DESIGN: Engineers with two and up to twenty years' experience in precision gyro and accelerometer development, servo techniques, digital techniques, solid state electronic development, advanced instrumentation and magnetic component design.

PRODUCTION: Electrical engineers to assume responsibility for placing complex devices such as platforms, floated gyros, accelerometers, vertical and rate gyros, calibrators and computers into production. Work with design engineers to introduce production know-how and techniques into original design. Responsible for estimating, processing, and tooling during the pre-production phase; directing assembly, calibration, and inspection efforts during initial production phases.

INSTRUMENTATION: Development and design in the critical areas of test instrumentation for Aero products. Two years' experience in test instrumentation desired.

To investigate any of the above professional opportunities at the Aeronautical Division, please write in confidence to Bruce Wood, Dept. **471.**

Honeywell H HONEYWELL

AERONAUTICAL DIVISION

1433 Stinson Blvd. N.E., Minneapolis 13, Minnesota

To explore professional opportunities in other Honeywell operations coast to coast, send your application in confidence to H. K. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

CIRCLE 909 ON CAREER INQUIRY FORM

THE SYSTEM ENGINEER

The major function of the System Engineer is to assist his client in making sound system decisions and to develop plans and specifications which he can verify and support. He is a source of ideas about the kinds of systems which are appropriate and feasible. He understands the problems of designing and building the system components. He is qualified to examine new concepts and alternate designs and can relate the utility of proposals to cost and time. He can evaluate designs proposed by other agencies and contractors. He helps his client decide what to build and how best to build it. He translates these decisions into plans which can be carried out by other contracting agencies. He devises system tests and evaluates the operational capability of the subsystems and the integrated system.

MITRE, formed under the sponsorship of Massachusetts Institute of Technology, is an engineering and development organization with major system responsibilities in air defense and air traffic control.

Engineers and scientists with a good theoretical background and an interest or experience in system work will find challenging opportunities in the following areas:

- COMMUNICATIONS
- RADARS
- COUNTERMEASURES
- DIGITAL COMPUTERS
- HUMAN ENGINEERING
- AIR TRAFFIC CONTROL

Positions on MITRE's Technical Staff are available in suburban Boston, Massachusetts, Montgomery, Alabama, and Fort Walton Beach, Florida.

NEW YORK INTERVIEWS DURING IRE CONVENTION MARCH 21-22-23-24

Senior members of the Technical Staff will be available for interviews at the MITRE suite in the Waldorf Astoria Hotel.

If you prefer to arrange an appointment in advance you are invited to CALL COLLECT
Frank Balanis, Lexington, Massachusetts • VOlunteer 2-8950

To arrange an immediate confidential interview, please send resume to Dana N. Burdette, Personnel Director, Dept. **15-AX**

THE
MITRE
CORPORATION

244 Wood Street — Lexington 73, Massachusetts

A brochure more fully describing MITRE and its activities is available on request.

CIRCLE 910 ON CAREER INQUIRY FORM

AEROJET-GENERAL

offers an
outstanding opportunity
for

DEPARTMENT HEAD-INSTRUMENTATION SOLID ROCKET MOTOR TESTING

One of the free world's largest rocket motor manufacturers is seeking an individual to manage its solid rocket motor test Instrumentation Department. The person filling this position will have a comprehensive electronic engineering background (M.S. or Ph.D. degree in E.E. or physics preferred) with 6 to 10 years of directly related experience in applied instrumentation.

This individual will be responsible for the technical and administrative direction of several hundred engineers and technicians engaged in the design, development, operation, and maintenance of multi-channel analog and digital data acquisition and processing systems, capable of measuring solid rocket motor performance parameters to one-quarter of one percent of the data point. In addition, he will be required to represent the Department at technical meetings with customers, associate contractors, suppliers, management, and project engineering personnel.

This is a middle-management position reporting directly to the Assistant Manager of Testing, Sacramento Plants. The salary, relocation allowances, and other benefits are commensurate with the position.

please submit a detailed resume outlining education, experience, and professional activities to:

E. P. James, Supervisor
Engineering Placement
AEROJET-GENERAL CORPORATION
Post Office Box 1947S
Sacramento, California

CIRCLE 911 ON CAREER INQUIRY FORM

YOUR CAREER

ENGINEER–IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographical areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures—regional symposia or lecture series which generally run one night a week for several weeks.

Regional Lectures

Managing the Development Engineering Function, AMA, Chicago, New York, San Francisco

In this seminar, the development engineering functions will be analyzed and their relationship to search and development will be discussed. The seminar is of interest to all personnel of both corporate departments and divisions. Discussion will cover these major subjects: steps from idea to product; the engineering role; basic training requirements; operations research and engineering; and organization for performance. The seminar will be held in: Chicago Mar. 21-23; New York Apr. 20-22; and San Francisco Apr. 25-27. For further information on this seminar and the following write to: American Management Association, Inc., 1515 Broadway, New York 36, N.Y.

Creating and Evaluating Research Projects, AMA San Francisco, Chicago

Research directors, executives directly associated with research projects, and supervisory personnel responsible for the execution of projects in the research laboratory will find this seminar of interest. The program will be devoted to consideration of the fundamentals involved in creating a well organized research project. The seminar will be held in: San Francisco Apr. 25-27; and Chicago May 16-18.

PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

Authors are invited to submit either 100-150 word abstracts, a 400-500 word summary or a completed paper for the **National Electronics Conference** scheduled for Oct. 10-12 to be held at the Sherman Hotel, Chicago, Ill. *Send to: Prof. Thomas F. Jones, Jr., Program Chairman, NEC, School of Electrical Engineering, Purdue University, Lafayette, Ind.*

ELECTRONICS JOBS
$6,000 to $75,000
Go Begging

It's true! Cadillac, the nation's largest Executive and Professional placement service, has many more electronic positions available than we can fill.

We represent every "Blue Book" Electronics firm in America, over 350 in all. Because of this, Cadillac is able to offer Electronics Engineers a choice of positions unequalled by any other firm.

FREE MONTHLY BULLETIN

Because you are an Electronics Engineer, our monthly Electronics Opportunities Bulletin and our Completely Confidential Placement Service are available to you FREE OF CHARGE.

"For your free Bulletin, each month listing America's BEST Electronics jobs, send your name and home address to:"

Eugene B. Shea
Executive Vice President
Cadillac Associates, Inc.
29 E. Madison Bldg., Dept. E2
Chicago 2, Ill.

CIRCLE 912 ON CAREER INQUIRY FORM

Mr. Engineer . . .

Retain your Identity at

BECKMAN'S SYSTEMS DIVISION

In Orange County, California

Here's your chance to be a big fish in a small pond . . . not that our Systems Division is too small . . . it's just that we're not so large and over organized that the individual and his efforts are submerged in a mass of humanity and a welter of paper work.

Our business is the design, development, and manufacture of proprietary electronic data processing and data acquisition system . . . research and development study projects pertaining to satellite programs . . . varied engineering design projects and other activities with both military and commercial significance.

There's ample elbow room for the non-organization man in any one of the following professional areas:

Logic Design • Systems Design • Analog Design • Systems Engineering • Digital Design • Project Management • Project Engineering • Electronic Design • Systems Evaluation and Modularization • Field Engineering • Applications Engineering

If you'd like to receive more information about us, we suggest you write to our Mr. J. W. Carlton enclosing a brief description of your background.

BECKMAN INSTRUMENTS, INC.
Systems Division
325 North Muller, Anaheim 6, California
25 miles south of Los Angeles, near the Pacific Coast

BECKMAN INSTRUMENTS, INC.
Electronic Components, Instruments, Systems . . . for Analysis, Measurement, Counting and Control.
Executive Offices: Fullerton, Calif.
Divisions: Berkeley • Helipot • International • Scientific & Process Instruments • Spinco • Systems.
Subsidiaries: Shockley Transistor Corp. • Beckman G.m.b.H., Germany • Beckman Instruments, Ltd., Scotland.

Beckman ®
© 1960 B.I.I.

CIRCLE 913 ON CAREER INQUIRY FORM

CIRCLE 914 ON CAREER INQUIRY FORM ›

PAGES
MISSING
ARE NOT
AVAILABLE